PORT HOUSTON
Electrical Distribution and Communications Facility Inspection and Condition Assessment Manual

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REVISION HISTORY

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CHAPTER 1: INTRODUCTION

1.1. General

Port Houston is a 25-mile-long complex of 150+ private and public industrial terminals along the broader 52-mile-long Houston Ship Channel. Eight (8) of the public terminals within Port Houston are owned, managed, and/or leased by the Port of Houston Authority (PHA) and include a wide variety of electrical distribution and communications assets.

This Electrical Distribution and Communications Facility Inspection and Condition Assessment Program (FICAP) manual defines the requirements, documentation, and reporting for the inspection and condition assessments of electrical distribution and communication assets at facilities owned or operated by the PHA. The asset classes in this manual are grouped on the system voltage level and functionality. The assets have ages that range from a few years old to approaching 100 years old. They have been constructed with a wide range of materials with components that have different lifecycles. The inspection and condition assessment of assets is an essential part of the Asset Management Program for the PHA to assist in assessing where assets are in their lifecycle and to optimize their capital and operations & maintenance (O&M) budget, as it provides the information necessary to:

- Define the condition of an asset at a point in time, which may be used for various purposes including to define the asset replacement value, monitor ongoing deterioration or damage over time (when inspections are conducted at regular intervals), and to define baseline conditions for legal purposes such as change of ownership
- Identify asset conditions that may compromise facility operations leading to a loss of supply or other reliability issues
- Understand component condition distributions within each asset class category
- Identify asset conditions that may lead to property damage, personnel injury, or environmental damage
- Evaluate the functional adequacy of the asset in terms of specific operations
- Assess conditions that require extensive maintenance, minor and/or major repair, or replacement to maintain or extend the useful service life of the asset
- Optimize the "Repair versus Upgrade versus Replace" decisions
- Allocate adequate capital and O&M funds while prioritizing such projects

OBJECTIVE

The objective of the electrical distribution and communications FICAP is to provide a uniform guideline for inspection teams to carry out baseline inspections, routine inspections, and condition assessments of the electrical distribution and communications assets owned by the PHA. One of the key objectives of this program is to provide inspection and assessment information appropriate for use by the PHA Asset Management, Project and Construction Management, and Maintenance Departments. The same material can also be used by any other stakeholders required to determine the need and timing of preventative or remedial actions to maintain the desired level of service and compliance. In addition, it is also used to provide information to GIS to enable the displaying of information through the PHA's system, "Portview".

Numerous challenges exist in making effective and consistent inspections and assessments, including the wide variety of facility types, incongruent electrical and communication component classes/subclasses, and different exposure conditions faced by overhead vs underground equipment. Personnel challenges include various levels of training, experience, and practices of engineers and inspectors conducting the inspections and assessments. Without a standardized approach to meet the PHA's specific asset management needs, these challenges result in disparate inspection findings and condition documentation across the entire electrical distribution and communications asset inventory.

The goal of this manual is to define the process, procedures, and requirements for completing inspections and condition assessments for electrical distribution and communications assets in a consistent manner. This manual has been structured to align with the general layout, flow, and structure of the Maritimes Facilities Inspection and Condition Assessment manual (structural assets), which was provided to the author as a guiding reference. The manual is intended to be used by qualified professional engineers, technologist, technicians, and inspectors, all of which may be either PHA staff or subcontracted external technical consultants.

1.2. Manual Scope

The scope of this manual includes the engineering requirements for conducting inspections and the associated condition assessments of the components of the PHA's electrical distribution and communication system, including associated civil assets. The manual does not address specific safety requirements for the inspection team, nor does it address procedures, guidelines and safety issues related to the inspections.

The scope of the manual is limited to the following five (5) asset classes. Assets are summarized on Single Line Diagrams (SLDs) showing their electrical connectivity in power grid (a sample[1] is provided in Appendix G).

1. HV assets
2. MV assets
3. LV assets
4. Communication assets
5. Civil assets

The HV asset class include point components such as power transformers and HV circuit breakers. The MV and LV asset classes include both point components (e.g., pad-mounted transformers, pad-mounted switchgears, etc.) and linear components (e.g., overhead conductors, power cables, etc.). Communications assets are composed of predominantly fiber enclosures, fiber optic cables, and communication termination points (e.g., antennas, boxes, communication hubs). There are also legacy communication channels being removed over time (e.g., copper wire pair, point to point antennas, etc.). Civil assets include manholes, handholes, duct banks, and fencing.

[1] It is recognized that SLDs are periodically updated and will change over time as facility evolves. Consequently, a sample SLD is provided without the expectation of keeping the most up to date SLDs attached to this manual. The most up to date SLDs are available from the PHA at request. The reader is encouraged to go to the Project and Construction Management (PCM) site for the latest version of the SLDs. The reader can also send requests or questions to the Project Controls Manager for the applicable property / site in question.

This manual addresses the following component types within the parent asset class:

- HV asset class:
  - Power transformers (PTX)
  - HV circuit breakers (HVCB)
- MV asset class:
  - Pad-mounted transformers (PMTX)
  - Pad-mounted switchgear (PMSG)
  - MV power cables (UGC)
  - Metal-clad switchgears (MCSG)
  - Overhead lines and components (OHL)
- LV asset class:
  - LV panelboards (PSWB)
  - LV power cables (LVPC)
  - Metering (LVMT)
- Communication asset class:
  - Fiber enclosures (CFE)
  - Fiber optic cables (CFO)
  - Communication termination points (TER)
  - Legacy communication components (LCC)
- Civil asset class:
  - Manholes (CMH)
  - Handholes (CHH)
  - Duct banks (CDB)
  - Fencing (CFG)

The manual is not intended for use in the inspection and condition assessment of:

- Components that are not listed under the defined asset classes.
- Low voltage components that are connected downstream of the distribution panel (beyond the first entry point in a building).
- MV overhead lines and components that are owned by the local utility, although they may be listed in the manual for completeness and to document their existence on PHA property
- Buildings, sheds, or other similar constructions.

1.3. Inspection and Condition Assessment Approach

The terms "inspection" and "condition assessment" refer to different but related activities.

An **inspection** is an evaluation procedure in which a qualified team leader carries out or supervises the observation, classification, and documentation of the physical or functional condition of an electrical distribution or communications asset. It may involve visual and mechanical inspection, infrared (IR) scanning, electrical and nondestructive testing methods, and material sampling and advanced testing (e.g., transformer oil sampling / testing) to determine the type(s) and severity of deterioration or distress of the component.

A **condition assessment** is an evaluation of the inspection results considering the significance of observed conditions. A condition assessment is based on engineering judgment considering qualitative and quantitative inspection findings and may be supplemented by engineering calculations. The outcome of a condition assessment is to determine the need and priority of maintenance, repair, or refurbishment actions for an asset. While this manual discusses various inspection types and procedures, unless otherwise noted, inspections conducted for the PHA are expected to include condition assessments in the form of both applicable component and overall asset ratings (discussed in the following sections).

The inspection and condition assessment processes in this manual use an element-based approach. This approach is aligned with that used in the Maritime Facilities Inspection and Condition Assessment Manual (structural assets). The general concepts and terms of this element-based approach are explained in the following sections of this chapter. Detailed procedures and guides for implementation are provided in subsequent chapters.

1.3.1. Hierarchy of Terminal and Asset Terminology

The premise of an element-based inspection and condition assessment approach requires the definition of a clear hierarchy extending from the macro level of PHA's location down to the element level. This manual uses the hierarchy shown in Figure 1.1 and the terms in this hierarchy are defined below.

Location	***Asset Class***	***Component***	***Element***
(e.g., Barbours Cut Terminal)	(e.g., Medium Voltage)	(e.g., Pad-mounted transformer, etc.)	(e.g., Tank, bushing, oil, winding, tap-changer, etc.)

Figure 1.1: Hierarchy of Facility Terms

An example for a hypothetical terminal using this hierarchy is shown in Figures 1.2 through 1.5. Element and component types are discussed in Chapters 3 and 4, respectively. In addition to the terms defined in these chapters, an extensive Glossary of Terms is provided in Appendix B.

Location This is the highest level in the hierarchy from an inspection and condition assessment perspective, although higher levels may be considered for asset management or other purposes. The location is typically comprised of a group of assets and is defined by distinct boundaries. It is a tract of land that is integral and not disjointed; for example, BayPort and Barbours Cut terminal.

Asset Class Each property normally has several electrical distribution and communication assets and associated civil assets, each of which may be classified into a unique asset class. In this manual, the assets are classified into the following five (5) classes: HV assets, MV assets, LV assets, communications assets, and civil assets. The boundaries of each asset are determined by level of distribution system and function within each PHA facility.

Component Each electrical distribution, communications and associated civil asset is typically comprised of several components. A component is a group of electrical, communications or civil elements that make up some part of the overall electrical distribution or communications asset. For example, typical electrical component types within the MV asset class include pad-mounted transformers, pad-mounted switchgears, MV power cables, metal-clad switchgears, overhead lines, and components, etc.

Element Each component is comprised of one or more element(s). Element types are defined by the component to which it belongs and its functional purpose. For example, typical elements of pad-mounted transformer include a nameplate, tank, bushing, oil, winding, tap changer, etc.

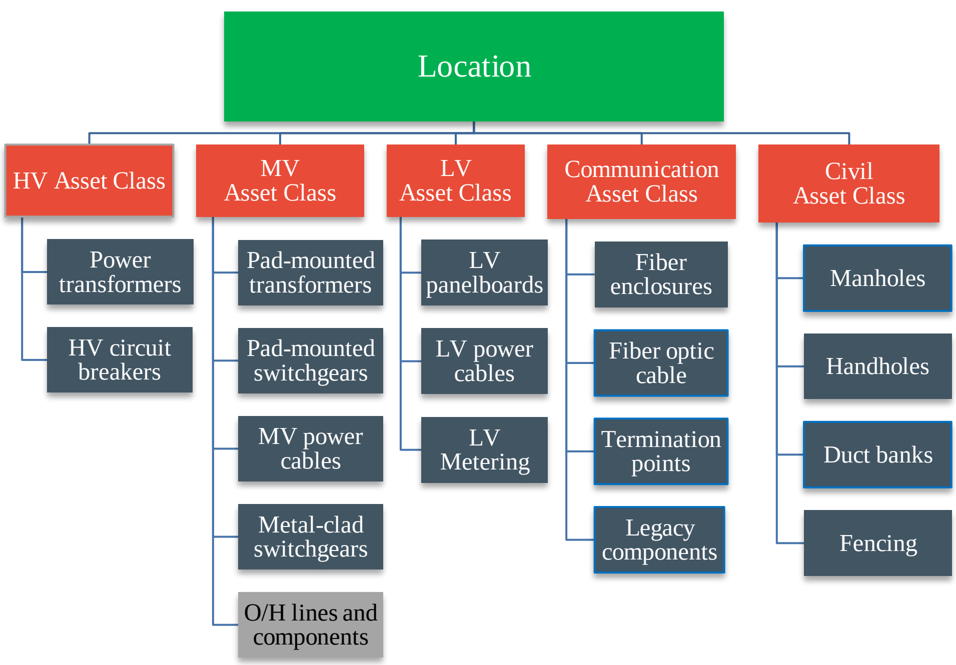

Figure 1.2: Example hierarchy applied to a hypothetical location, showing components. Items shown in grey are considered outside the scope and may be added in a future version.

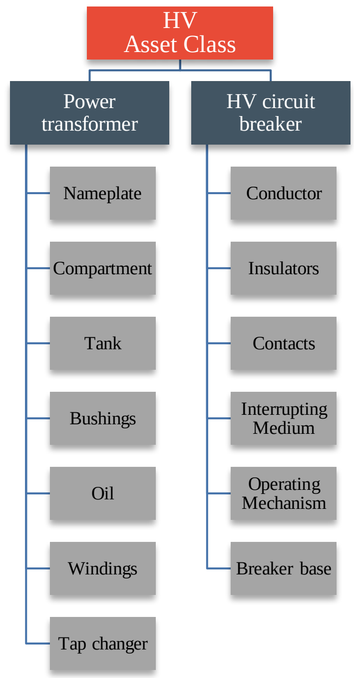

Figure 1.3: Example hierarchy showing elements in the HV asset class

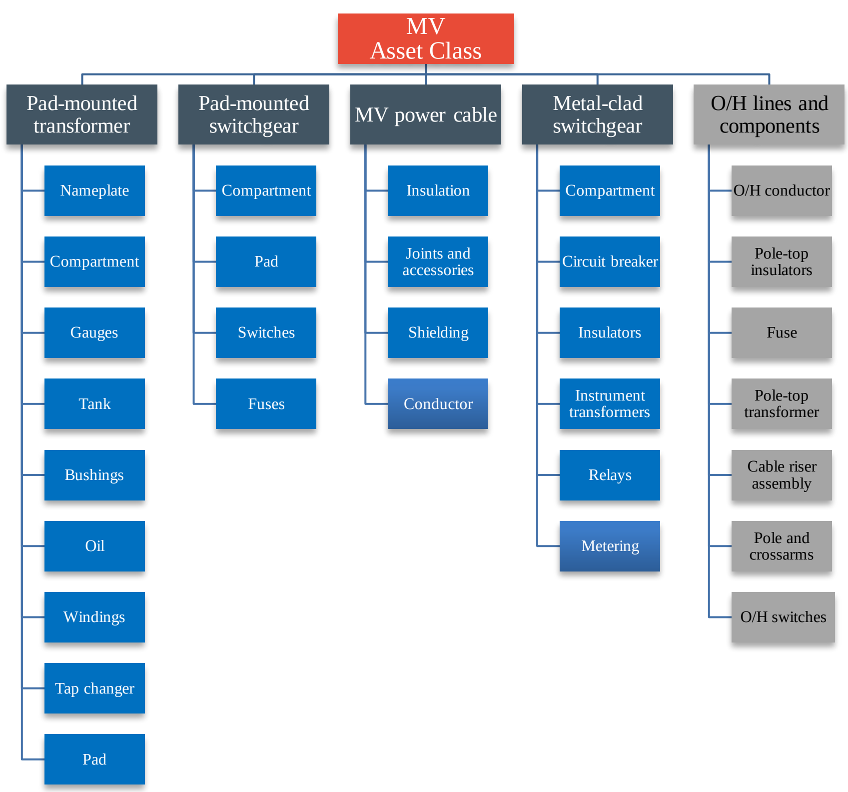

Figure 1.4: Example hierarchy showing elements in the MV asset class

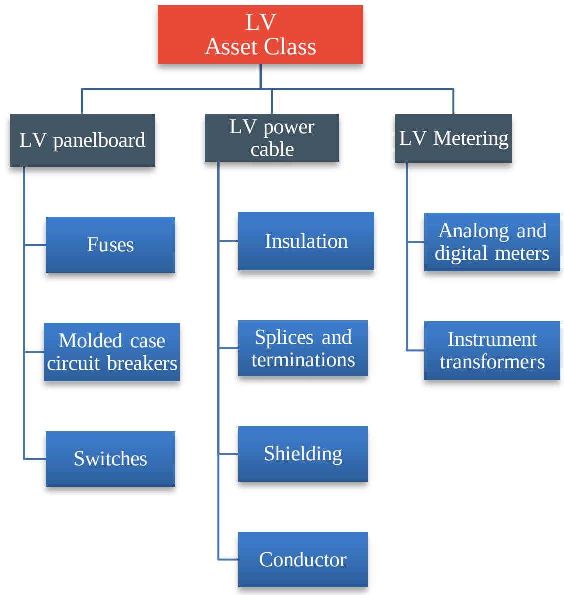

Figure 1.5: Example hierarchy showing elements in the LV asset class

1.3.2. Element-Based Inspection and Condition Assessment Approach

The inspection and condition assessment of an asset is a key element of the PHA's asset management programs and practices. The credibility of the inspection and condition assessment relies upon two (2) equally important factors:

1. The experience and knowledge of the technologist/engineer(s) responsible for the assessment, and
2. The completeness and quality of the observed condition of the asset determined during the inspection. The inspection findings should be observed and documented in a manner that provides the condition information necessary to facilitate a credible condition assessment. Specifically, the inspection findings should be characterized and reported in terms of:
    - Types of elements that may have experienced damage, deterioration, or defects (observed conditions). This is needed to assess the overall functional implications of observed conditions. It is generally more effective to characterize conditions according to element type as well
    - Type of observed condition (e.g., general degradation, corrosion, damaged insulation, oil degradation, high contact resistance, poor grounding connection, rusting, spalling of concrete, signs of arcing or short-circuit damage, rot or decay of wood pole, loose connection, etc.)
    - Severity of observed condition (e.g., type and size of defects, deviation of test values from accepted values as provided by manufacturer or industry standards, or factory/commissioning test reports, electrical or physical integrity, etc.)
    - Scope or extent of observed condition (e.g., minor, or major defect, length affected for linear components only such as overhead conductors, power cables, etc.)

To provide the type and detail of condition information described above, an element-based inspection is necessary. The element-based inspection approach documents the condition of each inspected element (e.g., relay, circuit breaker, duct bank, etc.) of the asset. Element condition states are used to provide a clearly defined indication of the type, severity, and extent of the observed conditions (i.e., damage, deterioration, or defects) for a given element. An individual element may exhibit more than one type of condition and may also exhibit different levels of observed conditions on the same element. Accordingly, the element-based inspection requires quantification of each condition type, severity, and extent for a given element.

For linear elements such as cable conductor and insulation, conditions are typically quantified by linear dimension (per foot) of the element's overall length. For point elements such as breakers, bushings, windings etc. conditions are typically quantified per unit. In all cases, the element condition states are assigned relative to the as-built or original condition of the element or to the acceptable test values per the relevant industry standards or manufacturer's guidelines. The definition and use of condition states at the element level improves the objectivity and repeatability of the inspection and condition assessment.

The detailed condition information collected through an element-based inspection includes visual inspection, and, where applicable, infrared scan (IR), mechanical, and electrical testing that provides the basis for the condition assessment. The inspection and condition assessment approach defined in this manual includes a condition assessment at both the component and asset class levels and is described by component ratings and asset condition ratings, respectively. Component ratings indicate the overall condition of a component and are determined based on engineering interpretation of the inspection findings for the elements that make up the component. The purpose of the component rating is to provide a condition assessment for each component in an asset class for use in assessing the overall condition of the asset class and to guide follow-up actions (e.g., detailed inspection, major repairs, upgrade, refurbishment, and replacement) and prioritize maintenance or repairs.

The asset condition rating is a condition assessment for the entire asset class (group of components) based on the component ratings and includes a qualitative description of the asset condition. The outcome of the inspection and condition assessment process for an electrical distribution and communications asset is represented by the combination of the overall asset rating along with a qualitative description, the component ratings, and the follow-up actions. The element-based inspection and condition assessment approach and its influence on component and overall asset ratings are summarized in Table 1.1. The condition assessment approach using component and overall asset class ratings is described in Chapter 6 of this manual.

Table 1.1: Summary of Element-Based Approach

Level	Purpose	Comment
Asset Class	▪ Asset class condition given by asset condition rating (ACR) guides follow-up actions and asset management decisions.	▪ Asset condition rating (ACR) is described as a numerical rating (0-100) and is supplemented by a qualitative (descriptive) assessment.
Component	▪ Component condition assessment indicates condition of components. ▪ Provide basis to determine asset condition rating.	▪ Component rating (CR) is described as a numerical rating (1-6). It is based on an engineering interpretation of the observed condition states and their corresponding implication(s) on physical and/or functional condition of the component.

Element	▪ Element condition states document the asset damage, deterioration, or defects at time of inspection in terms of:
	    ▪ Type of condition(s) (i.e., damage mechanism)
	    ▪ Severity of defect (i.e., moderate, severe)
	    ▪ Extent of defect (i.e., localized, or general)
	▪ Correlates conditions to element type.
	▪ Tracks conditions over time as indicated by inspections conducted at regular intervals.
	▪ Provides basis for component rating.
		▪ Detailed visual inspection and mechanical and electrical tests are conducted at the element level.
		▪ Element condition states are assigned based on predefined categories and quantified to define element condition.

1.4. FICAP Overview

Three (3) types of inspections and condition assessments are defined in the PHA FICAP:

Baseline: Inspection to establish asset inventory information and provide a baseline condition assessment for new assets and for existing assets where no previous inspection exists.

Routine: Regularly scheduled inspections to define asset class condition at a point in time.

Special: Inspection in response to specific situations, including:

a) Post-Event Inspection: To assess condition after an extreme event (e.g., short circuit fault, extreme weather-related outages such as hurricanes, floods, fires, etc.)

b) Due Diligence Inspection: To assess condition at times of change of ownership, lease, insurance, etc.

c) In-Depth Inspection: To determine the cause and significance of damage or deterioration and to provide further insight on component condition necessary to evaluate the need for more extensive maintenance, refurbishment, upgrades, and replacement

The primary aspects of the FICAP are the Baseline and Routine Inspections. Implementation of the program involves conducting a Baseline Inspection of each electrical distribution or communications asset in the PHA inventory followed by regularly scheduled Routine Inspections at prescribed intervals to track changes in the asset's condition over time. If the conditions observed during a Baseline or Routine Inspection require further or indicate that major repairs or refurbishment may be required, an In-Depth Inspection (with a specific scope defined by the PHA based on inspection results and the PHA's operational priorities) may be conducted. Post-Event and Due Diligence Inspections are conducted as and when needed. Each inspection type is described in detail in Chapter 2 of this manual.

1.5. Limitations of FICAP Manual

The inspection and condition assessment methodologies presented in the FICAP manual are subject to the following limitations:

- The inspection and condition assessment methodology outlined in this manual is broadly categorized into visual and mechanical inspection and electrical tests. The methodology does not consider other in-depth inspection methods including advance testing.
- This manual is limited to procedures outlining Baseline and Routine inspection types (*see* Chapter 2 for Inspection types). This manual does not define procedures or requirements for other inspection types (Post-Event, Due Diligence, or In-Depth Inspections) and Engineering Analysis.
- It is recommended that the condition assessment and inspection methodologies be reviewed periodically to take into account changes and advances in technology or best practices in the industry.

1.6. Manual Organization

The manual is organized in ten (10) chapters:

- **Chapter 1: Introduction** describes the scope and purpose of the manual and inspection program.
- **Chapter 2: Inspection Types** describes the inspection types in terms of objectives and scope of work.
- **Chapter 3: Elements and Element Conditions** presents the element types encountered in the PHA electrical distribution and communications facilities and discusses the element condition state descriptions used in this manual.
- **Chapter 4: Component Types** describes the component types encountered in the PHA electrical distribution and communications assets. The component types are presented in five (5) groups

based on their asset class and considers the condition rating criteria used to assess the component condition.

- **Chapter 5: Electrical Distribution and Communications Asset Types** describes the electrical distribution, communications and associated civil asset classes in the PHA inventory.
- **Chapter 6: Assessment and Rating Approach** presents the assessment and rating approach used for electrical distribution, communications and associated civil assets.
- **Chapter 7: Recommended Follow-Up Action Guidelines** provides guidance on the recommended actions that may arise following an inspection and condition assessment.
- **Chapter 8: Documentation and Reporting** describes the documentation and reporting requirements for inspections.
- **Chapter 9: Administrative Requirements** discusses administrative requirements associated with inspections, including inspection team qualifications and as safety, security, and insurance requirements. Limitations and responsibilities are also discussed.
- **Chapter 10: References** lists the references cited in this report, as well as other references suggested to provide relevant background information on inspection and condition assessment of electrical distribution and communications assets.

1.7. Abbreviations

The following abbreviations are referred to throughout the FICAP manual. Definitions are provided in the Glossary of Terms in Appendix B.

Table 1.2: Abbreviations

Abbreviation	Meaning
ACR	Asset Condition Rating
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CAD	Computer Aided Design
CB	Circuit Breaker
CCR	Civil Component Combined Rating
CDB	Duct Bank
CFE	Fiber Enclosure
CFG	Fencing
CFO	Fiber Optic Cable
CHH	Handhole
CMH	Manhole
CR	Component Rating
CS	Condition State
EA	Each
EMT	Electrical Metallic Tubing
EPR	Ethylene-Propylene Rubber Cable
CFG	Fencing
FICAP	Facilities Inspection and Condition Assessment Program
FR	Functional Component Combined Rating
GIS	Geographic Information System
Hi-Pot	High Potential (test)
HV	High Voltage
HVCB	HV Circuit Breaker

Abbreviation	Meaning
IEEE	Institute of Electrical and Electronics Engineers
IR	Infrared
KPI	Key Performance Indicator
LCC	Legacy Communications Component
LF	Linear Foot
LV	Low Voltage
LVMT	LV Metering
LVPC	LV Power Cable
MCSG	Metal-clad Switchgear
MTS	Maintenance Testing Standard
MV	Medium Voltage
NDT	Non-Destructive Testing
NETA	InterNational Electrical Testing Association
OHL	Overhead lines and components
O&M	Operations and Maintenance
PILC	Paper Insulated Lead Covered Cable
PF	Power Factor
PHA	Port of Houston Authority
PLC	Programmable Logic Controller
PMTX	Pad-mounted Transformer
PMSG	Pad-mounted Switchgear
PPE	Personal Protective Equipment
PSWB	LV panelboards
PTX	Power Transformer
PVD	Plan View Drawings
SCADA	Supervisory Control and Data Acquisition
SF	Square Foot
SF_6	Sulfur hexafluoride (a gaseous dielectric for electrical insulations)

Abbreviation	Meaning
SLD	Single Line Diagram
TER	Communications Termination Points
TTR	Transformer Turns Ratio
TRXLPE	Tree-resistant Cross-Linked Polyethylene (Cable)
UGC	Underground cables (MV)
VLF	Very Low Frequency
XLPE	Cross linked Polyethylene (Cable)

CHAPTER 2: INSPECTION TYPES

2.1. Type of Inspection and Level of Effort

Given the overall objectives of the inspection and condition assessment program described in Chapter 1, the specific objectives, scope, and level of effort involved in a given inspection or condition assessment may vary depending on the circumstances of an electrical distribution or communications asset. While this chapter discusses various inspection types, within the scope of the PHA FICAP and unless otherwise noted, inspections conducted for the PHA are expected to include condition assessments of applicable component and overall asset condition ratings.

2.1.1. Types of Inspection

This manual defines three (3) general types of inspections and several sub-types to address the range of objectives that may be desired. The inspection types and their associated objectives are summarized in Table 2.1.

Table 2.1: Summary of Inspection Types and Objectives

No.	Inspection Type	Sub-type	Primary Objective
1	Baseline	Visual Inspection	Inspection to establish the baseline (initial) component inventory information and component and overall asset ratings for a new asset or for an existing asset class where no previous record exists.
		Mechanical Test	
		Electrical Test	
2	Routine	Visual Inspection	Regularly scheduled inspection to define overall asset condition, component and overall asset ratings, and element condition states at a point in time and to allow tracking of conditions over time.
		Mechanical Test	
		Electrical Test	
3	Special	Post-Event	Rapid response inspection to assess overall condition following an extreme event such as cascading failures, extreme weather-related outage, lightning strike, fire, etc.
		In-Depth	In-Depth Inspection (i.e., advance testing or non-routine component specific diagnostic, etc.) to determine cause and/or significance of damage or distress of the component, to aid in determining the need for and timing of more extensive component maintenance, repair, refurbishment and/or replacement.
		Due Diligence	Inspection to establish the general condition, asset value, or need for and approximate cost of repairs, at times of change of ownership, lease, or for insurance purposes.

Since by design each inspection type will typically collect or evaluate different information, the definition of each type also includes a description of the levels of effort involved during the actual inspection. For this manual, the following levels of effort are defined, based on NETA MTS 2011[2], but these definitions can be broadly applied to communication and associated civil asset class also:

- *Visual Inspection.* A visual inspection is a qualitative observation of physical characteristics, including cleanliness, physical integrity, evidence of overheating, lubrication, etc.
- *Mechanical Test.* Mechanical tests involves the observation of the mechanical operation of equipment not requiring electrical stimulation such as manual operation of circuit breaker trip and close functions. It may also include tightening of hardware, cleaning, and lubricating.
- *Electrical Test.* Electrical tests involve the application of electrical signals and observation of the response. For example, applying a potential across an insulation system and measuring the resultant leakage current magnitude or power factor/dissipation factor. It may also involve application of voltage and/or current to metering and relaying equipment to check for correct response.

Inspection types, recommended frequencies, levels of effort, and scope of inspection are summarized in Table 2.2

As each inspection is conducted, the inspection and condition assessment report and associated reporting documents are then added to the asset file. The inspections, and mechanical and electrical tests, are typically performed by technicians, which could be PHA staff or external subcontracted technical consultants. Recommended follow-up actions and associated priority of such actions are reported for facilities management consideration as discussed further in Chapter 7.

2.1.2. Considerations for Level of Effort

Readily accessible elements are those with the following characteristics:

- Disassembly of the component is not required (opening doors and access panels using approved procedures is acceptable)
- Exposed to open atmosphere or with enclosures that facilitate easy access
- Do not require removal of overburden or other elements (i.e., excavation)
- Are not located within confined spaces

If confined spaces are identified, the types of elements in the confined space should be identified. If one or more elements can only be inspected from the confined space, a confined space entry may be required during the Baseline and Routine Inspections. The need for the confined space entry should be discussed with the PHA Project Manager.

In addition, according to the NEC requirements, minimum distance of 3 feet in front of electrical equipment is needed from a clear workspace requirement perspective. A Routine or Baseline Inspection may be delayed until the space and/or access is cleared.

[2] ANSI/NETA Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems, 2011

Table 2.2: Inspection Descriptions

Inspection Type		**Maximum Inspection Interval**	**Inspection Level of Effort**	**Scope of Inspection**
Baseline		Typically, once: ▪ After new construction ▪ To establish the baseline condition of an existing asset (initiates Routine Inspection) ▪ After significant modifications that alter the current asset single line diagram or plan-view drawing	▪ Visual Inspection ▪ Mechanical Test ▪ Electrical Test	Entire asset class
Routine		▪ Inspection interval will vary based on components type within each asset class. ▪ Manufacturer's recommendations, relevant industry standards including NETA MTS, IEEE standards, insurance requirements, PHA practices and engineering judgement should be used to determine the inspection intervals.	▪ Visual Inspection ▪ Mechanical Test ▪ Electrical Test	Entire asset class
Special	Post-Event	▪ As needed	▪ Visual Inspection ▪ Mechanical Test ▪ Electrical Test	Components of the asset class affected by the event.
Special	In-Depth	▪ As needed	It will vary depending on the type of element and may include: ▪ Visual Inspection ▪ Mechanical Test ▪ Electrical Test ▪ Other (as required)	As defined by the project scope
Special	Due Diligence	▪ As needed	▪ Visual Inspection ▪ Mechanical Test ▪ Electrical Test	Entire asset class

The inspection team may recommend removal of overburden, inspection openings, or other more extensive measures to inspect permanently inaccessible elements for follow-up Special Inspections. These areas should be identified by a project-specific scope and planned with the PHA Project Manager.

2.2. Baseline Inspection

A Baseline Inspection is an asset-wide inspection to provide clear baseline data for comparison with future inspections. This includes visual inspection, mechanical testing, and electrical testing. At a minimum, a Baseline Inspection is the first inspection for an asset and may be considered as its first Routine Inspection. The purpose of the Baseline Inspection is to:

- Develop an inventory record to be used as a point of reference for future inspections and condition assessments
- Identify all components and elements within the scope of the inspection and condition assessment for the asset
- Identify elements that are inaccessible or have special access requirements, including confined spaces
- Inspect the elements of the entire asset to set baseline condition states
- Develop component rating (component level) and asset condition rating (asset class level) as part of the condition assessment; engineers typically develop these ratings.

The Baseline Inventory record includes the following primary items:

- **Drawings.** Drawings should show the current asset layout, single line diagram and plan-view drawing. In particular, the documented asset layout should provide a clear delineation of asset boundaries, a labeling system for individual elements (i.e., assigning numbering to relays, circuit breakers, etc.). The Baseline Inventory drawings should also include a single line diagram (or operating diagram) showing key electrical components. The baseline drawings reflect a schematic "cumulative as-built" of the asset, incorporating any modifications, extensions, or demolition which may have occurred since original construction. For existing assets, this may require an extensive review of records and field verification of items.

  The operating diagram for a building should be posted at the building entrance. An operating diagram should also be posted in the facilities maintenance shop. Operating diagrams need to be updated quickly, as they assist in maintenance and emergency management.
- **Photographs.** Photographs should be collected and archived as reference information, especially to establish a baseline. The photographs should show the current assets and any construction work witnessed including when the assets were in partial construction.
- **Documented Quantities of Elements.** Using the established labeling system, the documented quantities of elements should provide a means for future Routine Inspections to be conducted rapidly (i.e., all future inspection teams will expect a certain number of relays or breakers).
- **Mechanical and Electrical Test Results.** The documented results for electrical and mechanical tests should provide a baseline value to compare the results of future Routine Inspections and track trends

(i.e., the inspection team can observe the baseline trip time for a circuit breaker during the Baseline Inspection and then trend it over time). These tests are often referred to as commissioning tests.

- **Engineering Reports.** All engineering reports that identify design, specifications, test/analysis/study results, sizing or related should be archived and accessible when asking about assets. This includes protection and coordination studies, which establish what fuse size, or Breaker protection or relay settings are used.
- **Computer Programs.** Many assets today require computer programs to operate. This includes protection relays, programmable logic controllers, communication switches, routers, and other intelligent devices. The computer programs and versions should be archived and tracked, so that periodic checks can be completed in the future for revision and update management and meeting any cyber-security requirements. It is recommended that more regular intervals be used to quickly confirm that the current version of software/firmware is installed and operating on the assets to minimize cyber-security risks.

With the asset layout defined and an established labeling system, the remaining portion of a Baseline Inspection is to document any existing condition states using an element-based approach (discussed in Chapter 3) and develop component and overall asset ratings as part of the condition assessment (discussed in Chapter 6). This portion is essentially the same scope as a Routine Inspection. It is important that the Baseline Inspection be comprehensive enough to provide a complete asset file for database purposes and to provide the basis for future inspections. A thorough and well-documented Baseline Inspection will facilitate time-efficient future Routine Inspections since asset inventory information and previous element-based inspection results will already be available as a starting point for easy comparison.

Ideally, a Baseline Inspection is performed shortly after construction is completed for a new asset. Existing assets with no or limited inspection documentation will require a Baseline Inspection to fully document pre-existing conditions. Baseline Inspections should also be performed after modifications or significant repairs/upgrades are performed within the asset class.

After the Baseline Inspection is completed, recommended follow-up actions should be generated as warranted. While it is important to comprehensively inspect the entire asset in a Baseline Inspection, if an element or component is not accessible due to temporary obstructions, a typical, recommended follow-up action is to flag the element for specific inspection during the next Routine Inspection, or sooner if an opportunity arises.

Finally, the Baseline Inspection provides recommendations for the timing and frequency of Routine Inspections, discussed in more detail in the following section.

2.3. Routine Inspection

The Routine Inspection includes a visual inspection, mechanical testing, and electrical testing (if applicable) and is the most commonly performed inspection type. Normally conducted at pre-defined inspection intervals, the purpose of the Routine Inspection is to:

- Inspect readily accessible elements of the components within a given asset class. The scope of elements to be included is the same as in the Baseline Inspection.

- Update the inventory record with drawings/photographs documenting any changes in the asset. Note that significant changes due to repair or refurbishment of the component within each asset class should be previously identified in the asset file as part of either a previous Baseline Inspection or Routine Inspection inventory record or repair/refurbishment record. Examples of repair/refurbishment include cable rejuvenation, oil reclamation, contact replacement, etc.
- Update the inspection forms with changed condition states (i.e., identify new conditions, verify old conditions remain unchanged, have been repaired, or have increased in severity or extent). This information should be detailed enough to properly scope Special Inspections or recommended follow-up actions, and to assist in assigning component and overall asset ratings as part of the condition assessment.
- Update component and asset class ratings as part of the condition assessment.

Changes in element condition states and component and overall asset ratings can be observed over time to provide trends useful for asset management decisions. For example, over time it could be shown from the element-level data that the measured insulation resistance on the power cables belonging to asset "A" has decreased 1 percent per year over the last 5 years, or that asset "B" has poor rating compared to asset "C" and extensive maintenance or repairs should be prioritized accordingly. If Baseline Inspection records are available and accurate, Routine Inspections can be efficiently conducted. While the inspection time is still dependent upon existing conditions, rapid changes in conditions are not typical; therefore, Routine Inspections can be more clearly focused on ensuring the existing record is updated with any changed conditions.

The inspection interval for Routine Inspections is defined by the PHA and may vary from component to component and element to element within each asset class. The inspection interval should be defined during the Baseline Inspection on an element level (or component level), according to the manufacturer's guidelines, insurance requirements, relevant industry standards, PHA practices and engineering judgement. The outcome of an inspection and condition assessment may recommend more frequent inspections for a particular asset based on observations of advanced or severe deterioration. More frequent inspections may also be recommended for assets where the type of use (e.g., rated beyond normal loading, public access, high impact assets) warrants more frequent assessment. Less frequent inspections may be recommended for newly constructed/installed/commissioned assets or for assets where the condition or use warrants an increased inspection interval. Selection of inspection frequency for any asset/component will be made by the PHA after review of the recommendations of the inspection and condition assessment team.

The inspection requirements for the Routine Inspection are the same as that described for the Baseline Inspection. After each Routine Inspection is completed, recommended follow-up actions may include Special Inspections with prescribed levels of effort (optional), or increased inspection frequency or levels of effort for future Routine Inspections.

2.4. Special Inspections

The primary inspection types under the FICAP are the Baseline and Routine Inspections. In some situations, Special Inspections may be required outside of the regular inspection program.

Three (3) types of Special Inspections are defined in this manual: Post-Event, In-Depth, and Due Diligence, as outlined below. These inspection types are would be implemented as and when needed at the discretion of the PHA.

2.4.1. Post-Event Inspection

A Post-Event Inspection is an immediate and rapid inspection that is performed in response to natural disasters (e.g., lightning strikes, floods, hurricanes) or other events (e.g., short-circuit fault, fire, etc.) that may have caused damage. The purpose of this inspection is to:

- Immediately survey the affected asset as soon as possible after the event takes place
- Inspect readily accessible elements in the affected area
- Assess the event's impact on overall physical and electrical integrity and functionality of the component within the asset
- Delineate damaged portions of the asset and the severity of damage
- Provide any recommended actions, such as replacing faulty components, repairs, or further evaluation
- Provide post-event component and overall asset ratings as part of the Post-Event condition assessment

The Post-Event Inspection is not a comprehensive inspection, but rather is targeted to the components that may be damaged. Findings of the inspection also have a different objective than Routine or Baseline Inspections. Accordingly, the component rating criteria for this inspection type (*see* Section 6.3) are different from those used for Baseline and Routine Inspections. The level of effort should be sufficient to make an overall assessment of the component condition related to the event in question. Typically, a Post-Event Inspection is a "bird's eye" view of elements to determine if the event caused significant damage. Previous inspection records should be reviewed and compared with observed damage to gauge whether any damage identified is new or a pre-existing condition.

The PHA has separate Post-Event Inspection procedures for other aspects of Port Houston's facilities (i.e., wharfs and structures). Inspection work performed for the electrical distribution and communications assets within this Manual should be coordinated with those efforts. Post-Event Inspections will be performed at the discretion of the PHA Director of Project and Construction Management, or their delegate.

2.4.2. In-Depth Inspection

In-Depth Inspections are non-routine inspections which are typically a result of a recommended action from a Routine Inspection or with the purpose to provide additional detailed insight on condition assessment to evaluate the need for more extensive maintenance, refurbishment or like-for-like replacement, upgrades, or retirement of a legacy component. The objective and scope for each In-Depth Inspection should be specifically defined and agreed upon between the owner and the inspection team. While In-Depth Inspections do not follow the predefined format of a Baseline or Routine Inspection, they are still expected to use consistent nomenclature and the evaluation of elements should be consistent with the element-based approach defined in this manual. An In-Depth Inspection is typically performed to collect detailed condition assessment information to:

- Understand the cause and extent of deterioration (destructively or nondestructively)
- Predict the remaining service life of a component or asset, if required
- Ensure ongoing reliable operation of the component within its asset class

- Evaluate the effect a particular condition has on physical or electrical integrity of the asset
- Determine the need for more extensive maintenance or refurbishment to maintain/increase the typical useful life of the component

The In-Depth Inspection may involve advanced testing. Examples include but not limited to the following:

- Partial discharge to detect incipient faults
- Degree of polymerization test
- Oil quality test
- Dynamic resistance measurement
- Humidity test
- SF6 leakage test
- Vibration analysis

2.4.3. Due Diligence Inspection

A Due Diligence Inspection is a limited inspection to provide relevant information for legal reasons, such as changes of ownership, tenants, leases, insurance policies, legislative requirements, etc. The objective and scope should be specifically defined and agreed to by the key stakeholders interested in the results of the Due Diligence Inspection and the inspection team. A Due Diligence Inspection is typically performed for one or more of the following reasons:

- Provide an engineering opinion of the state of the asset, and if required, probable cost of future maintenance or repair for financial, accounting, or insurance purposes
- Inspect a portion of readily accessible elements on the asset
- Estimate order-of-magnitude replacement or upgrade costs
- Provide general condition assessment of the asset as defined and agreed by the key stakeholders and the inspection team

2.5. Engineering Analysis

An inspection may identify significant damage, defects, atypical conditions, or potential functional concerns that may require an engineering analysis to fully assess the asset. This includes but not limited to:

- Power systems studies (HV, MV and LV assets only)
- Advanced statistical analysis
- New technology evaluation
- Overloading and assessment of component loss of life
- Prediction for an asset life based on failure of probability versus asset condition rating
- Others, as deemed appropriate

In these situations, the inspection and condition assessment team should include this finding in their recommended follow-up actions (*see* Section 7.5). In addition, the field data collected during inspection could be leveraged to update the PHA distribution system model (in ETAP) so that it reflects the accurate connectivity and asset data.

The engineering analysis is considered outside the scope of the FICAP and would be pursued at the discretion of the PHA.

2.6. Relationship Between Inspection Types

The primary objectives of the FICAP are achieved by conducting a Baseline Inspection for each electrical distribution and communications asset followed by regularly scheduled Routine Inspections. A Baseline Inspection establishes the initial asset inventory information and component and overall asset condition and is applied to every new asset and to existing assets where no previous inspection record exists. It may also be implemented after a major modification to an asset. A Routine Inspection defines the asset condition, component and overall asset ratings, and element condition states at a point in time and allows tracking of conditions over time. The outcomes of a Baseline or Routine Inspection may include:

- No further action is required; asset is scheduled for its next Routine Inspection
- More condition information is needed; conditions observed indicate that further investigation or repairs are required, prompting an In-Depth Inspection
- Minor repairs are required
- Immediate action is required; observed conditions may compromise physical or electrical integrity or facility operations or may lead to property or environmental damage or personnel injury and require immediate attention

The In-Depth Inspection is not considered part of the regular FICAP of Baseline and Routine Inspections and is implemented at the discretion of the PHA as and when warranted by other inspections or situations. The outcomes of the In-Depth Inspection may include:

- No action required (return to scheduled Routine Inspections)
- More information is required (further In-Depth Inspection or Engineering Analysis) depending on the conditions observed
- Repairs, refurbishments, or upgrades are required
- Like for like replacement or retiring of the legacy asset is required
- Immediate action is required; observed conditions may compromise physical or electrical integrity or facility operations or may lead to property or environmental damage or personnel injury and require immediate attention

The relationships between Baseline, Routine, and In-Depth Inspections are illustrated in Figure 2.1. The Engineering Analysis is also included in this figure, since it may be prompted as an outcome (Follow-Up Action) to an In-Depth Inspection. Further discussion of recommended follow-up actions (inspection outcomes) is provided in Chapter 7.

Due Diligence and Post-Event Inspections do not fit within the regular relationship of Baseline and Routine Inspections, but rather are prompted by specific needs or occurrences. These inspection types may be applied to electrical distribution and communications assets regardless of whether a Baseline Inspection has been conducted. The outcome of a Due Diligence or Post-Event Inspection may include:

- No further action is required; asset is scheduled for its next Routine Inspection (or Baseline Inspection if not already completed).
- More information is needed; an In-Depth Inspection is required, possibly followed by Engineering Analysis, repairs, or refurbishment, or retiring of the asset.
- Minor repairs are required
- Immediate action is required to address conditions that may compromise physical or electrical integrity or facility operations or may lead to property or environmental damage or personnel injury.

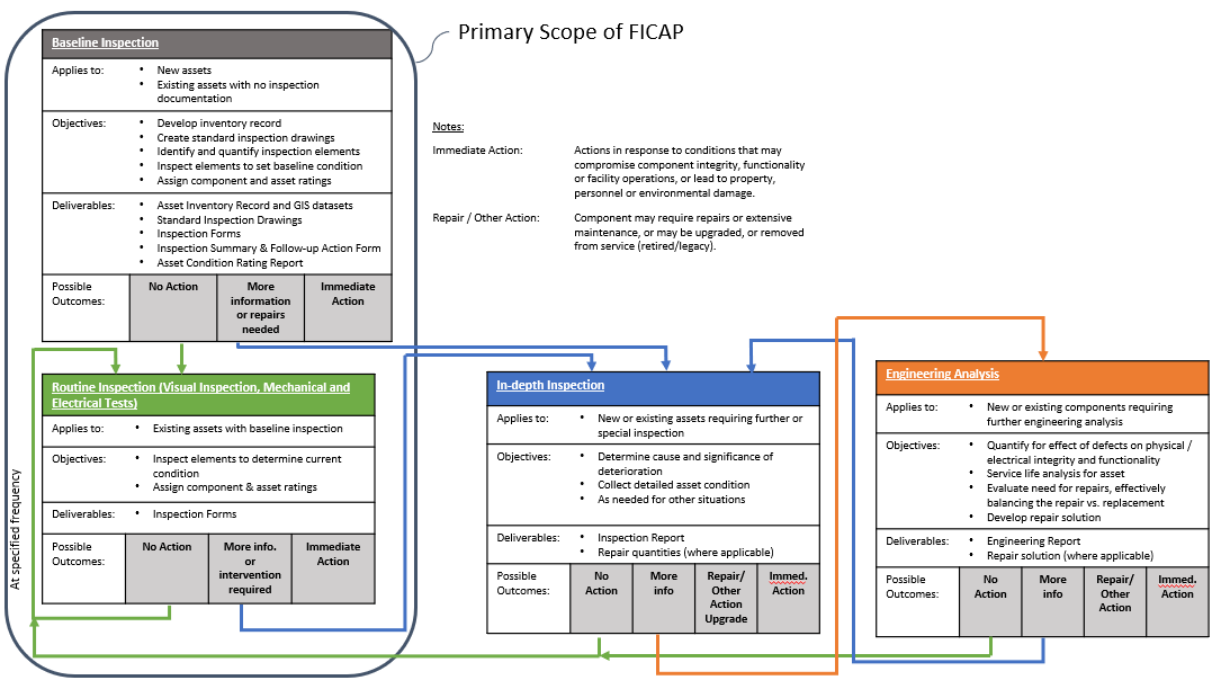

Figure 2.1: Relationship between Baseline, Routine, and In-Depth Inspections

CHAPTER 3: ELEMENTS AND ELEMENT CONDITIONS

3.1. General

Components within an asset class (HV, MV, LV, communication, civil) consist of multiple individual elements. As discussed in Chapter 1, conducting the inspection on an element basis provides a systematic, objective, and comprehensive means of collecting inspection data. The following sections describe the elements that form a component, as well as how the conditions of these individual elements are described during an inspection using defined condition states.

3.2. Element Type Descriptions

A broad range of element types within electrical, communication and associated civil components may be encountered. Element types are primarily defined by their functional purpose. Appendix C provides a list of element types arranged by the component with which it is associated. Terminology used in the element descriptions is defined in the Glossary of Terms (Appendix B). This list of element types contains the following information to describe each individual element:

- ***Associated component:*** This provides the component of which the individual element is a part.
- ***Element code:*** This code is used to indicate the element type for ease of documentation. The first three (3) to four (4) letters of the code (listed before the dash) are descriptive of the associated component and the last two (2) or three (3) letters indicate the element type, as defined in Table 3.1.
- ***Element descriptor:*** A unique name is given for the individual element, as defined in Table 3.1.
- ***Element identification:*** The element is described in narrative for identification and categorization by the field inspection personnel.
- ***Measured units:*** This indicates the measurement basis by which an element's condition state is quantified (e.g., area units, linear units, or per element occurrence).

While the element list in Appendix C is extensive, the list is not comprehensive and other elements may be present in some electrical distribution and communications assets within the PHA inventory. The element types for a particular asset should be defined during the scope of a Baseline Inspection and should be referred to for all subsequent Routine or other inspections. Categorization of undefined element types should be discussed with the PHA project contact to ensure that naming is consistent with the PHA asset management system.

Table 3.1 provides examples of element descriptions for a pad-mounted transformer (component).

Table 3.1: Example of Select Element Descriptions

No.	Element Code	Element Descriptor	Element Identification	Units[3]
1	PMTX – NP	Pad-Mounted Transformer Nameplate	An element which defines the transformer static data such as KVA rating, frequency, voltage, connection type, insulation level, serial number, oil weight and total weight, cooling type, etc.	EA
2	PMTX – CPT	Pad-Mounted Transformer Compartment	An element which contains all other spaces enclosed within the transformer. This may include fins, control panels, electrical/control termination enclosure, etc. The transformer tank is excluded from the compartment.	EA
3	PMTX – TNK	Pad-Mounted Transformer Tank	An element which houses the winding, insulation and tap changer. This includes any cooling fins that may exist.	EA
4	PMTX – PAD	Pad-Mounted Transformer Foundation	A partially buried, pre-cast concrete element which provides a solid foundation to mount the transformer on.	EA
5	PMTX – GG	Pad-Mounted Transformer Gauges	Necessary monitoring elements (gauges or dials) of the pad-mounted transformer. These elements include, but are not limited to, oil level, temperature, and pressure vacuum gauges.	EA
6	PMTX – BSH	Pad-Mounted Transformer Bushings	An element that allows a termination point to make electrical connections.	EA
7	PMTX – OIL	Pad-Mounted Transformer Oil	An element of the transformer insulation (paper-oil combination) and a cooling medium.	EA
8	PMTX – WDG	Pad-Mounted Transformer Winding	Electrical coils of wire (typically copper) to produce necessary flux.	EA
9	PMTX – TC	Pad-Mounted Transformer Tap Changer	An element which adjusts the voltage ratio of a transformer. This can be an on-load type (automatic), or an off-load type (manual, only when transformer de-energized, hence locked switch handle).	EA

It is worth noting that the transformer loading history (data values) used to determine the survival rate and remaining life / health of adequacy of the component is not included within the scope of Baseline, Routine, Due Diligence, or Post-Event Inspections.

[3] EA = Each

3.3. Element Conditions and Condition States

Element conditions include potential damage, deterioration, or defects that may exist in an individual element. Conditions may be material-specific (e.g., rust on element surfaces of a component, cracking of porcelain type insulator) or may be experienced by the element (e.g., poor oil quality, weak insulation, high contact resistance, moisture in insulation, tap changer ratio anomalies, an increase in breaker open/close timing, etc.).

During a Baseline, Routine, or Special Inspection relevant conditions should be documented for each individual element using four (4) standard, predefined condition states specific to the various conditions to be observed. The condition states are classified into the following four (4) options:

- CS1 (Good)
- CS2 (Fair)
- CS3 (Poor)
- CS4 (Severe)

An example of selected element condition states that occur in pad-mounted transformer bushings is shown in Table 3.2.

Table 3.2: Example of Select Condition States for Pad-Mounted Transformer Bushing

Condition Code	Condition	Definition	Condition States (CS)			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
PTBC	Cracking	Cracked or chipped porcelain, or broken polymer or taped insulation.	No cracks or breaks.	N/A	A few hairline cracks or one tape layer coming loose / off.	Cracks greater than the size of a quarter or more than one layer of tape coming loose / off.
PTBG	Gasket leaks	Bushing gasket deterioration resulting in oil leakage.	No oil leak or streaks.	Minimum oil leaks.	Moderate oil leaks.	Significant oil leaks.

A list of typical conditions and their defined condition states is provided in Appendix D.

To provide a complete characterization of the element condition, three (3) features of the condition should be established:

- Type of damage or deterioration

- Severity of damage or deterioration
- Scope or extent of damage or deterioration. This is quantified by the length, area, or number of elements having the condition state in question.

The process of providing this characterization is presented in the following section.

3.3.1. Documenting Element Condition States

The condition states provide a means for the inspection team to characterize and quantify any observable conditions exhibited by an individual element. As each element is inspected, the observed condition is categorized into one of the predefined condition states. An element may experience multiple conditions, (e.g., a bushing can be cracked and may also have gasket leaks issues at the same time). Inspection records for data entry are discussed in Chapter 8.

Table 3.3 provides an example of collected condition state data during a Routine Inspection. In this example, the element condition states for a pad-mounted transformer are shown. The Element ID is based on the naming scheme used to uniquely identify each element, as described in Section 8.3. Each pad-mounted transformer bushing element has a total of 6 units (3 bushings on the high voltage side and 3 bushings on the low voltage side of the transformer, no external X0 bushing[4]) in the example.

For the first pad-mounted transformer element (labeled "PMTX 5-1"), one unit of the element was characterized as CS4 because significant oil leakage was observed from a bushing. Hairline cracks were also identified on the same bushing. These observations for PMTX 5-1 are recorded in Table 3.3 as follows:

- No (0) units are inaccessible for inspection.
- 1 unit of PTBG in CS4
- 0 [1] unit of PTBC in CS3; since this unit of PTBC is coincident with the unit of PTBG (CS4), it is listed as "0" for summing purposes so that the total units with distress is correctly recorded as 1. Square brackets are used to denote that the unit of CS3 PTBC was 1, but that it was concurrent with a higher-level (CS4) condition state
- 5 units of CS1; this is the total number of bushing units of PMTX 5-1 without deterioration or as good as new

Table 3.3: Example of Condition States for Pad-Mounted Transformer Select Elements

Element Location ID	Element / Condition Code	Units	Total Quantity	In-accessible	Condition States (quantity [counted with another CS])			
					CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
PMTX 5-1	PMTX-BSH	EA	6	0	5	0	0	1
	– PTBG	*EA*	*1*				*0*	*1*
	– PTBC	*EA*	*1*				*0[1]*	
PMTX 5-2	PMTX-BSH	EA	6	0	3	0	2	1
	–PTBG	*EA*	*3*	*0*			*1[1]*	*1*
	–PTBC	*EA*	*1*				*1*	
Subtotal	**PMTX-BSH**	**EA**	**12**	**0**	**8**	**0**	**2**	**2**

[4] X0 bushing is defined as LV bushing for the common neutral point on winding

For the second pad-mounted transformer (labeled "PMTX 5-2"), 1 unit of bushing was categorized as CS4 PTBG and 2 units of bushings were categorized as CS3 PTBG. It is to be noted that within the 2 units of PTBG, 1 unit of CS3 PTBC was also identified. In this situation, the concurrent distress units are both CS2, so the inspection team must use field inspection report to determine which of the two simultaneous conditions (CS3 cracked bushing or CS3 gasket leak bushing) is more severe for the element from the impact of failure perspective. In this case, it is assumed that PTBC is deemed the higher-level or more severe condition state. The inspection observations for PMTX 5-2 are recorded in Table 3.3 as follows:

- No (0) units are inaccessible for inspection
- 1 unit of PTBG in CS4
- 1 [1] unit of PTBG in CS3; the bracket notation indicates that there are 2 units of PTBG (CS3), but that 1 unit is concurrent with another condition (PTBC in this case).
- 3 units of CS1; this is the total inspectable units of PMTX 5-2 without deterioration or as good as new

To report quantities for pad-mounted transformer elements as a group, the quantities are summed based on the condition state subtotals, irrespective of which type of condition was the cause of a condition state. For this specific example, this results in a total of 12 units of pad-mounted transformer bushings, of which 8 units are CS1, 0 is CS2, 2 are CS3, and 2 are CS4 (total of 12 units with an assigned condition state). The use of the square brackets to indicate units of concurrent deterioration types is necessary to correctly arrive at the condition state totals for the pad-mounted transformer element group. In this example, all the units of the element were readily accessible for the inspection and hence the fields under the column "In-accessible" are left blank.

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CHAPTER 4: COMPONENT TYPES

4.1. General

A component is a group of elements within a particular asset class as listed below. Asset classes are described in detail in Chapter 5.

1. HV asset class
2. MV asset class
3. LV asset class
4. Civil asset class
5. Communication asset class

4.2. Component Definitions

This subsection discusses the commonly encountered component types for electrical distribution and communications assets. The components list, as provided below, is not exclusive; other component types may be present in some electrical distribution and communications assets within the PHA facilities. The component types for a particular asset class should be defined during the scope of a Baseline Inspection and should be referred to for all subsequent Routine or other inspections. Categorization of undefined component types should be discussed with the PHA project contact to ensure that naming is consistent with the PHA asset management system. Pictures have been provided to help identify the assets. Where pictures have been acquired from equipment vendors, references are provided.

4.2.1. HV Asset Class

PHA has a high voltage substation, 138 kV substation at Bayport, and is responsible for its maintenance.

Power Transformer

Power transformers[5] at a substation are used to step down high voltage to a medium level voltage with typical ratings in the range of several MVA.

The insulation in most power transformers consists of both paper/pressboard and oil. Most Power transformers use mineral oil for insulation and cooling purpose and have sealed tank construction.

Power transformers are one of the most critical components and have a high impact of failure. Some major consequences of power transformer failure include unplanned interruption, safety risk, reliability impact, environmental impact (e.g., oil spill, PCB, etc.) and revenue loss. Power transformers in North America have an average expected age of 30 to 40 years.

[5] Indicative Picture, Reference: https://www.electpower.com/types-of-transformers/

HV Circuit Breaker

HV circuit breaker[6] is a switching device capable of making, carrying, breaking current at normal conditions. The major task of the HV circuit breaker is to safely interrupt fault current thus protecting the other substation / distribution equipment.

HV circuit breakers are typically stratified based on the interrupting medium. The most common interrupting medium include

- SF6,
- Oil,
- Air (blast)

Most of the HV circuit breakers either employs spring-based, hydraulic-based or pneumatic operating mechanism for switching operation. The reliability of the HV circuit breaker is highly dependent on its operating mechanism.

4.2.2. MV Asset Class

Pad-Mounted Transformer

Pad-mounted transformers[7] are compact distribution transformers that steps down the medium voltage to service level voltage. Most pad-mounted transformers use mineral oil for insulation and cooling purpose and have sealed tank construction.

Typically, the primary winding of the pad-mounted transformer is connected in delta configuration while the secondary winding is connected in grounded-wye connection. Pad-mounted transformers are usually located near the load (building) and operate in radial model for economic reasons. The typical design of pad-mounted transformers sports a separate compartment for each voltage level (MV and LV) and is equipped with hinged doors.

The typical useful life of a pad-mounted transformer is 30 to 40 years. For this manual, the pad-mounted transformer component is further broken down into elements. These may include:

[6] Indicative Picture, Reference: https://assets.new.siemens.com/siemens/assets/api/uuid:57363d51dd291bd91128dd7665ae64e808f2fdf2/high-voltage-circuit-breakers-portfolio-en.pdf
[7] Site visit Port Houston April 25, 2019

Metal-clad Switchgear

Metal-clad switchgears[8] are used to protect and control the MV distribution feeders.

Metal-clad switchgears are typically stratified based on the interrupting medium (SF_6, vacuum, oil, air type) of the circuit breakers which helps to interrupt continuous load current or fault currents. These are 3-phase switching devices. Metal-clad switchgears have a draw out feature for visual inspection including infrared scanning and electrical and mechanical testing (i.e., debris/contamination check, breaker timing testing, contact resistance, etc.).

This permits continuity of service to the rest of the distribution feeders during inspections. For this manual, the metal-clad switchgear component is further broken down into elements which may include:

- Compartment
- Breakers
- Insulators
- Instrument transformers (CT, PT)
- Relays
- Metering (revenue and non-revenue)[9]

Pad-Mounted Switchgear

Pad-mounted switchgears[10] are used for underground distribution application and used for switching and protection of underground distribution feeders. They are typically mounted on a concrete pad above ground to support structural loading whose foundation is buried underground. The above ground access simplifies operations and maintenance.

For this manual, the pad-mounted switchgear includes the following key elements for inspection and maintenance purposes:

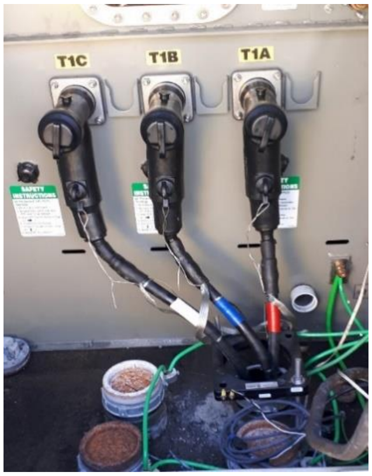
- Compartment
- Fuses
- Switches (Air insulated or Vacuum-Break)
- Concrete foundation (Pad)

[8] Picture Reference: https://www.eaton.com/us/en-us/catalog/medium-voltage-power-distribution-control-systems/vacclad-w-5-15-kv--36-wide-metal-clad-medium-voltage-switchgear.html

[9] Metering element consists of revenue class (high accuracy) and non-revenue class (low accuracy) equipment. PHA is not responsible for the maintenance and inspection of revenue meters belonging to the utility. However, Inventory Record Sheet is provided in Appendix F-1.1 for PHA to track the location and relevant information of meter location (i.e. linkage in GIS). This also provides PHA with a future opportunity for collection / storage of information (i.e. consumption and billing), in support of maintenance and forward planning activities.

[10] Picture Reference: Federal Pacific switchgear catalog, medium voltage, 4.16 – 35kV, page 4

MV Power Cable



MV power cables11 are one of the complex linear assets in an electrical distribution system. They serve the purpose of carrying and distributing power to the load. MV cables are typically categorized by cable insulation type or cable installation type. This may include:

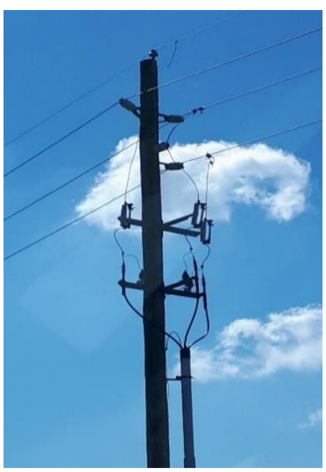
- XLPE – Cross-linked polyethylene cables
- TRXLPE – Tree-resistant XLPE
- EPR – Ethylene-propylene rubber cables
- PILC – Paper insulated lead covered cables

From the installation point of view, the cables are typically installed in ducts or conduit, but may also be direct buried, in conduits or installed in trenches (crane flexible power connections).

For this manual, the underground cables are further componentized into the following key elements for inspection and maintenance purposes.

- Cable joints, terminations, and splices
- Cable shielding
- Cable insulation
- Conductor

Overhead Lines & Components



Overhead lines[12] and components, typically supported on wood pole structures, form the overhead distribution system. Overhead lines and components are cheaper than underground asset categories, however they are more vulnerable to weather conditions and the environment. Depending on the exposure, this can reduce the expected useful life of the overhead line or component.

O/H lines and components can be categorized into the following key elements:

- Poles (wood, steel, concrete) and crossarms
- O/H conductor material (copper or aluminum)
- Insulators (porcelain, polymer-based)
- Pole-top transformer (oil-filled)
- Manual/remote controlled switches

The PHA recognizes that O/H lines and components fall under the utility's ownership boundary. As the PHA is not responsible for maintaining this asset, O/H line and components are acknowledged to exist in this manual, for the purposes of completeness and not discussed in detail (no entries in Appendix C).

[11] Site visit Port Houston, April 25, 2019
[12] Site visit Port Houston, April 25, 2019

4.2.3. LV Asset Class

LV Panelboards

LV panelboard[13] is a distribution point for 3-phase voltage typically supplying low voltage loads (may include lighting load) and installed within cabinet or enclosure. A panelboard is a collection of LV switches as shown in the figure[14]. Individual switches may or may not contain fuses.

The LV panelboard has a main incoming breaker to energize the low voltage bus for feeding the power into different branch circuits while providing a switch (and fuse) for each outgoing circuit. They are modular in design and are available in different dimensions.

For this manual, the panelboard includes the following key elements for inspection and maintenance purposes:

- Switches
- Fuses
- Molded Case Circuit Breaker

LV Power Cables

LV power cables are one of the major components of LV assets. They serve the purpose of carrying and distributing power to the end load. They are typically single core and constructed with solid or stranded copper or alumni conductor and uses XLPE or similar plastic as the main insulation. From the installation point of view, low voltage cables are installed in conduit or raceways.

For this manual, the LV cables include the following key elements for inspection and maintenance purposes:

- Insulation
- Splices and terminations
- Shielding
- Conductor

[13] Site visit Port Houston, October - November 2020
[14] Site visit Port Houston, April 25, 2019

Metering

The metering component[15] is integral to understand the energy consumption in the PHA facility as well as existing voltage and currents on each phase.

This consists of analog and digital meters to measure current, voltage, power factor, kW, kWh, kVAR and if required, an instrument transformer to operate the meter. For this manual, the metering component is componentized as follows:

- Meter (Analog and Digital)
- Instrument Transformers

An instrument transformer is a current transformer or potential transformer, as required.

4.2.4. Communications Asset Class

Fiber Enclosure

A fiber optic enclosure is a distribution point for fiber optic cable. It provides connection points for strands between fiber cables. These panels can be installed indoors or outdoors or in water tight underground enclosures.

Some enclosures are passive and contain no other equipment. Others may include routers, or other electronic equipment to boost signal strength or to manage loops of fiber cables thus enhancing communications system reliability.

Fiber Optic Cable

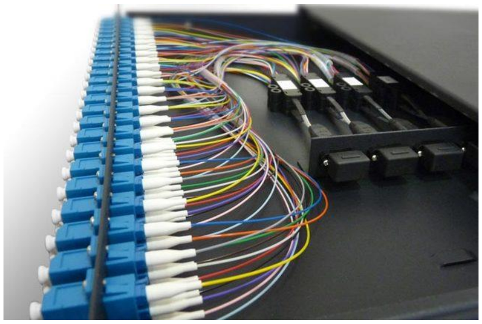
A fiber optic[16] cable is the key component of a communication asset class. It is a wired medium used to send data and signals to monitor and control the PHA facilities. The fiber optic infrastructure allows a robust internal communication network and generally shows good resilience against environment variables.

Fiber optic cable consists of several strands of fiber optic; consequently, one cable may have many dedicated communication paths that need to be identified. For this manual, fiber optic cables have been broken down into the following elements:

- Fiber optic jacket
- Fiber optic core (strands)
- Fiber optic connectors

[15] Eaton, TB01500003E specification guide, April 2018, section 21.0 low voltage switchboards, page 7 of 98
[16] Fiber optic cable and splice box

Communications Termination Points

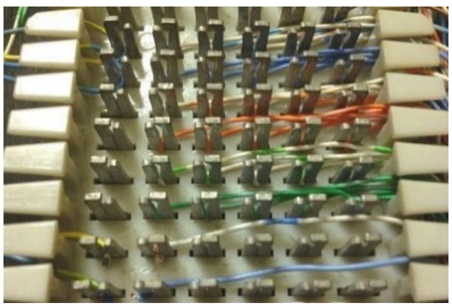


Communications termination points connect communication cables from one location to another.

In this manual, Terminations are further broken down into the following elements:

- Antenna
- Switch or Router
- Server
- Other (Placeholder category for other elements that have yet to be determined)

Legacy Components



Legacy communication components[17] are not classified by their functionality, but by their age. Legacy components are considered obsolete based on inter-operability issues, relevant industry standards, or industry best practices.

Failure of legacy components will not result in a like-for-like replacement, but in upgrading the component to a newer component. Legacy components identified at PHA facilities include:

- Copper wire
- Point to point antenna (creating a communication path through the air)

4.2.5. Civil Asset Class

Manhole

A manhole[18] is the underground room (space) in which a person may enter. It allows termination of cables to allow an underground power cable connection or change in cable direction/level. It may be required from a cable installation or maintenance point of view. It may contain cable splices that require visual inspections, maintenance (e.g., cable injection, etc.) or testing.

They are usually composed of concrete and come prefabricated in different dimensions. Manholes have a typical useful life of 50 to 60 years. For this manual, manholes have not been further broken down into elements.

Concrete Handhole ("Handhole")

A handhole is chamber asset that facilitates access to cables and equipment. Like manholes, handholes are

[17] Example of copper pair communications (old telephone style wiring); https://en.wikipedia.org/wiki/66_block
[18] Site visit Port Houston, October - November 2020

usually composed of concrete and come prefabricated in different dimensions.

A handhole[19] allows termination of cables to allow an underground power cable connection or change in cable direction/level. It may be required from a cable installation or maintenance point of view. It may contain cable splices that require visual inspections, maintenance (e.g., cable injection, etc.), or testing. Concrete handholes along with duct banks are used to hold fiber optic cable runs

Handholes are typically accessible at ground level and are shallower than manholes. For this manual, handholes have not been further broken down into elements.

Duct Bank

Duct banks[20] provide a conduit for underground electrical and communication cables to traverse a site while providing additional mechanical protection to underground cables. If required, cable replacement is significantly easier when installed through a duct bank vs. earlier methods of direct burial. They are usually composed of plastic or metal ducts, and concrete-encased infrastructure and have a mean useful life of 50 – 80 years, which is greater than the typical useful life of MV cables.

In this manual, duct banks are categorized under the civil asset class. For this manual, the duct bank component has not been further broken down into elements.

Fencing

Classic chain-link fence[21] and associated hardware (gates etc.) around critical components is used as a physical security barrier. The physical barrier ensures the protection of important assets, improves safety, and provides an impedance against animal incursions.

Fencing around the substation is required to be adequately grounded to limit the step and touch potential.

For this manual, fencing has not been further broken down into elements.

[19] Picture Reference: https://www.utilitystructures.com/utility-products/electrical-handholes/opsd.html
[20] Picture Reference: http://www.geotechlocating.com/services_manhole.php
[21] Site visit Port Houston April 25, 2019

CHAPTER 5: ELECTRICAL DISTRIBUTION AND COMMUNICATION ASSET TYPES

For this manual, an electrical distribution and communications asset is a reporting unit that has a defined boundary and serves a functional purpose within the PHA facility/location. The following major asset types applicable to the FICAP manual are listed and described hereafter.

1. HV asset class
2. MV asset class
3. LV asset class
4. Civil asset class
5. Communication asset class

The components described in Chapter 4 are assigned to the above listed asset class (parent class). In this manual, an asset class may be comprised of more than one component. Each component will have a unique function and independent failure modes and deterioration mechanisms, and different useful life.

5.1. HV Asset Class

The HV asset class comprises of substation assets that have a nominal rating of at least 69 kV. This asset class typically consists of substation components such as power transformers, high voltage breakers, high voltage instrument transformers, surge arrestors, HV lines and cables and associated monitoring, protection and control infrastructure, station yard and building, station fence, geotechnical and ground grid, station structures including open air bus and insulator system, foundations, and oil containment (under transformers).

PHA has a high voltage substation, 138 kV substation at Bayport, and is responsible for its maintenance. The HV asset class is briefly presented in the manual for the purpose of completeness. In addition, all corresponding inventory, inspection, and maintenance forms will also be created in a future version.

5.2. MV Asset Class

The MV asset class comprises of typical MV distribution system components, with a nominal system voltage greater than 1000 V and less than HV. It typically consists of either overhead components or underground distribution components that routes the power from the substation throughout its service loads. The MV assets deliver electrical power up to a few MVA.

Without the loss of generality, the MV asset class can be broadly categorized into the following categories.

- **Underground System Assets:** This type of MV asset includes underground components such as medium voltage cables, pad-mounted transformers, and pad-mounted switchgears. This asset group has greater security, is mostly hidden, and is less affected by outside weather or human/foreign interference than overhead system assets. These assets are typically more expensive than equivalent capacity assets of the overhead type.
- **Overhead System Assets:** This type of MV asset includes overhead components such as wood poles, overhead conductors, metal-clad switchgears, and various pole mounted components. The

overhead asset category of asset is typically easier to design, construct, commission and is cheaper in cost than their underground counterpart. However, they are more often affected by harsh weather variables and require larger clearances for safety and reliability. There is also a possibility of overhead assets getting in the way of large vehicles (i.e., cranes, etc.) or equipment, and are subject to accidents.

Electricity at MV enters most PHA property as feeders either from the local utility, or from its own substation, depending on the facility. Utility assets on PHA property are tagged and identified to clarify ownership as well as operations and maintenance responsibility. The MV power grid is predominantly radial. At BayPort terminal, an open looped configuration is operated to improve reliability.

At the time of writing there are no distributed energy resources (i.e., distributed generation, battery energy storage, etc.) that could backfeed power.

5.3. LV Asset Class

In this manual, the LV asset class comprises of LV distribution system assets that have a nominal rating of 1000V or less. The LV assets are fed by the MV/LV pad-mounted or pole-top distribution transformer.

For this manual, the scope of LV assets is restricted to the first connection point. This point is typically a LV panelboard or LV switchgear. The PHA distribution system is operated as a radial feed, and in some cases steps down to lower voltages like 480/277V, or 120/240 V. Cables for this voltage level are mostly underground duct banks, armored, in cable tray or in rigid conduit.

Some facilities have revenue metering units on the LV side of distribution transformers. These components are identified and are owned by the local utility. The PHA has no maintenance or operations responsibility on these components other than to keep them accessible to the local utility staff.

5.4. Communication Asset Class

In this manual, the communication assets are a distinct class of asset that serve the purpose of:

a) Security communications
b) Technical information exchange (i.e. cranes to/from maintenance) for operations
c) To some extent, monitoring and control of MV and LV assets across the PHA system facility

This asset class consists of communication components such as:

a) Fiber enclosures
b) Fiber optic cables
c) Communication terminations points
d) Legacy components (e.g., copper wire, etc.)

The function is to collect / transmit digital and analog data/information between field devices and a master system and perform monitoring and control functions on field intelligent devices. The layout and design of the communication system is typically handled through a set of standardized protocols and standards that allow interoperability and compatibility among different field devices.

At one facility, the PHA has crane monitoring software that records equipment Key Performance Indicators (KPIs) and general performance KPIs to help the maintenance group address any operational problems as they occur.

5.5. Civil Asset Class

For this manual, the civil asset class has been componentized into manholes, handholes, and duct banks, to house the power and communication cables of various voltage levels, as well as fencing and gates to protect the electrical assets.

Manholes, handholes and duct banks are constructed in various designs, shapes and sizes depending on the application and location. Manholes are chambers that a person can enter (confined space), whereas handholes are generally shallow, and cannot be entered or accessible from ground level.

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CHAPTER 6: ASSESSMENT AND RATING APPROACH

6.1. General

As described in Chapter 1, this manual employs an element-based inspection and condition assessment approach wherein inspections are performed at the element level and ratings are assigned at the component and asset level. Based on the individual component ratings and the element-level inspection data, an overall asset class rating is produced describing the overall asset class condition.

Baseline, Routine, and Due Diligence Inspections each involve a detailed inspection to categorize the condition states of individual assets. Using well-defined element condition states (as presented in Chapter 3) provides a justifiable, consistent, and comprehensive indication of element condition. The detailed element condition information facilitates an engineering evaluation of the element condition to provide a sound basis for rating each component of the electrical, communication, and associated civil assets. The component ratings in turn allow conclusions to be made regarding the overall asset class condition.

As described in Chapter 2, the objectives of a Post-Event Inspection are typically different from those of other inspection types. Given the circumstances of an extreme event, the Post-Event Inspection is intended to provide a more rapid and overall condition assessment of a specific damage location in comparison to the more detailed element-based inspections. For this reason, the component and asset ratings approach for Post-Event Inspections is defined differently than other inspections and is detailed in Section 6.3.

The preceding sections define the condition rating process for components and overall asset class for Baseline, Routine, and Due Diligence Inspections.

6.2. Component Rating

This section defines the component condition assessment process for Baseline, Routine, and Due Diligence Inspections. It may also be applied to In-Depth Inspections, depending on their specific objectives and scope.

Upon completion of the element-based inspection, the condition assessment process involves determining ratings for each equipment. The component ratings are assigned relative to the assumed as-built condition of the equipment (near new) and are intended to reflect physical conditions including the effects of deterioration or damage. They are not intended to rate the component or asset regarding its current or future use or loading, which may be different from that at the time of original construction.

The element-based inspection and condition assessment approach defined in this manual provides a quantitative evaluation of element condition using the element condition states and quantities as described in Chapter 3. There is no direct (quantitative) relationship or formula to relate the element condition states (in Appendix D and Appendix F) to the component ratings, since the influence of the element conditions on the component condition depends on many complex factors. Instead of a formula-based approach, the engineer assigns component ratings based on an interpretation of the influence of the observed element conditions on the component condition. Engineering judgement must be applied to determine the component rating for a particular component. The factors to be considered include:

a) Element condition state defined in terms of:

- Type of damage, deterioration, or defects (e.g., corrosion, material decay, impact damage, or water)
- Severity of damage, deterioration, or defects (e.g. type and size of defects, section loss, insulation loss, ingress of nature / vegetation, functional obsolescence)
- Scope or extent of damage, deterioration, or defects (e.g. local or general in terms of number of defects, quantity, or length affected)

b) Implication of observed damage, deterioration, or defects on the functional performance of the affected elements.

c) Overall implication of the element condition on the electrical or communications system performance, serviceability, and functionality of the component in question, including redundancy of elements in the component or system. For example, failure of a power cable or communications cable may have minimal short-term impact, because of redundant secondary paths available (automatic or manual switching). In contrast, a duct bank failure resulting in two or more cables being out of service, compromising system redundancy would severely impact electrical and /or communications system performance.

The component should generally be rated considering its overall condition, which may not necessarily reflect localized or element-level conditions. However, since both the severity and extent of the conditions should be considered, localized severe conditions in one element may have a negative effect on the overall performance of the entire component, thereby resulting in a lowered rating for the component. The component rating is selected by interpreting condition states that apply to a broad range of elements. Accordingly, the engineer making the condition assessment should be qualified and have appropriate knowledge and experience in terms of the electrical and communication system, component, and associated deterioration.

The component ratings in this manual are assigned on a scale from 1 to 6, ranging from “Critical” to “Good” condition. Different component rating criteria are provided in Figure 6.1.The component ratings should be accompanied by recommended follow-up actions, which are an important part of the inspection and condition assessment outcome. The follow-up actions provide guidance as to what actions may be required to address or further investigate the condition of a particular asset or element. Any asset with a rating of 3 (Poor) or less must be accompanied by a recommended follow-up action. Recommended follow-up actions are described in Chapter 7.

6. Good	•Minor or no problem noted. The asset is as good as new.
5. Satisfactory	•Normal wear and tear. The asset is fit for normal operation.
4. Fair	•Minor or limited moderate damage. There is a low-medium level of probability that the asset will not function well under normal operating condtion.
3. Poor	•Moderate or excessive deterioration. There is a medium-high level of probability that the asset will not function well under normal operating condition.
2. Serious	•Defect, damage, or deterioration affects functional purpose of the asset. There is a high level of probability that the asset will fail in the near future.
1. Critical	•Substantial deterioration with localized failure of component. Significant restriction to operation and asset requires immediate intervention while in-situ repair not possible.

Figure 6.1: Component ratings and rating criteria

6.3. Condition Rating for Post-Event Inspections

As described in Chapter 2, the purpose and scope of the Post-Event Inspection is notably different from that of the other inspection types. Specifically, the Post-Event Inspection is intended to provide an immediate, rapid overall assessment of an asset after an extreme event such as a hurricane, flood, fire, or electrical fault to determine whether the event resulted in significant damage that requires minor repair, refurbishment, restricted operation, or replacement of the asset. Because of this immediate need, they may often be conducted by PHA staff or by an on-call electrical testing and engineering firm. The outcome of the Post-Event Inspection should be a damage rating for the major components of the asset, and recommended follow-up actions with prioritization.

Given the unique nature of the Post-Event Inspection, the condition assessment protocol is different from that used for the other inspection types. Specific factors to be considered include:

a) In an assessment of electrical assets after an event, only electrical testing can determine whether the given asset can be put back into service. This includes applicable tests that are performed during the commissioning of the asset. For other assets, the inspection can be a visual assessment or a test depending on what is best suited to validate equipment functionality and technical compliance.

   - **Visual assessment** – If the specific element type or nature of the event suggests that the asset may be at risk, the scope of the inspection should be expanded to include additional testing to gain further insight. Specific element conditions arising from the event should be noted in the inspection report.
   - **Testing** – If there are indications or concerns that insulation or conductance or mechanical movement or bandwidth has been compromised, suitable testing should be completed to validate the good condition of the equipment before it is put back into service.

b) Due to the rapid need for deployment, qualifications of the inspector(s) conducting the Post-Event Inspection may be adjusted at the discretion of the PHA Director of Project and Construction Management.

c) Each major asset should be assigned a damage rating based only on event-related conditions. Pre-existing damage, deterioration, or defects resulting from other degradation mechanisms or occurrence should not influence the post-event ratings. However, any conditions requiring immediate attention, such as those that may compromise component operations, or lead to normal or catastrophic damage, should still be noted in the inspection report, and addressed in the follow-up actions, regardless of cause.

d) The post-event damage ratings used in this manual are presented in Table 6.1. The rating scheme has six (6) levels. The alternate scheme, including the use of letters instead of numbers to indicate the rating levels, is important to distinguish the inspection objectives and outcomes those in the other inspection types.

e) The ratings in Table 6.1 are intended to be applied to the major components of the asset and should reflect the overall condition of the component resulting from the event. Both the severity and the extent of the damage should be considered, along with its functional implications, when assigning the damage ratings.

f) Follow-up actions should accompany assignment of the damage ratings. These may include emergency actions, repairs, further inspection, engineering analysis, or no action required.

Table 6.1: Damage Ratings for Post-Event Inspections

Rating	Description
A	No significant event-induced damage observed; no further action is required
B	Minor event-induced damage observed, but all primary elements of the asset are sound. Minor repairs may be required, or additional testing may be needed to provide further insight into the component, but the priority is low.
C	Moderate to major event-induced damage observed that may have significantly affected the capacity, insulation, and/or normal operation of the component. Additional testing is required for comprehensive assessment of component condition. Equipment may be repaired in-situ.
D	Major event-induced damage has resulted in failure of components. Physical signs of serious damage, defects or deterioration are present. There is a high level of probability that equipment cannot be repaired in-situ. Urgent intervention is necessary.
E	Equipment needs extensive repair or needs to be replaced all together
X	Unable to assess condition at time of inspection.
Applicable component types: All	

6.4. Asset Condition Assessment

This section discusses the asset condition assessment for Baseline, Routine, and Due Diligence Inspections, which includes an asset condition rating and a qualitative description of the asset condition. The asset condition rating (score out of 100) for each asset class (HV, MV, LV, Communications, and Civil) is derived using the Component Ratings (1 – 6) , which is in turn based on the inspection on element level for each component. Figure 6.2 below provide a simple diagram showcasing the relationship between the Component Rating and ACR.

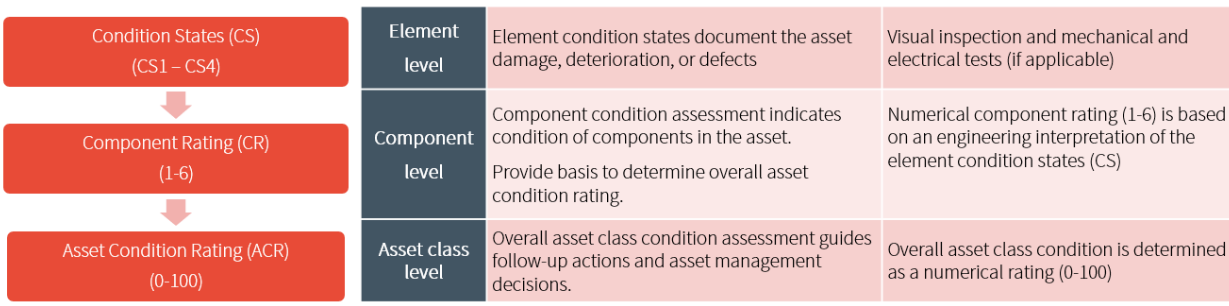

Figure 6.2: Relationship between the Component Rating and ACR.

It may also be applicable to In-Depth Inspections depending on the objectives and scope of the In-Depth Inspection.

The asset condition rating (ACR) reflects the condition of the asset class and is based on the component ratings assigned to the electrical and communication components (functional components) and civil components of the asset. Table 6.2 provides the asset condition rating formulae for different asset classes considered in the manual - determined as a score out of 100 as follows:

Table 6.2: Asset Condition Rating for Different Asset Classes

Asset Class	ACR Equation	ACR Equation-Conditions
HV assets	$ACR = 1.25 * FR$	$0 \le FR \le 80$
MV assets	$ACR = 1.25 * FR$	$0 \le FR \le 80$
LV assets	$ACR = 1.25 * FR$	$0 \le FR \le 80$
Communication assets	$ACR = 1.25 * FR$	$0 \le FR \le 80$
Civil assets	$ACR = 5 * CCR$	$0 \le CCR \le 20$

Where,

ACR = Asset Condition Rating
“100” corresponds to an asset in new or near new condition
“0” corresponds to an asset in critical (end of life) condition

FR Functional Component Combined Rating (FR) is a combined rating based on condition of functional components with a maximum score of 80. This includes all applicable electrical or communication components.

CCR Civil Component Combined Rating (CCR) is combined rating based on condition of applicable civil components with a maximum score of 20.

The upper bounds on the FR and CCR contribution to the ACR score reflects the relative importance of the components on the functional adequacy of the asset class. FR and CCR are determined based on the applicable component ratings (defined in Section 6.2) as described in the Section 6.4.1.

6.4.1. Determining Functional Component Combined Rating (FR)

The asset rating contribution from the functional components is determined using the following equations for a given asset class:

HV Asset Class	$FR^{HV} = 80 - \left[\sum_{n=1}^{N} Deduction^{Component(n)}\right], 0 \le FR \le 80$ $FR^{HV} = 80 - [Deduction^{PTX} + Deduction^{HVCB}]$
MV Asset Class	$FR^{MV} = 80 - \left[\sum_{n=1}^{N} Deduction^{Component(n)}\right], 0 \le FR \le 80$ $FR^{MV} = 80 - [Deduction^{PMTX} + Deduction^{PMSG} + Deduction^{UGC} + Deduction^{MCSG}]$
LV Asset Class	$FR^{LV} = 80 - \left[\sum_{n=1}^{N} Deduction^{Component(n)}\right], 0 \le FR \le 80$ $FR^{LV} = 80 - [Deduction^{LVPC} + Deduction^{PSWB} + Deduction^{LVMT}]$
Communications Asset Class	$FR^{Comm} = 80 - \left[\sum_{n=1}^{N} Deduction^{Component(n)}\right], 0 \le FR \le 80$ $FR^{Comm} = 80 - [Deduction^{CFE} + Deduction^{CFO} + Deduction^{LCC} + Deduction^{TER}]$

Where, $Deduction^{Component(n)}$ is the **Deduction value** of the n^{th} Component (e.g., PTX, HVCB, PMTX, etc.) based on the overall Component Rating as defined in Table 6.3. The FR deductions are based on the following factors:

- Significance of the asset to the overall integrity of the asset class
- Ease of maintenance, repair, and/or replacement of asset

Note that there is no standard way of assigning the deductions and other variation of deduction values can be used. More advanced methods may involve tuning or calibrating the deductions based on the asset historical inspection/maintenance data and failure statistics.

Table 6.3: FR Deduction Table

Overall Component Rating[22]	HV Asset Class		MV Asset Class				LV Asset Class			Communication Asset Class			
	PTX	HVCB	PMTX	PMSG	UGC	MCSG	PSWB	LVPC	LVMT	CFE	CFO	LCC	TER
1 (Critical)	60	60	50	50	60	50	40	40	15	40	50	25	60
2 (Serious)	40	40	30	30	40	30	30	30	10	30	35	15	40
3 (Poor)	20	20	15	15	20	15	25	25	5	20	25	10	30
4 (Fair)	10	10	10	10	15	10	15	15	3	8	10	5	10
5 (Satisfactory)	5	5	3	3	5	3	5	5	1	3	5	3	5
6 (Good)	0	0	0	0	0	0	0	0	0	0	0	0	0

6.4.2. Determining Civil Component Combined Rating (CCR[23])

The asset rating contribution from the civil components is determined as follows:

Civil Asset Class	$\boldsymbol{CCR = 20 - \left[\sum_{n=1}^{N} Deduction^{Component(n)}\right]}, 0 \leq CCR \leq 20$ $\text{CCR} = 20 - [Deduction^{CMH} + Deduction^{CHH} + Deduction^{CDB} + Deduction^{CFG}]$

Where, $Deduction^{Component(n)}$ is the deduction value of the n^{th} Component (e.g., CMH, CHH, CDB, and CFG) based on its Component Ratings as defined in Table 6.4.

22 Depending on the objective, an Overall Component Rating can be generated by either taking the average Component Rating of all the components or taking the average Component Rating of the worst performing components of asset class (*See* Table 6.5).

23 CCR is not applicable to Electrical and Communications assets i.e., CCR = 0 for those asset classes

Table 6.4: CCR Deduction Table

Overall Component Rating[24]	Deduction by Component			
	Manholes (CMH)	**Handholes (CHH)**	**Duct bank (CDB)**	**Fencing (CFG)**
1 (Critical)	20	10	15	20
2 (Serious)	15	5	10	15
3 (Poor)	10	3	5	10
4 (Fair)	5	2	3	5
5 (Satisfactory)	3	1	1	2
6 (Good)	0	0	0	0

Table 6.5: Guide - Use of Condition Assessment for Investment Planning

Goal	Description	Action
Long term view (capital investment)	Capital planning (sustainment) assumes that assets naturally age and need to be "refreshed" over their lifecycle. The frequency of this refresh depends on their rate of degradation over time. This may include material properties or operational criteria (like fault operations of CB's). Less capital is needed if the condition of the assets degrades as a slower rate compared to those of a faster rate. The goal here is to set budgets over several years based on trends in asset condition.	Take the average Component Rating of all assets with valid condition scores and calculate an average. A sample of assets from an asset class, if it is sufficiently large, can be used to predict the entire asset class. Capital required is reflected by how poor the condition is vs how good a condition is desired, over the time period being considered
Short term view (reliability impact)	In this case, and where evidence exists to support, assets with a poor condition are more likely to fail than those in good condition. This short term view, works like a filter to find the items that will most likely fail, and where desirable, allows for short listing assets that require attention in the near term. The measure of success can be statistically evaluated by looking at cost to repair under planned scenario (pro-active) vs reactionary repair (post failure events). Systems / assets that have operationally parallel assets or functionality, where one failure does not impact operations may benefit from a run to failure approach.	Take the average of the worst performing assets, with valid condition scores. Capital required is reflected on short term needs to address issues before a failure occurs. Capital can be augmented by known failure rates, in anticipation of pending failures in the near future, for those assets where a "run to failure" mode of operations is acceptable.

[24] Depending on the objective, an Overall Component Rating can be generated by either taking the average Component Rating of all the components or taking the average Component Rating of the worst performing components of asset class (*See* Table 6.5).

6.5. Example Calculations for Asset Condition Rating (ACR)

Sample calculations to determine the ACR for five (5) hypothetical assets (one from each asset class) are shown in Table 6.6.

Table 6.6: Sample Asset Condition Rating

Asset Class	Component	Overall Component Rating (1 – 6)	Deduction	FR (0-80)	CCR (0-20)	ACR (0-100)
HV Asset Class	PTX	5	5	65	N/A[25]	81.25
	HVCB	4	10			
MV Asset Class	PMTX	3	15	37	N/A	46.25
	PMSG	4	10			
	UGC	4	15			
	MCSG	5	3			
LV Asset Class	LVPC	3	25	27	N/A	33.75
	PSWB	3	25			
	LVMT	4	3			
Comm Asset Class	CFE	4	8	42	N/A	52.5
	CFO	5	5			
	LCC	2	15			
	TER	4	10			
Civil Asset Class	CMH	6	0	N/A	17	85
	CHH	6	0			
	CDB	5	1			
	CFG	5	2			

The component ratings have been assumed for the purposes of this example and would normally be assigned by the subject matter expert as part of the condition assessment for the assets. Once the component ratings are ascribed, the asset condition rating (ACR) on an asset class level is calculated.

The process of determining the functional component combined rating (FR) and civil component combined rating (CCR), is illustrated below to calculate the ACR for five (5) different asset classes.

6.5.1. Calculation of ACR for Asset 1 (belongs to the HV Asset class)

The component ratings for the functional components are used to determine the functional component combined rating, FR. Using the component ratings for Asset 1 as listed in Table 6.6, the FR deductions are determined using Table 6.7 as follows:

[25] "N/A" means that component type not applicable (not present) to the respective asset class (HV, MV, LV, Communication, Civil); consequently, there is no deduction.

Table 6.7: FR Deduction – Asset 1

Component	FR Deduction	Comments
Power Transformers	For component rating of 5, **PTX** is 5	A component rating of 5 represents Satisfactory condition hence the deduction is insignificant which implies that it has limited impact on the overall HV asset class condition
HV Circuit Breakers	For component rating of 4, **HVCB** is 10.	A component rating of 4 represents a Fair condition hence the deduction is moderate

i) <u>Calculate FR:</u>

$$FR^{HV} = 80 - \left[\sum_{n=1}^{N} Deduction^{Component(n)}\right], 0 \leq FR \leq 80$$

$$FR^{HV} = 80 - [Deduction^{PTX} + Deduction^{HVCB})]$$

$$FR = 80 - [5 + 10] = 80 - 15$$

$$FR = 65$$

ii) <u>Calculate CCR:</u>

No CCR component in the equation of the ACR for this asset class (MV).

iii) <u>Calculate ACR:</u>

$$ACR = 1.25 * FR$$

$$ACR = 1.25 * 65$$

ACR = 81.25 for Asset 1

6.5.2. Calculation of ACR for Asset 2 (belongs to the MV Asset class)

Using the component ratings for Asset 2 as listed in Table 6.6, the FR deductions are determined using Table 6.8 as follows:

Table 6.8: FR Deduction – Asset 2

Component	FR Deduction	Comments
Pad-mounted transformers	For component rating of 3, **PMTX** is 15	A component rating of 3 represents Poor condition of pad-mounted transformer, resulting in a substantial deduction of 15.
Pad-mounted switchgears	For component rating of 4, **PMSG** is 10	While the ratings for these components (PMSG and UGC) are the same, the deduction for pad-mounted switchgear is less than the cable. The higher deduction in UGC reflects that the repair/maintenance work is relatively difficult to perform and requires a longer outage time compared to the PMSG and thus have an impact on overall condition of the asset class.
MV power cables	For component rating of 4, **UGC** is 15	
Metal-clad switchgear	For component rating of 5, **MCSG** is 3	A component rating of 5 represents Satisfactory condition hence the deduction is insignificant which implies that it has limited impact on the overall MV asset class condition.

iv) <u>Calculate FR:</u>

$$FR^{MV} = 80 - \left[\sum_{n=1}^{N} Deduction^{Component(n)}\right], 0 \leq FR \leq 80$$

$$FR^{MV} = 80 - [Deduction^{PMTX} + Deduction^{PMSG} + Deduction^{UGC} + Deduction^{MCSG})]$$

$$FR = 80 - [15 + 10 + 15 + 3] = 80 - 43$$

$$FR = 37$$

v) <u>Calculate CCR:</u>

No CCR component in the equation of the ACR for this asset class (MV).

vi) <u>Calculate ACR:</u>

$$ACR = 1.25 * FR$$

$$ACR = 1.25 * 37$$

ACR = 46.25 for Asset 2

6.5.3. Calculation of ACR for Asset 3 (belongs to the LV Asset Class)

Using the component ratings for Asset 3 as listed in Table 6.6, the FR deductions are determined using Table 6.9 as follows:

Table 6.9: FR Deduction – Asset 3

Component	**FR Deduction**	**Comments**
LV panelboards	For component rating of 3, **PSWB** is 25	A component rating of 3 represents that component is in Poor condition hence the deduction is only 10 points. The ratings and deduction are same for LVPC and PSWB as they have about the same impact on overall condition of the LV asset class.
LV power cables	For component rating of 3, **LVPC** is 25	
LV metering	For component rating of 4, **LVMT** is 3	A component rating of 4 represents that component is in Fair condition. The deduction is only 3 points as they LV metering has the lowest impact compared to other components on the overall integrity of LV asset class.

i) <u>Calculate FR:</u>

$$FR^{LV} = 80 - \left[\sum_{n=1}^{N} Deduction^{Component(n)}\right], 0 \le FR \le 80$$

$$FR^{LV} = 80 - [Deduction^{LVPC} + Deduction^{PSWB} + Deduction^{LVMT}]$$

$FR = 80 - [\,25 + 25 + 3] = 80 - 53$

$FR = 27$

ii) <u>Calculate CCR:</u>

No CCR component in the equation of the ACR for this asset class (LV).

iii) <u>Calculate ACR:</u>

$ACR = 1.25 * FR$

$ACR = 1.25 * 27$

ACR = 33.75 for Asset 3

6.5.4. Calculation of ACR for Asset 4 (belongs to the Communication Asset class)

Using the component ratings for Asset 4 as listed in Table 6.6, the FR deductions are determined using Table 6.10 as follows:

Table 6.10: FR Deduction – Asset 4

Component	**FR Deduction**	**Comments**
Fiber enclosures	For component rating of 4, **CFE** is 8	A component rating of 4 represents a Fair condition hence the deduction is moderate (8 points)
Fiber optic cable	For component rating of 5, **CFO** is 5	A component rating of 5 represents a Satisfactory condition hence the deduction is insignificant which implies that it has limited impact on the overall communication asset class condition.
Legacy communication component	For component rating of 2, **LCC** is 15	A component rating of 2 represents a Serious condition. However, the deduction is not quite significant as the assets have already been identified as legacy assets and there may not be any maintenance plan beyond replacement upon the component failure.
Termination points	For component rating of 4, **TER** is 10	A component rating of 4 represents a Fair condition hence the deduction is moderate

i) <u>Calculate FR:</u>

$$FR^{Comm} = 80 - \left[\sum_{n=1}^{N} Deduction^{Component(n)}\right], 0 \le FR \le 80$$

$$FR^{Comm} = 80 - [Deduction^{CFE} + Deduction^{CFO} + Deduction^{LCC} + Deduction^{TER}]$$

$$FR = 80 - [8 + 5 + 15 + 10] = 80 - 38$$

$$FR = 42$$

ii) <u>Calculate CCR:</u>

No CCR component in the equation of the ACR for this asset class (communication asset class).

iii) <u>Calculate ACR:</u>

$$ACR = 1.25 * FR$$

$$ACR = 1.25 * 42$$

ACR = 52.5 for Asset 4

6.5.5. Calculation of ACR for Asset 5 (belongs to the Civil Asset class)

Using the component ratings for Asset 5 as listed in Table 6.6, the CR deductions are determined using Table 6.11 as follows:

Table 6.11: CCR Deduction – Asset 5

Component	CCR Deduction	Comments
Manhole	For component rating of 6, **CMH** is 0	A component rating of 6 represents a component which is as good as new. Hence CMH deduction (zero) has no impact on the overall civil asset class condition.
Handholes	For component rating of 6, **CHH** is 0	A component rating of 6 represents a component which is as good as new. Hence CHH deduction (zero) has no impact on the overall civil asset class condition.
Duct bank	For component rating of 5, **CDB** is 3	A component rating of 5 represents a Satisfactory condition hence the deduction is insignificant which implies that it has limited impact on the overall civil asset class condition.
Fencing	For component rating of 5, **CFG** is 5	A component rating of 5 represents Satisfactory condition, so the deduction is minor.

i) **Calculate FR:**

No FR component in the equation of the ACR for this asset class (civil asset class).

ii) **Calculate CCR:**

$$\boldsymbol{CCR = 20} - \left[\sum_{n=1}^{N} Deduction^{Component(n)}\right], 0 \le CCR \le 20$$

$$\mathrm{CCR} = 20 - [Deduction^{\,CMH} + Deduction^{\,CHH} + Deduction^{\,CDB} + \ Deduction^{\,CFG}]$$

$$CCR = 20 - [0 + 0 + 1 + 2] = 20 - 3$$

$$CCR = 17$$

iii) **Calculate ACR:**

$$ACR = 5 * CR$$

$ACR = 5 * 17$

ACR = 85 for Asset 5

6.6. Description of Asset Class Condition

The numerical asset condition rating (ACR) may be used by the PHA to guide asset management including maintenance decisions. However, a single rating may not provide sufficient refinement or detail to properly guide decisions and recommended follow-up actions for all situations. Accordingly, the outcome of an inspection and condition assessment project must also include an overall qualitative description of the asset condition that addresses the following, to facilitate investment planning decision making:

- Brief discussion of the ratings for all components of the asset
- Discussion of the implications of the reported component ratings on the overall asset condition rating and recommended actions
- Proposed of recommended follow-up actions, and an indication of how the condition rating will change if the work is completed

The combination of the component rating, asset condition rating and the narrative condition assessment will provide a more complete evaluation of the overall performance and adequacy of the asset class.

CHAPTER 7: RECOMMENDED FOLLOW-UP ACTION GUIDELINES

7.1. General

Each inspection and condition assessment should include recommended follow-up actions as part of the inspection outcome. The recommended follow-up actions may include suggestions for repair, maintenance, further investigation, or immediate actions to remedy or avoid conditions that may compromise physical or electrical integrity, reliability, or lead to property damage, personnel injury, or environmental damage.

The recommended follow-up actions for the FICAP, depending on the severity and implications of the conditions observed, are listed below, and further described in the following sections:

- No action required
- Investigation recommendations
- In-Depth Inspection
- Engineering Analysis
- Immediate intervention

It is noted that more than one recommended action may arise from the condition assessment of a given asset. All actions should be prioritized in a consistent manner across all assets. In all cases, a brief justification should be provided for any recommended actions. If competing actions are recommended for one asset, a suitable comparative evaluation should be completed, to determine the best action to move forward with.

7.2. No Action Required

If the inspection and condition assessment does not indicate that any form of follow-up action is required (such as those described in the following sections), the inspection recommendation is reported as "no action required" until the next Routine Inspection on the Follow-Up Action Form (*see* Chapter 8). The inspection and condition assessment team should provide the following for a recommendation of no action required:

- Recommendation for the timing of the next Routine Inspection – Depending on the condition rating determined during a Routine Inspection, the frequency of subsequent Routine Inspections may be adjusted. The final selection of inspection and/or testing frequency will be made by the PHA.

If several successive "no action required" assessments for one asset are complete, it is recommended that PHA review the inspection frequency cycle and determine if the period between inspections can be increased, taking into account any seasonal factors or other compliance requirements that may drive more frequent inspections.

7.3. Investigation Recommendations

The inspection and condition assessment of an asset may reveal conditions that require some form of follow-up action, but that do not represent an immediate action or emergency (*see* Section 7.6). These conditions or situations may include:

- Conditions requiring maintenance
- Conditions requiring minor repairs

- Conditions requiring major refurbishment (e.g., transformer oil leaks repair, power cable rejuvenation, etc.)
- Conditions requiring replacement of one or more elements
- Elements where a condition state of CS4 (Severe) was assigned during the inspection.

Element condition state CS4 (Severe) represents the most severe condition of the element for the condition type in question. The CS4 condition may correspond to:

- High likelihood of asset failure in near future
- An increased safety risk to operator or public
- An actual environmental impact (e.g., oil leak, SF6 gas leak of predefined quantity)

Although the element condition state information is considered during the condition assessment process when assigning component ratings, the CS4 condition for an individual element warrants In-Depth inspection as a recommended follow-up action.

When a Routine, Baseline, Post-Event, or Due Diligence Inspection identifies conditions that require follow-up actions (other than Immediate Actions), the following information should be on provided on the Follow-Up Action Form (*see* Chapter 8):

a. Classify the recommendation as ***priority*** or ***routine***:
   - **Priority**: The action to address the observed condition should take precedence over other actions (e.g., routine maintenance), but the condition needing repair does not appear to immediately compromise the electrical or physical integrity or functionality of the asset. Priority repairs may also be necessary to prevent further damage, deterioration, or defects from reaching the point at which future repairs become significantly more costly or infeasible.

   - **Routine**: The action can be addressed as part of a routine maintenance program. Routine actions are those that can be scheduled in the future without compromising the physical or electrical integrity or functionality of the asset, and without significantly increasing the future cost of maintenance or repair.

b. Provide a brief justification of the need for the action and the associated priority.
c. Recommend whether an In-Depth Inspection is needed to properly identify the cause and implications of the damage, deterioration, or defects. The results of the additional inspection will aid in intervention strategy.

7.4. In-Depth Inspection

As discussed in Chapter 2, an In-Depth Inspection is not part of the scope of the FICAP Baseline and Routine Inspections. Rather, an In-Depth Inspection may be recommended as a follow-up action to a Baseline, Routine, or Due Diligence Inspection to obtain the additional information as it relates to condition to improve the reliability of the Baseline, Routine, or Due Diligence Inspection condition assessment and evaluate the need for more extensive maintenance and rehabilitation. An In-Depth Inspection is warranted where an Investigation was not able to identify the cause or significant of distress or deterioration. The recommendation for In-Depth Inspection should include:

a. Description of the asset conditions and a brief written justification for the additional inspection, including an evaluation of its priority.

b. Objective of the In-Depth Inspection. The objectives may vary, but some examples include:

- Determine the cause or significance of deterioration
- Collect detailed condition and quantity information necessary to evaluate the need for more extensive maintenance
- Gain full access to a component or element that was not fully accessible previously; this may involve a planned outage
- Verify element and component adequacy or determine baseline conditions (where no existing baseline information is available) for asset inventory purposes, or as needed to conduct an Engineering Analysis

The In-Depth Inspection may involve material sampling and analysis, and advance testing as recommended by manufacturer.

When an In-Depth Inspection has been conducted with the intent of determining the cause or significance of damage, deterioration, or defects, and to collect the information necessary for the preparation of maintenance documentation, the inspection and condition assessment team's recommendations should include the following:

- Recommend repair, replacement and/or refurbishment actions and classify the repair, replacement and/or refurbishment recommendations as ***priority*** or ***routine*** as defined in the preceding section
- Provide a cost estimate for the repair and/or refurbishment activities
- Included within the cost estimate is a determination on what work methodology will be used, tools/equipment/cranes to be used, and if it is feasible to carry our extensive maintenance repair in-situ or not

It is assumed that in most cases, the scope of work for the In-Depth Inspection will be such that enough information is gathered to complete a future cost estimate (i.e. another additional In-Depth Inspection is not required). However, in some situations the objectives or outcomes of the In-Depth Inspection may require an Engineering Analysis to supplement the In-Depth Inspection findings. In this case, the need for an Engineering Analysis may be recommended as a follow-up action to an In-Depth Inspection.

7.5. Engineering Analysis

When an In-Depth Inspection identifies significant damage, defects, atypical conditions, or potential functional concerns, an Engineering Analysis may be recommended. Engineering Analysis typically involves either material testing, and/or electrical studies. In the event of material testing, a sample of the material is to be sent to a testing facility, with results returning for engineering review. For electrical studies, the recommendation for an Engineering Analysis should include some, or all, of the following, depending on applicability:

a. Scope statement of the issue

b. Brief written justification for the Engineering Analysis, including an evaluation of its priority

c. Objective of the Engineering Analysis, which may include any or all of the following:

i. Power systems studies (HV, MV and LV assets only)
   - Load flow analysis (including N-1 contingency and load forecasts)
   - Short-circuit study
   - Protection coordination study
   - Harmonic study
   - Transient analysis
   - Reliability analysis
   - Arc flash study
   - Motor starting study
   - Other as deemed appropriate

ii. Advanced statistical analysis to assess the impact of select refurbishment type on the service life of an asset (survival analysis to assess whether cable rejuvenation was an effective remedial measure for specific cable type or not)

iii. Infrared survey of electrical equipment

iv. New technology evaluation especially if it reduces the need for ongoing maintenance and inspections

v. Prediction for an asset life based on failure of probability versus Component Rating

vi. Other as deemed appropriate

The Engineering Analysis will normally be performed considering the normal operating condition of an asset (e.g., loading, capacity, number of cable splices, condition of the component), which may be different from the original nameplate rating for the component. The requirements should be determined in consultation with the PHA.

Note that an Engineering Analysis is beyond the scope of the FICAP Baseline and Routine Inspections and is only conducted at the discretion, and under the direction of, the PHA. If included in the scope defined by the PHA, an Engineering Analysis may include preparation of a set of repair and refurbishment documents suitable for bidding the work.

7.6. Immediate Actions

Immediate Actions are required when any inspection and/or condition assessment identifies severe conditions that have occurred, or appear likely to occur, that have the potential for component catastrophic failure and/or environmental damage, or that may affect physical or electrical integrity or facility operations or are deemed to pose a safety issue. Immediate actions are intended to be responses to extreme conditions or emergency situations and are not intended to apply to conditions requiring routine maintenance or repairs.

Upon identifying conditions that have the potential for property damage, personnel injury, environmental damage, or that may affect physical or electrical integrity or facility operations, the inspection and condition assessment team shall take the following actions:

- The PHA project contact shall be notified immediately by phone with follow-up notification in writing to the PHA project contact within established guidelines.
- Provide a justification for the immediate response including a brief description, test reports and photographs of the condition(s) of concern.
- Maintenance work order issued for immediate corrective action.
- Where unsafe electrical condition(s) exist, the equipment will be shut down from its supply point, and the supply point(s) will be locked out and tagged, until corrective action is complete.

An In-Depth Inspection (Section 7.4) or Engineering Analysis (Section 7.5) may be recommended by the inspection and condition assessment team to further ascertain the extent and implications of the observed conditions, and to evaluate the need for more extensive repair or replacement to address the conditions and to maintain or even extend the typical useful life of the component as recommended by the manufacturer or based on industry guidelines.

CHAPTER 8: DOCUMENTATION AND REPORTING

8.1. General

This section describes documentation and reporting requirements for the inspection and condition assessment program. Documentation and reporting are standardized to promote efficiency in inspection and reporting, enable comparison among assets, and provide for data storage and analysis via an asset database. A form-based reporting approach is used for most inspection types. Documentation begins with a standard asset description (Electrical Distribution and Communications Asset Inventory Record, or "Inventory Record Form"), and Standard Drawing Set. This information is intended to reflect persistent aspects of the assets that would only change if significant repairs or modifications are performed to the asset. The inspection documentation consists of four standard forms to report element-based inspection condition states and quantities, report inspection notes and photographs, summarize the condition assessment, and document follow-up actions.

The following sections discuss the inspection forms and standard drawing requirements. Examples of an Inventory Record, Inspection Summary, Inspection History, Element Form, and Follow-Up Action Form are provided in Appendix F. Finally, deliverables for each type of inspection and general record-keeping requirements are defined.

8.2. Inventory Record

The Inventory Record Form is a record document reflecting the as-built state of the asset. The Inventory Record should be created as part of a Baseline Inspection and revised if changes are identified through a Routine or Special inspection. The Inventory Record should be updated after any modifications or significant repairs are performed.

The following information should be included as it pertains to each asset:

- **Identification** – Identification of the asset by the appropriate property/terminal and asset ID. These identifiers are coordinated with the Port of Houston Authority's GIS implementation.
- **Asset Classification** – Categorization of the asset based on the asset class (i.e., MV, LV, communications, civil) and component (e.g. MV – pad-mounted transformer).
- **Year of Original Construction** – The year when the asset was originally constructed. If there are multiple construction dates, the original date of construction refers to the construction date of the oldest component.
- **Year(s) of Significant Modification or Repairs** – Year(s) of significant modifications or repairs. Significant modifications are defined as work that alters the asset's footprint or changes components; this definition applies regardless of the percentage of asset being modified.
- **Inspection Frequency** – The designated frequency for Routine Inspections (set by the PHA). The inspection frequency may vary according to scope of Routine Inspection (e.g. visual inspection every year, mechanical inspection every three years, etc.).
- **Asset Characterization Data** – Pertinent asset data including component nameplate data, relevant geometric data (i.e. dimensions such as length of cable), and key baseline data (for example, commissioning test results, manufacturer reference data and/or results from Baseline Inspection tests). This may include asset load data (historical current flows or power flows), or in the case of

communications systems, volume of data flow. Where relevant, weather and/or temperature data may also be included.

- **Asset History** – A narrative describing the history of the asset construction, repairs, and modifications. If known, the reason for modifications or repairs should be noted.
- **Reference Information List** – A list of existing drawings (titles, dates, and general scopes of work), reports, data tables, OEM information, and other sources as required. At a minimum, original ready for construction design drawings, and any modification made during construction (as-builds) should be listed.
- **Components and Elements** – A list of components and elements comprising the asset. For each component, applicable element types should be listed and briefly described. Component descriptions should include the location and extent of component on the asset. Descriptions of elements should include the construction material. If a standard component is not present on the asset, it should be listed with "none" as the description.

  Electrical component categories include pad-mounted transformer, pad-mounted switchgear, power cables, metal-clad switchgear, O/H components.

  Communication component categories include fiber optic cable, legacy communication components and terminations (end user locations, routers, switches, etc.).

  Civil component categories (that house electrical and communications infrastructure) include duct banks, manholes, handholes, fencing, etc.
- **Figures** – Typical figures illustrating the location and configuration of the asset. At a minimum, these include the following: maps showing location of the facility relative to all PHA properties and a map marking the location of the asset within the facility; a Single Line Diagram; a plan-view of the asset; detail drawings as required (with annotations, part numbers, assemblies).
- **Revision History** – A table logging revisions to the document. This table is included because the inventory record is intended to be semi-permanent. The table shows the revision number, person, and date of the revision author, a date and person responsible for verification of the revision, and comments describing the reason for the revision.

8.3. Reference Inspection Drawings

Reference Inspection Drawings are created within the scope of the Baseline Inspection, and are used as a reference for Baseline, Routine, Due Diligence, and Post-Event Inspections. Drawings are important to present the layout of the assets and identify types and locations of elements. Due to the long history of many of the electrical distribution and communications assets at the Port of Houston Authority, the current configuration of a particular asset may be the result of multiple alterations performed over the years, which may have been recorded in multiple sets of single line diagrams, and construction and plan-view drawings.

Therefore, creating Reference Inspection Drawings has two main purposes. The first purpose is to create a schematic, cumulative as-built of the current configuration of the asset, which would then be verified as part of the field work in the Baseline Inspection. The second purpose is to define a consistent naming scheme for all elements of the asset, so that the Baseline Inspection and future inspections, modifications, and repairs can quickly and accurately identify and locate each element for documentation and reporting purposes.

8.4. Inspection Summary

The Inspection Summary Form summarizes the findings of a Baseline, Routine, Due Diligence or Post-Event Inspection, including presenting the asset and component condition assessment findings. The Inspection Summary Form includes the following information:

- **Identification –** Identification of the asset by the property and asset ID. These identifiers are coordinated with the PHA's GIS implementation.
- **Inspection Information –** Type of inspection performed, date, scope, and personnel performing the inspection. Personnel performing the inspection should provide their qualifications in an attached roster.
- **Inspection Procedures –** Version of the manual used for the inspection and any variances from the defined procedures. References to specific standards or manufacturer's guidelines (e.g., insulation resistance test for 480 V power cable performed per NETA MTS).
- **Component Rating and Element Summaries –** Tables of ratings for each component and type of elements, if applicable. These tables match the components and elements provided in the Inventory Record**.**
- **Asset Condition Rating–** A narrative describing the asset's overall condition assessment and presenting the asset condition rating for each asset class (*see* Section 6.4).
- **Figures –** Representative photographs or figures of conditions for various components. All photos provided should be referenced in the narrative.

8.5. Inspection History

The Inspection History is a log of the inspections that have been performed for the asset. All inspections meeting the criteria in this manual should be logged. This form contains the following information:

- **Identification** – Identification of the specific component and asset by the property and asset ID.
- **Date** – The month and year when the inspection was performed.
- **Inspection Type** – Baseline, Routine, Post-Event, In-Depth, or Due Diligence.
- **Inspection Firm** – The prime firm performing the inspection. Sub-consultants (if used) are not listed on this form.
- **Component Rating Summaries and Asset Condition Rating**– A list of the component ratings resulting from the condition assessment, and the asset condition rating (asset class level) and qualitative descriptions. These values would only be entered for Baseline, Routine, or Due Diligence Inspections.

8.6. Inspection Forms

Inspection Forms are applicable to Baseline, Routine, and Due Diligence Inspections. They may also be used as part of the deliverable for an In-Depth Inspection if appropriate. An example of these documents is provided in Appendix F. The use of these documents signifies that the inspection was performed in accordance with inspection requirements of this manual. Inspection Forms include the recorded observations on an element-level basis for the asset and are intended to be the archival version of the inspection's field notes.

It is anticipated that separate inspection forms will be generated for each component. Inspection Forms should include the following information:

a. **Identification** – Identification of the specific component and asset by the property and asset ID.

b. **Component Summary** – Observed condition states for each type of element in the component.

c. **Element Record –** For each element, identification of the element type, location, total quantity, and conditions observed. For each type of condition, quantify the portion affected for each condition state (i.e. area, length, or entire component). Each entry should include a unique element identifier, referenced from the Reference Inspection Drawing.

d. **Photographs** – Photographs specific to a particular element or condition. While photographs are not required for each element or condition, a representative number of photographs should be taken to show typical conditions. The photograph filename should be listed with the applicable element. Entries for the photograph may be abbreviated to the sequence number if unique identification of photographs is maintained. Requirements for photographs submitted to the project database with the inspection forms are as follows:

  - File Format: JPEG
  - Size: 2048 pixels on longest edge (or larger as technology permits)
  - Naming scheme: *Location – Component Type - Specific tag/location (e.g., W32-PB-PB5)*

8.7. Follow-Up Actions

The Follow-Up Action Form documents the recommended follow-up actions for Baseline, Routine, Due Diligence and Post-Event Inspections. Follow-up actions should be categorized as defined in Chapter 7 and should include a brief justification and a prioritization. Investigation recommendations (as a follow-up action) may include maintenance or minor corrective actions that do not require an engineered design. The recommended follow-up actions should include photographs showing the conditions to be addressed where applicable. A sample Follow-Up Action form is included in Appendix F.

8.8. Report Requirements

Baseline, Routine, Due Diligence and Post-Event Inspections have defined deliverables with standardized methods of reporting. Expected deliverables for each are listed in Table 8.2.

By their nature, In-Depth Inspections may have unique deliverables that do not fit standard templates. These deliverables may include technical reports, drawings, or other documentation. At a minimum, In-Depth Inspection deliverables should provide the following information:

1. Objective and scope
2. Methodology, including reference to procedures or standardized test methods (e.g. NETA, IEEE, ASTM) as appropriate
3. Record of observations and data, including field or laboratory data.
4. Interpretation of observations and data
5. Recommendations
6. Summary

7. Seal of responsible Design Professional

Table 8.2: Deliverables for Standard Inspections

Deliverable	Type of Inspection			
	Baseline	**Routine**	**Post-Event**	**Due Diligence**
Inventory Record	Yes. Includes initial generation of document.	Revise only if change identified	No	Revise only if change identified
Standard Inspection Drawing Set	Yes. Includes initial generation of document.	No	Marked-up Standard Drawing identifying extent of damage.	Revise only if change identified
Inspection Forms	Yes. Includes initial generation of document.	Yes. Relies on inspection forms generated by Baseline.	No	Yes. Relies on inspection forms generated by Baseline.
Inspection History	Yes. Includes initial generation of document.	Update	Update	Update
Inspection Summary	Yes	Yes	Yes[1]	Yes
Follow-Up Action Form	Yes	Yes	Yes	Yes
Submission into PHA database	Yes	Yes	Yes	Yes

[1]Use inspection summary form, but with Damage Rating from Post-Event Inspection (*see* Section 6.3)

Note, it may be necessary to markup drawings, if changes are made to the equipment during maintenance or repairs, if parts are used that are not "like for like" replacements. This part may be from a different manufacturer, or increased insulation requirements, or increased fiber count (fiber optic cable). It is recommended that a qualified person (Engineer or designate by PHA project manager), have decided on the parts to be used, prior to replacement.

8.9. Project Record Requirements

At the end of the Inspection, deliverable documents should be submitted to the Project Manager in electronic format[26] via the PHA's Project Port Webpage. After receipt and approval by the Project Manager, information from the Inventory Record, Inspection Forms (including referenced photographs), and Inspection Summary should be entered by the inspection firm into the PHA Asset Database as described in Section 8.10.

The inspection firm should maintain electronic records of the deliverable documents for a minimum of 4 years after submission. Unused photographs, paper notes, or other documentation not included in the project deliverables may be discarded after submission.

[26] Format of electronic documentation should be PDF/A-1 as defined by ISO 19005-1.

8.10. Inspection Database Requirements

PHA has developed a digital database to collect and report aspects of completed inspections. These inspections are to be submitted with a digital database template provided by the PHA to the inspection firm, so that the digital data may be incorporated into the master database.

As shown in Figure 8.1, the digital inspection system is comprised of three (3) tiers. The master database is maintained by the PHA. All digital inspection information is housed there for analysis and reporting, as well as the ability to provide inspection firms historical inspection information at the start of their inspections. Firms will be provided a digital inspection database template in SQL database format (e.g. Microsoft Access) with basic forms to allow for data entry. While the data is not required to be directly entered into the digital database template, submission to the port is required to be in the exact SQL structure provided, as the data will be digitally be inspected then imported into the master database. Detailed instructions for use of the system will be provided with the digital database template. The methodology of collecting data in the field is left to the inspection firm.

Upon completion of the inspection, the inspection firm is required to transfer the required inspection documentation into the digital database template originally provided. This provides access to the required report forms to be submitted to the PHA, as well to attach photographs and drawings utilized for the inspection. Contractors should print the standard forms from the database, and review and certify that their findings are correctly entered. Printed versions of these forms should then be submitted as a part of the sealed engineering report.

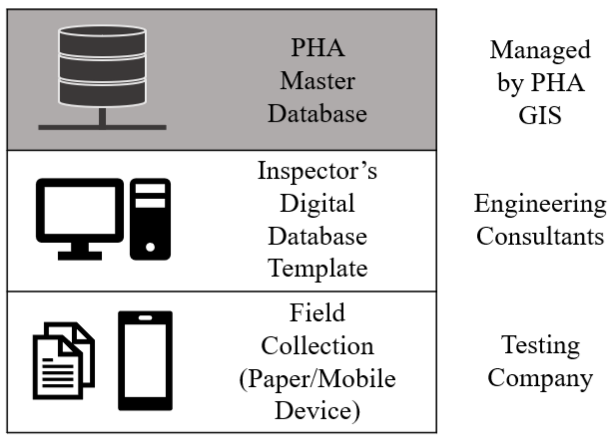

Figure 8.1: Digital inspection database hierarchy

8.11. FICAP Battle Test Access Database Instructions

The battle test FICAP tool has been designed to allow users to collect and enter information into an access database, serving as the intermediate step prior to being uploaded into the Azure DB.

The tool consists of data entry forms to allow quick and simple data capture, as well as a few queries to build a master table and create an overall ACR score for the assets. Navigation through the tool is done by using the navigation panel within Microsoft Access. This panel is divided into 10 sections with their individual purposes, which are defined below.

Main Screen

In this grouping we see three items:

1. Asset Navigation: This page allows the user to navigate through the inventory update forms.

2. frm_INSPECTION_INFORMATION: This form is used to enter meta data about the inspection, such as inspector firm, inspection type etc. This form should be one of the first filled out, as it will simplify data entry for each of the individual assets.

3. Update Master Component Rating Table: This update query is used to rebuild the "INSPECTION_COMPONENT_RATINGS" master CR table. The query will delete the old master table and create a new one with the updated asset IDs and their corresponding component rating.

Core Tables

Most of these tables store critical information for the data entry lookups, report calculations, amongst other data for the tool to work correctly. In a typical inspection or inventory update, these tables should not be modified.

The only table being modified is the db0_INSPECTION_INFORMATION table, done so by using the form found in the "Main Screen" grouping.

Inventory Tables

These tables store inventory information (refer to table F.1 from the manual) and are modified by using the inventory forms.

Inventory Forms

Each of the asset types has its own form for data entry. The process of entering data has been simplified with the use of queried drop-down menus that provide the inspector with the only information that should be entered in that field.

The actions of saving, deleting, adding a new record, and navigating through the inventoried assets is done by using the buttons on these pages.

Inspection Tables

These tables store inspection information (refer to table F.3 from the manual) and are modified by using the inspection forms.

Inspection Forms

Like the inventory forms, each of the asset types has its own form for data entry. The process of entering data has been simplified with the use of queried drop-down menus that provide the inspector with the only information that should be entered in that field.

The actions of saving, deleting, adding a new record, and navigating through the inspected assets is done by using the buttons on these pages.

Reports

The ACR summary report is created by opening the "rpt_COMPONENT_ACR_SUMMARY". When this report is opened it will refresh and rebuild a new version that contains the latest inspection CR ratings.

While the report is open, the inspector can use the access toolbar to display a print preview of the report and print it if required.

*Note: If the report is open while changes are made to the inspection tables, it will have to be closed and re-opened to generate a new report.

Subforms

This section contains subforms required to print the ACR summary. No changes should be made to anything in this set.

Supporting Structures

This section contains queries and supporting structures required to perform various calculations within this tool and should not be modified.

Unassigned Objects

The INSPECTION_COMPONENT_RATINGS master table will be found here due to the nature of the update query. Upon running the update query, this table will be deleted

CHAPTER 9: ADMINISTRATIVE REQUIREMENTS

9.1. Inspection and Condition Assessment Team Qualifications

The inspection and condition assessment of existing electrical distribution and communications facilities requires specialized knowledge and experience to ensure that the results of the evaluation are credible and repeatable and provide the information necessary for the intended asset management purposes. The incongruent electrical and communication assets subclasses introduce additional complexities with regards to inspection and condition assessment and typically requires deep knowledge and extensive experience of various asset subclasses.

The inspection and condition assessment of electrical distribution and communications assets should be carried out by a team with the appropriate knowledge and experience, including:

a. Design, evaluation, maintenance, and repair knowledge specific to electrical distribution, communications, and associated civil assets including:
   - Design requirements specific to electrical distribution, communications and associated civil components
   - Understanding of electrical and communications equipment and ability to interpret significance of observed damage, deterioration, or other functional or integrity asset deficiencies
   - Understanding of applicable electrical and mechanical tests used to assess asset condition, and the knowledge to interpret such test results
   - Familiarity with advanced diagnostic, repair, and rejuvenation methods as they relate to electrical distribution, communications, and associated civil components and elements

b. Visual, IR scanning, electrical and mechanical testing, and materials sampling for assessing existing assets

c. Degradation and aging mechanisms found in electrical distribution, communications, and associated civil assets

d. Methods and requirements for characterizing and quantifying damage and degradation

e. Experience with the performance and interpretation of engineering analyses

f. Inspection and condition assessment documentation and reporting requirements

g. Safety requirements for conducting inspections and maintenance testing

The typical scope and scale of a condition assessment inspection requires that the work is conducted using a team approach. Each team member should have the training, knowledge, and experience necessary to conduct the aspects of the inspection and condition assessment for which they are involved or responsible. The intent of this document is not to determine the specific elements of an inspection and condition assessment team, but to propose a typical team structure and define required minimum qualifications for team members.

The typical project team structure consists of an Inspection and Condition Assessment Project Manager who oversees the inspection team and a team of engineers/technologists responsible for conducting the condition evaluation. The same personnel may be involved in both the inspection and condition assessment if their qualifications are appropriate, or the two teams may be separate.

The following sections present minimum qualification requirements for the on-site inspection team, for the condition assessment team, and for individual team members. The responsibilities and qualifications for the overall project manager are defined as part of the on-site inspection team, although this person is also responsible for the condition assessment scope.

9.1.1. Inspection Team Composition and Qualifications

A typical organizational structure for an on-site inspection team is illustrated in Figure 9.1. Although the number of persons on a team may vary from project to project, the minimum number of personnel for the on-site inspection should be one Team Leader and one Team Member for safety and practical reasons. For illustration purposes, the inspection team is split into electrical distribution and communications, and civil asset classes, although in practice some personnel may take part in multiple aspects of the inspection. The on-site inspection team structure shown in Figure 9.1 may apply to teams consisting of PHA personnel, consultants, or some combination thereof.

The minimum qualifications for the members of the on-site inspection team (Figure 9.1) are defined below. The PHA Director of Project and Construction Management may adjust qualification requirements on a project-specific basis. Post-event inspector qualifications will be at the discretion of the PHA Director of Project and Construction Management.

Inspection and Condition Assessment Project Manager

- Responsible for overall direction and supervision of project team conducting the inspection and condition assessment.
- Responsible for overall project scope, including:
  - On-site inspection and maintenance activities;
  - Condition assessment and rating;
  - Documentation and reporting;
  - Recommendation of follow-up actions; and,
  - Establishing a quality assurance and quality control process for the inspection and condition assessment.
- Responsible for coordinating inspection teams.
- Primary point of contact with PHA Project Manager.

Electrical Distribution and Communications Inspection Team Supervisor

- Responsible for planning, preparing, and performing inspections, and testing including day-to-day inspection activities.
- Responsible for direction and supervision of Inspection Team Members.
- Responsible for communication with Project Manager at regular intervals.
- Must always be on-site during inspection.
- Must inspect a minimum of 25% of the electrical distribution and communications assets.
- Must observe and evaluate all unusual asset conditions and problems, including those noted by Electrical Distribution and Communications Inspection Team Members.

Civil Assets Inspection Team Supervisor

- Responsible for planning, preparing, and performing civil asset inspections, including day-to-day activities.
- Responsible for communication with Project Manager at regular intervals.
- Must always be on-site during civil asset inspection.
- Must inspect a minimum of 25% of the civil assets.
- Must observe and evaluate all unusual civil conditions and problems noted during inspection, including those indicated by Civil Asset Inspection Team Members.

Electrical Distribution and Communications Inspection Team Member

- Under the direction of the Electrical Distribution and Communications Team Leader assists the with some or all aspects of day-to-day inspection and testing activities.

Civil Assets Inspection Team Member

- Under the direction of the Civil Assets Team Leader, assists the with some or all aspects of day-to-day inspection activities.

Figure 9.1: On-site inspection team composition and responsibilities

The minimum qualifications for the members of the on-site inspection team (Figure 9.1) are defined In Table 9.1 below.

Table 9.1: Onsite Inspection Team – Minimum Qualifications[27]

Inspection and Condition Assessment Project Manager	• Registered Professional Engineer licensed in the State of Texas. • Specialized in electrical distribution system engineering (alternatively communications systems engineering, if scope of work is exclusive to communication systems). • A minimum of 10 years of experience in the inspection, design and/or construction of electrical distribution and communication equipment, including medium and low voltage equipment. • Successfully completed the Port of Houston Electrical Distribution and Communications Facility Inspection Training Program[28].
Electrical Distribution and Communications Inspection Team Leader	• Successfully completed the Port of Houston Electrical Distribution and Communications Facility Inspection Training Program[28]. and one of the following two • Registered professional engineer, or Certified Technical Tradesperson (Electrical) or equivalent or • A minimum of 7 years of experience in inspection of electrical distribution and communication assets, including medium voltage equipment.
Electrical Distribution and Communications Inspection Team Member	• Successfully completed the Port of Houston Electrical Distribution and Communications Facility Inspection Training Program[28]. and one of the following two • Graduate of a four-year engineering curriculum (electrical and certified as EIT), or Certified Technical Tradesperson (Electrical) or equivalent or • A minimum of 3 years of relevant experience in inspection of electrical distribution and communications equipment, including medium voltage equipment.
Civil Assets Inspection Team Leader	• Successfully completed the Port of Houston Electrical Distribution and Communications Facility Inspection Training Program[28]. and one of the following two • Registered professional engineer, or Certified Technical Tradesperson (Electrical or Civil) or equivalent or • A minimum of 7 years of experience in inspection of civil assets associated with electrical distribution and communications facilities.

[27] The PHA Director of Project and Construction Management may adjust qualification requirements on a project-specific basis. Post-event inspector qualifications will be at the discretion of the PHA Director of Project and Construction Management.
[28] Completion of the Port of Houston Electrical Distribution and Communications Facility Inspection Training Program is valid for a period of five (5) years, after which time the Training Program must be retaken.

Civil Assets Inspection Team Member	• Successfully completed the Port of Houston Electrical Distribution and Communications Facility Inspection Training Program[28]. and one of the following two • Graduate of a four-year engineering curriculum (electrical and certified as EIT), or Certified Technical Tradesperson (Electrical) or equivalent or • A minimum of 3 years of relevant experience in inspection of civil assets associated with electrical distribution and communications facilities.
Other Team Members	• Other personnel with lesser qualifications than those defined above may be present to perform manual tasks related to the inspection or to support operations.

9.1.2. Condition Assessment Team Composition and Qualifications

The condition assessment requires an engineering interpretation of the on-site inspection findings. Accordingly, the condition assessment team will largely consist of engineers. The structure for the condition assessment team is less formal than that of the on-site inspection team. The condition assessment team is led by the Inspection and Condition Assessment Project Manager as defined in the preceding section. Apart from the Project Manager, there are no specific requirements for condition assessment team composition or team member qualifications, except that all personnel involved with the condition assessment must have successfully completed the Port of Houston Electrical Distribution and Communications Facility Inspection Training Program. The personnel signing the condition assessment report shall be a Professional Engineer.

9.2. Safety Requirements

Inspection of an existing electrical, communication and related civil asset presents numerous inherent safety risks for inspection personnel. Proper safety training and certification of inspection personnel is essential, as is continual awareness of safety concerns by all team members during the conduct of the inspection. Job safety must meet local and state regulations.

The inspection team Project Manager and the inspection team supervisors should have solid understanding of the rules and standards that administer safe inspection and testing and are responsible for providing safe working conditions during the inspection, including:

- Ensuring all team members have appropriate safety training in the application of safety procedures and use of safety equipment applicable to their job functions and site/facility standards
- Responsibility to ensure every team member on the site is aware of electrical hazards and are aware of how to stay safe around them
- Before starting an electrical and mechanical testing, ensure that all the applicable live components are de-energized and follow site-specific Lock-Out / Tag-Out procedures. Contact with a live asset or working too close to a live asset can cause severe injuries, and in some cases, death.
- Before entering any confined space location, ensure that all applicable site/facility safety procedures pertaining to confined spaces are familiar to all team members and complied with during the Inspection and Condition Assessments.

- Providing necessary safety equipment
- Discussing safety procedures for each inspection task with team members
- Enforcement of safety procedures and regulations

Individual inspection team members should have solid understanding of the rules and standards that administer safe inspection and testing and are responsible for their own safety and the safety of others, including:

- Knowledge of PHA safety rules and regulations, including but not limited to safe limits of approach, confined space entry, lock out tagout, and manhole evacuation procedures.
- Use of appropriate personal protection equipment and clothing
- Safety of other team members (warn others of unsafe actions)
- Recognition of personal limitations (lack of knowledge or skill, physical limitations)
- Maintaining appropriate attitude and awareness during inspection (avoiding distraction and boredom, ignoring, or not recognizing hazards, etc.)
- Reporting of accidents and injuries
- Access and knowledge on use of necessary safety equipment

9.2.1. PHA Safety Policy

The Project Manager and all members of the inspection team must be familiar with the Port of Houston Health and Safety Policy and must attend a Contractor and Consultant Safety Orientation before beginning work at Port Houston. Consultants and contractors shall abide by the tariff assigned to each terminal as outlined by the contract.

The inspection team is responsible for providing their own personal protection equipment, including:

- **High Visibility Vest** required inside the property or conducting work adjacent to a roadway.
- **Hard Hats** required where an overhead hazard is present for work specially in MV asset zones, construction zones, under cranes, in confined spaces or where an overhead hazard is present.
- **Safety Footwear** required in a construction zone or where a foot hazard is present.
- **Safety Glasses** with ANZI Z87.1 rating with side shields, required for work in a construction zone or where an eye hazard is present.
- **Arc Flash Protective Clothing** and face shield required when arc flash risk is present.
- **Hearing Protection** required for work in a construction zone or where noise levels exceed.
- **Hand Protection**, appropriate for exposure to the specific type of hazard (e.g. electrical, chemical – oils, etc.) is required where a hand hazard is present.

Additional safety related requirements and practices will be addressed in the PHA Safety Orientation. In the event of a medical emergency, fire, vehicle incident, chemical spill, or chemical leak, the PHA Dispatch must be notified at 713-670-3611.

Note that all current PHA Health and Safety Policies and the requirements of the PHA Safety Orientation will supersede the safety-related content in this manual in the event of a discrepancy.

9.3. Other Administrative Requirements

Consultants and contractors shall comply with Security Requirements, Insurance, Limitation and Responsibility, and other issues as outlined by the contract.

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CHAPTER 10: REFERENCES

10.1. Cited References

IEEE. (2000). *IEEE 100: The Authoritative Dictionary of IEEE Standard Terms, Seventh Edition.* New York, New York: Institute of Electrical and Electronics Engineers.

ANSI/NETA MTS (2011), Standard for Maintenance Testing Specification for Electrical Power Equipment and Systems

10.2. Suggested References

The select references below provide additional information on the subjects relevant to the FICAP program.

IEEE Std. C57.12.90 – Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.

IEEE Std. 1861-2014 – Guide for On-Site Acceptance Tests of Electrical Equipment and System Commissioning of 1000 kV AC and Above

ASTM standards related to the oil quality assessment including but not limited to:

- Breakdown Voltage (ASTM D877)
- Neutralization (ASTM D974)
- Interfacial Tension (ASTM D971)
- Moisture content (ASTM D533)
- Power Factor (ASTM D924)
- Color and visual (ASTM D1524)

APPENDIX A – PHA Electrical Distribution Asset List

NOTICE TO READER

The asset lists in the following pages reflect actual information from two selected facilities; Bayport and Barbours Cut. Each page represents one substation or asset grouping based on historical maintenance practices. These asset lists are provided as indicative examples of the minimum requirements of what should be included in the current asset listing, which is managed by the PHA. For current versions of the Asset Lists, the reader is encouraged to contact the GIS site, Portview, which is available on PHA's SharePoint system. Readers can also contact the Manager of the GIS team

BAYPORT TERMINAL SUBSTATIONS

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: 12.47 KV Cables and Crane Loop switches		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	12.47 Loop feeder tie switches	12.47	3	
2	12.47 Crane Loop switches	12.47	12	
3	Sets of 3 phase cables- Loop switches	12.47	18	
4	Sets of 3 phase cables- Crane switches	12.47	24	
5	iDP 210 Relay		12	
6	SE 134C Ground check relays		12	
7	Oil samples including DGA		12	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: MAIN 138 KV		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	SF6 Breakers	138	5	Including time-travel analysis.
2	Air switches	138	13	
3	15/25 MVA, 138- 12.47 KV Transformers	138	3	Including tap changer insp.
4	Outdoor Vacuum Breakers	12.47	14	
5	Air Switches	12.47	28	
6	225 KVA Auxiliary Services Transformers	12.47	3	
7	Schweitzer Relays 351,387, 551		20	
8	Lightning Arresters	12.47	36	
9	Sets of MV cables	12.47	9	VLF tests only.
10	Local and remote breaker tripping	12.47		Function testing
11	Grounding Resistors	12.47	3	
12	Outdoor Bus Structures			All 138 and 12.47 KV buses
13	Lightning Arresters	138	6	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Auto Terminal.		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	3000 amps switchboards	0.48	1	
2	800 ATS	0.48	1	
3	Dry Type Transformers < 150 KVA	0.48	7	
4	Distribution panels <400 amps		19	
5	600 amps panelboard	0.48	1	
6	400 amps panels	0.48	2	
7	400 Amps MCC	0.48		
8	2000 KVA Oil filled transformer	12.47	1	
9	MCBs > 400 Amps	0.48	7	
10	Dry Type Transformers 225 KVA	0.48	1	
11	Medium Voltage Vacuum Switches	12.47	9	
12	iDP Relays		6	
13	Sets of MV Cables	12.47	3	
14	Oil samples including DGA			

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Building Services Subs 1.		
ITEM	**DESCRIPTION**	**KV**	**QTY**	**REMARKS**
1	1600 amps switchboards	0.48	1	
2	1000 KVA Oil filled transformer	0.48	1	
3	Dry Type Transformers < 150 KVA	0.48	1	
4	Distribution panels <400 amps	0.48	5	
5	iDP 210 Relay		1	
6	12.47 KV set of cables	12.47	2	
7	Vacuum three way loop switch	12.47	1	Mounted on power Xmer
8	MCBs> 400 amps	0.48	3	Primary injection testing
9	Oil Samples including DGA		3	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Building Services Subs 2.		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	1600 amps switchboards	0.48	1	
2	1000 KVA Oil filled transformer	0.48	1	
3	Dry Type Transformers < 150 KVA	0.48	1	
4	Distribution panels <400 amps	0.48	5	
5	iDP 210 Relay		1	
6	12.47 KV set of cables	12.47	2	
7	Vacuum three way loop switch	12.47	1	Mounted on power Xmer
8	MCBs> 400 amps	0.48	3	Primary injection testing
9	Oil Samples including DGA		3	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Building Services Sub 4.		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	1600 amps switchboards	0.48	1	
2	1000 KVA Oil filled transformer	0.48	1	
3	Dry Type Transformers < 150 KVA	0.48	1	
4	Distribution panels <400 amps	0.48	5	
5	iDP 210 Relay		1	
6	12.47 KV set of cables	12.47	2	
7	Vacuum three way loop switch	12.47	1	Mounted on power Xmer
8	MCBs> 400 amps	0.48	3	Primary injection testing
9	Oil Samples including DGA		3	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Central Plant & Admin Bldg		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	Three way oil filled loop switch	12.47	2	
2	Oil filled 3 MVA transformers	12.47	2	
3	3000 busducts	0.48	2	Inspect, Megger, Contact Resistance
4	Air circuit breakers	0.48	13	
5	sets of primary cables	12.47	4	
6	Double ended 4 KA switchboard	0.48	1	
7	Single ended 1 KA switchboard	0.48	1	
8	600 amps ATS	0.48	1	
9	600 amps emergency switchboard	0.48	1	
10	Distribution panels < 400 amps		7	
11	iDP 210 Relays.		2	
12	Oil Samples including DGA		4	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Gate Services Bldg		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	2000 amps switchboards	0.48	1	
2	1500 KVA Oil filled transformer	0.48	1	
3	Dry Type Transformers < 150 KVA	0.48	18	
4	Distribution panels <400 amps	0.48	15	
5	Main breaker 2500 amps	0.48		
6	MCBs < 400 Amps	0.48	10	
7	MCBBs > 400 Amps	0.48	2	
8	iDP 210 Relay		1	
9	12.47 KV set of cables	12.47	2	
10	Vacuum three way loop switch	12.47	1	Mounted on power Xmer
11	Oil samples including DGA tests		2	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Maintenance and Repair and Marine Emergency Bldgs.		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	1600 amps switchboard	0.48	1	
2	600 amps MCC	0.48	1	
3	Molded case breakers	0.48	10	
4	Dry type transformers < 150KVA	0.48	5	
5	400 amps integrated switchboard	0.48	1	
6	Distribution panels < 400 amps		15	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Reefer Substation 1		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	3000 amps switchboards	0.48	1	
2	2000 KVA Oil filled transformer	12.47	1	
3	Dry Type Transformers < 150 KVA	0.48	1	
4	Distribution panels <400 amps	0.48	6	
5	iDP 210 Relays		1	
6	12.47 KV set of cables	12.47	2	
7	Vacuum three way loop switch	12.47	1	Mounted on power Xmer
8	MCBs> 400 amps	0.48	5	Primary injection testing
9	Capacitor bank	0.48	1	
10	Oil samples including DGA		1	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Reefer Substation 2		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	3000 amps switchboards	0.48	1	
2	2000 KVA Oil filled transformer	12.47	1	
3	Dry Type Transformers < 150 KVA	0.48	1	
4	Distribution panels <400 amps	0.48	6	
5	iDP 210 Relays		1	
6	12.47 KV set of cables	12.47	2	
7	Vacuum three way loop switch	12.47	1	Mounted on power Xmer
8	MCBs> 400 amps	0.48	5	Primary injection testing
9	Capacitor bank	0.48	1	
10	Oil samples including DGA		1	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Reefer Substation 3		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	3000 amps switchboards	0.48	1	
2	2000 KVA Oil filled transformer	12.47	1	
3	Dry Type Transformers < 150 KVA	0.48	1	
4	Distribution panels <400 amps	0.48	6	
5	iDP 210 Relays		1	
6	12.47 KV set of cables	12.47	2	
7	Vacuum three way loop switch	12.47	1	Mounted on power Xmer
8	MCBs> 400 amps	0.48	5	Primary injection testing
9	Capacitor bank	0.48	1	
10	Oil samples including DGA		1	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Reefer Substation 4		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	3000 amps switchboards	0.48	1	
2	2000 KVA Oil filled transformer	12.47	1	
3	Dry Type Transformers < 150 KVA	0.48	1	
4	Distribution panels <400 amps	0.48	6	
5	iDP 210 Relays		1	
6	12.47 KV set of cables	12.47	2	
7	Vacuum three way loop switch	12.47	1	Mounted on power Xmer
8	MCBs> 400 amps	0.48	5	Primary injection testing
9	Capacitor bank	0.48	1	
10	Oil samples including DGA		1	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Reefer Substation 6S1		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	3000 amps switchboards	0.48	1	
2	2000 KVA Oil filled transformer	12.47	1	
3	Dry Type Transformers < 150 KVA	0.48	1	
4	Distribution panels <400 amps	0.48	6	
5	iDP 210 Relays		1	
6	12.47 KV set of cables	12.47	2	
7	Vacuum three way loop switch	12.47	1	Mounted on power Xmer
8	MCBs> 400 amps	0.48	5	Primary injection testing
9	Capacitor bank	0.48	1	
10	Oil samples including DGA		1	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Reefer Substation 6S2		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	3000 amps switchboards	0.48	1	
2	2000 KVA Oil filled transformer	12.47	1	
3	Dry Type Transformers < 150 KVA	0.48	1	
4	Distribution panels <400 amps	0.48	6	
5	iDP 210 Relays		1	
6	12.47 KV set of cables	12.47	2	
7	Vacuum three way loop switch	12.47	1	Mounted on power Xmer
8	MCBs> 400 amps	0.48	5	Primary injection testing
9	Capacitor bank	0.48	1	
10	Oil samples including DGA		1	

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Stevedore Support Bldg. 2		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	600 amps switchboards	0.48	1	
2	400 ATS	0.48	1	
3	Dry Type Transformers < 150 KVA	0.48	2	
4	400 Amps MCBs	0.48	1	
5	Panels < 400 amps	0.208	1	
6				

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Stevedore Support Bldg. 3		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	600 amps switchboards	0.48	1	
2	400 ATS	0.48	1	
3	Dry Type Transformers < 150 KVA	0.48	2	
4	400 Amps MCBs	0.48	1	
5	Panels < 400 amps	0.208	1	
6				

PORT OF HOUSTON AUTHORITY				
MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BAYPORT		SUBSTATION ID: Stevedore Support Bldg. 5		
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	600 amps switchboards	0.48	1	
2	400 ATS	0.48	1	
3	Dry Type Transformers < 150 KVA	0.48	2	
4	400 Amps MCBs	0.48	1	
5	Panels < 400 amps	0.208	1	
6				

BARBOURS CUT TERMINAL SUBSTATIONS

MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BARBOURS CUT			SUBSTATION ID: FIRE BARRACKS	
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	LV switchboards > 800 Amps	0.48	1	
2	MCBs > 400 Amps	0.48	1	
3	Pad Mount Transformer	12.47	1	
4	Set Primary Cables	12.47	1	
5	Oil Sample including DGA test		1	

MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BARBOURS CUT			SUBSTATION ID: NEW WHARF 1	
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	Three way oil filled loop switch	12.47	6	
2	Oil filled 500 KVA transformer	12.47	1	
3	Air circuit breakers > 400A	0.48	1	
4	sets of primary cables	12.47	6	
5	Dry type 50 KVA transformer	0.48	1	
6	Distribution panels < 400 amps	0.48	1	
7	150 Amps MTS	0.48	1	
8	iDP 210 Relays.		5	
9	Distribution panels < 400 amps	0.48	3	
10	Oil Samples including DGA		4	

MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BARBOURS CUT			SUBSTATION ID: NEW WHARF 2	
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	Three way oil filled loop switch	12.47	6	
2	Oil filled 500 KVA transformer	12.47	1	
3	Air circuit breakers > 400A	0.48	1	
4	sets of primary cables	12.47	6	
5	Dry type 50 KVA transformer	0.48	1	
6	Distribution panels < 400 amps	0.48	1	
7	150 Amps MTS	0.48	1	
8	iDP 210 Relays.		5	
9	Distribution panels < 400 amps	0.48	3	
10	Oil Samples including DGA		4	

MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BARBOURS CUT			SUBSTATION ID: OLD SUBSTATION No 1	
ITEM	**DESCRIPTION**	**KV**	**QTY**	**REMARKS**
1	MV fused air switches	12.47	15	
2	MV air circuit breakers	12.47	7	
3	GE Electromechanical relays		28	
4	Oil filled power transformers	12.47	9	
5	MV compartments	12.47	18	
6	Sets of MV cables	12.47	12	
7	LV switchboards	0.48	7	
8	MCBs > 400 Amps	0.48	4	
9	1200 Amps ATS	0.48	1	
10	Oil Samples including DGA		9	

MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BARBOURS CUT			SUBSTATION ID: SUBSTATION No 4	
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	MV fused air switches	12.47	12	
2	MV air circuit breakers	12.47	5	
3	GE Electromechanical relays		20	
4	Oil filled power transformers	12.47	6	
5	MV compartments	12.47	18	
6	Sets of MV cables	12.47	5	
7	LV panelboards	0.48	4	
8	Grounding resistors	7.2	2	
9	MCBs > 400 Amps	0.48	8	
10	Oil Samples including DGA tests		6	

MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BARBOURS CUT			SUBSTATION ID: SUBSTATION No 5	
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	MV fused air switches	12.47	10	
2	MV air circuit breakers	12.47	5	
3	GE Electromechanical relays		20	
4	Oil filled power transformers	12.47	5	
5	MV compartments	12.47	17	
6	Sets of MV cables	12.47	5	
7	LV panelboards	0.48	3	
8	Grounding resistors	7.2	2	
9	MCBs > 400 Amps	0.48	4	
10	Oil Samples including DGA tests		5	

MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BARBOURS CUT			SUBSTATION ID: SUBSTATION No 6	
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	MV fused air switches	12.47	11	
2	MV air circuit breakers	12.47	5	
3	Digitrip 3000 relays		5	
4	Oil filled power transformers	12.47	5	
5	MV compartments	12.47	15	
6	Sets of MV cables	12.47	5	
7	LV switchboards > 800 Amps	0.48	3	
8	Grounding resistors	7.2	2	
9	MCBs > 400 Amps	0.48	4	
10	Oil Samples including DGA tests		5	

MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BARBOURS CUT			SUBSTATION ID: NEW MAIN 12.47 KV SUBSTATION (BLDGS A AND B)	
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	1200 Amps Switch	12.47	2	
2	1200 Amps Vacuum Breakers	12.47	8	
3	75 KVA Station Service Transformers	12.47	2	
4	1200 Amps Metal Clad Switchgear, 6 Bays Each	12.47	2	
5	GE Multilin 350 Relay		8	
6	Distibution panels	0.24	2	
7	Fused switch	12.47	2	For auxiliary services Xmer
8	Medium voltage cable sets	12.47	6	VLF testing

MAINTENANCE TESTING OF ELECTRICAL SYSTEMS				
LIST OF ELECTRICAL EQUIPMENT PER SUBSTATION				
TERMINAL: BARBOURS CUT			SUBSTATION ID: PRE- CHECK,	
			ENTRY AND EXIT GATES	
ITEM	DESCRIPTION	KV	QTY	REMARKS
1	LV Switchboards< 400 Amps	0.48	5	
2	MCBs > 400 Amps	0.48	3	
3	Dry Type Transformers < 225 kVA	0.48	9	
4	Automatic Transfer switches	0.48	3	225, 400 and 800 A
5	Distribution Panels> 400 Amps	0.208	1	
6	Lighting Panels	0.208	14	

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APPENDIX B – GLOSSARY OF TERMS

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Term	Definition
American National Standards Institute (ANSI)	The primary organization for fostering the development of technology standards in the United States. website: www.ansi.org
American Society for Testing and Materials (ASTM)	An organization that develops international standards for materials, products, systems, and services used in construction, manufacturing, and transportation Website: www.astm.org.
Antennas	The part of a transmitting or receiving system that is designed to radiate or to receive electromagnetic waves.
Arc	For overhead powerlines, a luminous discharge of electricity across an insulating medium, usually accompanied by the partial damage of the electrodes. Visible discharge is called corona.
Arc Flash Study	The evaluation of a workplace facility (switchgear) by an electrical safety expert to determine hazards and risks in relation to electrical systems. With the help of a system model, the amount of energy released during an electrical fault can be calculated. This is used to determine the PPE required, and safe working distances from electrical components prone to arc flashes.
Asset (Class) Condition Rating	Reflects the overall condition of the components within the defined asset class and is based on the component ratings assigned to the electrical and communication components (functional components) and civil components of the asset class. Calculated as a score out of 100.
Asset Class	A group of assets that perform a specific function.
Asset Class HV	Asset class HV comprises of typical high voltage (HV) components.
Asset Class LV	Asset class LV comprises of low voltage (LV) PHA distribution system assets.
Asset Class MV	Asset class MV comprises of typical medium voltage (MV) distribution system components.
Asset Replacement Value	The monetary cost (including materials, labor, and overhead cost) to replace an asset with a new one, expressed in present day dollars.
Backfeed	To energize a section of a power network in the reverse direction from the normal power flow.
Baseline Inspection	An asset-wide inspection to provide strong baseline data as it relates to inspection and maintenance for comparison with future inspections.
Bushing	An insulating structure, including a through conductor, or providing a passageway for such a conductor through an object, barrier, or wall.
Cable Joint	A connection between two or more separate lengths of cable with the conductors in one length connected individually to conductors in other lengths and with the protecting sheaths so connected as to extend protection over the joint.
Cable Rejuvenation	Process to restore the insulating properties of XLPE stranded cables.

Term	Definition
Cable Shielding	The practice of confining the electric field of the cable to the insulation surrounding the conductor by means of semiconducting layers, conductors (shielded or braided), or both, which are in contact or bonded to the inner and outer surfaces of the insulation.
Cable Tray	A unit or assembly of units or sections, and associated fittings, made of metal or other noncombustible material forming a continuous rigid structure used to support cables.
Capacitive Voltage Transformer (CVT)	This device, typically found only on high voltage systems, converts large voltages to small voltages.
Circuit Breaker	A device designed to open and close an electrical circuit, and to open the circuit automatically on a predetermined overload of current, without injury to itself when properly applied within its rating. The device can interrupt a load and in some cases a fault current (see also *Switch*).
Circuit Breaker Trip	A circuit breaker that shuts off the electrical flow to protect the circuit or downstream connected elements from damage.
Civil Asset Class	The asset class composed of all traditional structures within the distribution system that has been componentized into manholes, handholes, cable ducts and fencing.
Civil Component Combined Rating	A combined rating based on the condition of applicable civil components with a maximum score of 20. This may include manholes, handholes, duct bank and fencing.
Commissioning Tests	Tests applied to an asset, or system of assets, at site to show that the asset has been installed correctly and is able to operate as intended.
Communication Asset Class	A distinct class of asset that serve the purpose of security communications, technical information exchange and monitoring and control of HV, MV and LV assets in the PHA Properties.
Communication Channel	A facility that permits signaling between two points.
Communications Termination Points	Communications Termination Points connect communication cables from one location to another.
Component	A lower level asset, within the asset hierarchy, that belongs to an asset class.
Component Rating	Indicates the overall condition of a component and are determined based on engineering interpretation of the inspection findings for the elements that make up the component.
Condition Assessment	A condition assessment is an evaluation of the inspection results considering the significance of observed conditions. It is based on technical judgment considering qualitative and quantitative inspection findings and may be supplemented by engineering calculations.
Condition States	Provides a means for the Inspection Team to characterize and quantify any observable conditions exhibited by an individual element.

Term	Definition
Conduit	A metal or plastic raceway. If encased in concrete or other rigid materials, it is called a duct within a duct bank. Not all conduit is installed in a duct bank.
Contact Resistance	Resistance to current flow, due to surface conditions on the contacts of a switching device (switch, circuit breaker, etc.) when contacts are touching one another.
Copper Wire Pair	Twisted pair of copper cables used for signals communications to help reduce noise and distortion.
Cross Linked Polyethylene Cable (XLPE)	MV or HV electrical cables insulated by cross-linked polyethylene insulation material.
Current Transformer (CT)	This device transforms large currents to small manageable currents. The small currents are used for displays, relaying (protection) or metering purposes. The CT accuracy determines which application it can be used for. *See* Instrument Transformer.
Delta Configuration	In a 3-phase power system, the Delta configuration has the three phases connected like a triangle. There is no neutral point. Voltage is measured "Line to Line" or phase to phase.
Destructive Sampling/Testing	Prolonged endurance testing of equipment or a specimen until it fails to determine service life or design weakness. Samples used for destructive testing are not returned to service.
Dissipation Factor Test	Also known as a tangent delta test or power factor test to measure the dielectric losses in an insulation.
Dissolved Gas Analysis (DGA)	DGA is widely accepted test to detect gases in oil that leads to incipient faults in oil-immersed transformers
Distribution Transformers	Transferring electrical energy from a primary distribution circuit (medium voltage, MV) to a secondary distribution circuit (low voltage, LV) or consumer's service circuit.
Duct Bank	The duct bank typically consists of plastic or metal ducts (conduit) encased in concrete. It contains electrical and communication underground cables. The duct bank provides mechanical protection of the cable, and a well-defined route, allowing more safe construction around the power cable and easier installation/replacement.
Dynamic Resistance Measurement	A test for evaluating MV or HV circuit breaker performance to assess the breaker contacts' condition.
Electrical Distribution and Communications Asset	A reporting unit which has a defined boundary and serves a functional purpose. Four primary asset classes are considered: MV asset class, LV asset class, civil asset class, and communication asset class.
Electrical Distribution and Communications Facility Inspection and Condition Assessment Program (FICAP) Manual	This FICAP manual defines the requirements, documentation, and reporting for inspection and condition assessments of electrical distribution and communication assets at facilities owned or operated by the PHA.

Term	Definition
Electrical Metallic Tubing (EMT)	A thin-walled metal raceway of circular cross section constructed for the purpose of the pulling in wires or cables after it is installed. It provides less mechanical protection than conduit as it is lighter (thinner walls).
Element	Each component is comprised of one or more elements. Element types are defined by the component to which it belongs, its functional purpose.
Element Code	This code is used to indicate the element type for ease of documentation. The first two (2) to four (4) letters of the code before the dash are descriptive of the associated component and the last two or three letters indicate the element type, as defined in Table 3.1.
Element Descriptor	A unique name is given for the individual element, as defined in Table 3.1.
Element Identification	The element is described in narrative for identification and categorization by the field inspection personnel.
Element Type	Element types are defined by the component to which it belongs, its functional purpose.
Element-Based Inspection	Documents the condition of each inspected element of the asset, and requires quantification of each condition type, severity, and extent for a given element.
Engineering Analysis	For this manual, "engineering analysis" is assumed to include but not limited to power system studies, advance statistical analysis to assess the impact of select refurbishment type on the service life of asset, new technology evaluation, overloading and assessment of component loss life, prediction for an asset life based on failure of probability vs asset condition rating, and other as appropriate.
Ethylene-Propylene Rubber Cable (EPR)	Electrical power cables insulated by ethylene-propylene rubber is a generic term for a wide range of polymers based on copolymers of ethylene and propylene. It is more resistant to certain aging factors. It has an operating design temperature of 105 deg C, instead of the standard 90 deg C, thus permitting a higher ampacity for the same size cable, or, a smaller size cable for a given ampacity when compared to XLPE.
Fault Currents	A current that flows from one conductor to ground or to another conductor owing to an abnormal connection or event in the power grid (including an arc). A fault current flowing to ground may be called a ground fault current.
Fiber Optic	Fiber optic refers to the technology and medium used in the transmission of data as pulses of light through a strand or fiber medium made of glass or plastic (optical fiber), versus being sent as electrical pulses through conductive metal, like copper wires.
Fiber Optic Cables	A cable containing one or more optical fibers.
Fiber Optic Core	The core of a conventional optical fiber is a cylinder of glass or plastic that runs along the fiber's length. The core is surrounded by a medium with a lower index of refraction, typically a cladding of a different glass, or plastic.
Frequency Response Analysis (FRA)	Frequency response analysis is a measure of magnitude and phase of the output as a function of frequency, in comparison to the input.
Functional Component Combined Rating	A combined rating based on condition of functional components with a maximum score of 80. This includes all applicable electrical or communication components.

Term	Definition
Fuse	A device that protects a circuit by controlled melting (open state) its current-responsive element when an overcurrent or short-circuit current passes through it.
Geographic Information System (GIS)	A system designed to capture, store, manipulate, analyze, manage, and present all types of data that is linked on a coordinate system.
Grounded-Wye Connection	Power and distribution transformers so connected that one end of each of the windings of a polyphase transformer (or of each of the windings for the same rated voltage of single-phase transformers associated in a poly-phase bank) is connected to a common point (the neutral point) and the other end to its appropriate line terminal.
Grounding Connection	A connection used in establishing a ground and consists of a grounding conductor, a grounding electrode, and the earth (soil) that surrounds the electrode or some conductive body which serves instead of the earth.
Handholes	A civil element which facilitates access to electrical and communications equipment such as cables, etc. Handholes are distinct from manholes as they are generally shallow and cannot be entered.
Harmonic Studies	A series of studies performed to determine harmonic distortion levels and filtering requirements within a facility and to determine if harmonic voltages and currents are at acceptable levels. harmonics are identified by integers (2,3,4, etc.), based on the fundamental frequency (50/60 Hz). Results are expressed in terms of the percent magnitude relative to the fundamental harmonic. *See* IEEE 519.
High Voltage (HV) Assets	A class of nominal system voltages greater than 69 kV
Incipient Faults	Slow developing faults.
In-Depth Inspection	In-Depth Inspections are non-routine inspections which are typically a result of a recommended action from a previous/Routine Inspection or with the purpose to provide additional detailed insight on condition assessment to evaluate the need for more extensive maintenance, refurbishment or like-for-like replacement, upgrades, or retirement of a legacy component.
Infrared Scan (IR Scan)	A non-destructive testing to assess the condition of the asset. An IR scan can examine the asset operating temperature to detect defective/deteriorated elements, bad connections, or overloaded elements.
Inspection	An inspection is an evaluation procedure in which a qualified team leader carries out or supervises the observation, classification, and documentation of the physical or functional condition of an electrical distribution or communications asset.
Institute of Electrical and Electronics Engineers (IEEE)	The IEEE is the world's largest technical professional association. It is a non-profit organization that is dedicated to advancing the theory and application of electrical and electronics engineering and computer science.
Instrument Transformers	Instrument transformers (CT, PT or CVT) transform high voltage and current to standardized level for metering and protection purposes.
Insulation	A material having a high resistance to current flow and used to retard the flow of current to the outside. Insulation is typically rated by the voltage class of equipment it is installed in.

Term	Definition
International Electrical Testing Association (NETA)	NETA is an association of leading electrical testing companies comprised of visionaries who are committed to advancing the industry's standards for power system installation and maintenance.
Key Performance Indicator (KPI)	A measurement of the performance and progress of a particular project, initiative, effort made, power grid performance and/or process, in terms of the aims and goals of a company, or to facilitate continuous improvement (i.e. quality management); examples include power grid reliability, availability, outage frequency, and outage duration.
Legacy Asset or Legacy Component	An asset or component that has lost its original value by being outdated, technically obsolete, or its function no longer provides sufficient productivity.
Linear Components	Assets that are physically very long in shape and are typically described as existing between two points vs. existing at a single point. Examples include power cables, duct banks, overhead distribution lines, etc.
Location	This is the highest level in the asset hierarchy from an inspection and condition assessment perspective.
Low Voltage (LV)	Voltage at 600 V or less.
Maintainable Element	It is an element that can be changed out to repair or refurbish a component or asset.
Maintenance Testing Standard	A document that is used individuals seeking to assure that the electrical power equipment and systems in their care operate reliably and safely in conformance with industry and manufacturer standards and tolerances.
Manholes	An underground element in which a person may enter to access electrical cables, equipment, etc.
Medium Voltage (MV)	A class of nominal system voltages greater than 600 V and up to 69 kV
Medium Voltage Distribution Feeders	All circuit conductors between the service equipment, or the generator switchboard of an isolated plant, and the final branch-circuit overcurrent device.
Metal-Clad Switchgears	Used to protect and control the MV distribution feeders or as a distribution point of medium voltage. They are typically stratified based on the interrupting medium of the circuit breakers which helps to interrupt continuous load current or fault currents. These are 3-phase switching devices.
Molded Case Circuit Breaker	A circuit breaker assembled as an integral unit in a supported and enclosed housing of insulating material.
Motor Control Center	This specialized switchgear is a distribution point for 3-phase voltage typically to motors in a plant but can be used to distribute power to other distribution points.
Nameplate	An element of an asset that identifies its common static data including manufacturer's name and the rating of the asset.

Term	Definition
Nominal Rating	Generic static parameters (i.e. voltage, power, etc.) for a given equipment. Very similar to the equipment class ratings. Nominal ratings are used for equipment sizing. This differs from the actual operating values which may change with time.
Non-Destructive Testing (NDT)	Testing of a nature which does not impair the usability of the asset; examples include infra-red scanning, voltage measurements, online partial discharge tests, etc.
Oil Quality Testing	It's an offline condition monitoring test to assess the condition of oil (acid number, color, breakdown voltage, interfacial tension, etc.).
Oil Reclamation	Oil reclamation is a process to restore the properties of transformer insulating oil close to the new oil. This is commonly done via filtering (Fullers earth method).
Open Looped Configuration	A control system that has no means for comparing the output with input for control purposes. An example within a power grid would include a looped power feeder configuration with an open point.
Operating Voltage	The actual voltage, or nominal voltage present on a portion of the electrical power grid. *See* Voltage Class.
Over Current Protection	A form of protection(s) that operates when current exceeds a predetermined value.
Overhead Distribution System	Type of distribution system composed of overhead wires, poles, pole top insulators, pole-top transformers, and other assets all situated above ground and largely pole-mounted.
Overhead Lines and Components	Overhead (O/H) lines and components form the overhead distribution system which is typically supported on poles structures.
Overhead System Assets	The collection of assets within an Overhead Distribution System, largely comprised of overhead components such as poles, overhead conductors, metal-clad switchgears, and various pole mounted components. (See also *Overheard Distribution System*)
Overloading	Operation of equipment in excess of normal, full load rating, or of a conductor in excess of its rated ampacity. When such a condition persists for a sufficient length of time, it causes damage, failure, or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload.
Pad-Mounted Switchgears	Pad-mounted versions of switchgears are used for underground distribution applications such as switching and protection of underground distribution feeders. They are typically mounted on a concrete pad above ground to support structural loading whose foundation is underground.
Pad-Mounted Transformer	Pad-mounted versions of transformers are compact distribution transformers that steps down from medium voltage levels to service level voltage.
Panelboards	A single panel or group of panel units designed for assembly in the form of a single panel; including buses, automatic overcurrent devices, and with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front.
Paper Insulated Lead Covered Cable	Electrical cables insulated by layers of paper and covered in lead.

Term	Definition
Paper Sampling	Offline condition assessment method (invasive sampling) to assess the degree of polymerization of paper.
Personal Protective Equipment (PPE)	Safety equipment worn by a person to reduce the risk of exposure or general injury
Plan-View Drawing	A plan-view is an orthographic projection of a facility viewed from above.
Point Components	Stationary assets (e.g., pole, transformer, breaker).
Point to Point Antennas	A communication channel that services just two terminals/antennas.
Post-Event Inspection	A Post-Event Inspection is an immediate and rapid inspection that is performed in response to natural disasters (e.g., lightning strikes, floods, hurricanes) or other events (e.g., short-circuit fault, fire) that may have caused damage.
Potential Transformer (PT)	This device converts large voltages to small manageable voltages by changing the magnitude and maintaining the phase. The small voltages are used for displays, relaying (protection), or metering purposes. The PT accuracy determines which application it can be used for. *See* Instrument Transformers.
Power Cables	Power cables are one of the complex linear assets in electrical distribution that can carry power up to a few MWs depending on the voltage class. Power cables serve the purpose of carrying and distributing power to the load.
Power Factor	The ratio of the total power input in watts to the total voltampere.
Primary Winding	For power and distribution transformers, primary winding is the winding on the energy input side. For instrument transformers, it is the winding intended for connection to the circuit that will be measured or controlled.
Programmable Logic Controller (PLC)	A programmable logic controller (PLC) is an industrial solid-state computer that monitors inputs and outputs and makes logic-based decisions for automated processes or machines.
Protection Coordination Studies	A collection of studies undertaken to verify that the protection devices, relays, breakers, fuses, etc. within a system are coordinated correctly and are sized appropriately for the equipment that they are protecting. Coordination means that the device closest to a fault acts first to minimize the impact of the power outage.
Protection Relays	An electric device designed to respond to input conditions in a prescribed manner and, after specified conditions are met, to cause contact operation or similar abrupt change in associated electric control circuits.
Radial Model	Type of distribution system configuration that is simplest and least expensive to operate but has the lowest level of redundancy. All the feeders head out from the substation, and do not loop back or inter-connect with other feeders.
Readily Accessible Elements	Readily accessible elements are elements whose disassembly of the component is not required, may be exposed to open atmosphere or within enclosures that facilitate easy access, do not require removal of other elements, and are not located within confined spaces.
Reliability Analysis	Study performed to assess the reliability of power supply and to evaluate the system reliability indices. It can also be used to evaluate the reliability of a delivery point and the impact of device outage frequency and duration.

Term	Definition
Routers	A functional unit that interconnects two computer networks that use a single network Layer procedure but may use different Data Link Layer and Physical Layer procedures.
Routine Inspection	A Routine Inspection defines the asset condition, component and overall asset ratings, and element condition states at a point in time and allows tracking of conditions over time.
Secondary Winding	For power and distribution transformers, secondary winding is the winding on the energy output side. For instrument transformers, the winding that is intended to be connected to the measuring or control devices.
Service (Useful) Life	The period of time from initial operation to retirement of a system, structure, or component.
Service Voltage Level	Utilization voltage level based on the requirement of the served load.
Short Circuit	The condition in which the output terminals of the power supply are directly connected, resulting in near-zero output voltage and high currents.
Short-Circuit Study	An analysis of an electrical system that determines the magnitude of the currents that flow during an electrical fault.
Single Line Diagram (SLD)	A diagram that shows, by means of single lines and graphical symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
Spalling	Spontaneous separation of a surface layer (concrete) from a metal.
Special Inspection	Inspection in response to specific situations, including Post-Event Inspections, Due Diligence Inspection, and In-Depth Inspection.
Step Down Transformer	A transformer in which the power transfer is from a higher voltage source circuit to a lower voltage circuit.
Step Up Transformer	A transformer in which the power transfer is from a lower voltage source circuit to a higher voltage circuit.
Structured Query Language (SQL)	Database language to create, maintain, and access databases.
Supervisory Control and Data Acquisition (SCADA)	A central control system that consists of network controller interfaces, input/output points, communication equipment, and software. They are used to monitor and control equipment in an industrial process.
Surge Arrestor	Used to protect electrical equipment such as transformers, circuit breakers, cables, and bushings, against the effects of overvoltage caused by incoming surges.
Survival Rate	Part of a survival analysis. Percentage of assets surviving at a given time.
Switch	A manual device used to open and close electrical circuits. *See* Circuit Breaker.
Tap Changer	A selector switch device used to change transformer taps with the transformer de-energized.
Transient Analysis	The analysis of a circuit/network’s response to arbitrary excitations (switching, lightning etc.). This analysis is typically performed in time domain using commercially available solvers (PSpice, EMTP etc.). The obtained outputs are network quantities (currents and node voltages) as a function of time.

Term	Definition
Tree-Resistant Cross-Linked Polyethylene Cable (TR-XLPE)	A type of crosslinked polyethylene (XLPE) used to insulate power cables, developed to-resist the water-treeing failure often experienced by underground cables. *See* XLPE-TR.
Underground System Assets	This collection of assets includes underground components such as medium voltage cables, pad-mounted transformers, pad-mounted switchgears. The type of asset system has a greater security, is largely hidden from view, and is less affected by outside weather or human/foreign interference than overhead system assets. These assets are typically more expensive than equivalent capacity assets installed overhead.
Vibration Analysis	The process of measuring the vibration levels and frequencies of industrial machinery and using that information to determine the “health” of the machine, and its components.
Voltage Class	Distribution system voltage classification in the facility. This is different from the actual operating voltage; for example, MV asset class electrical equipment can be operated at any voltage lower than this (i.e. 15 kV). Some excursions above the nominal voltage are also allowed.
Voltage Transformer	*See* Potential Transformer.

APPENDIX C – ELEMENT DESCRIPTIONS

- Table C-1. MV Elements
- Table C-2. LV Elements
- Table C-3. Communication Elements
- Table C-4. Civil Elements

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Element Code(s)	Element Descriptor	Element Identification	Units[1]
Pad-Mounted Transformer (PMTX)			
PMTX – NP	Pad-Mounted Transformer Nameplate	An element that defines the transformer static data such as KVA rating, frequency, voltage, connection type, insulation level, serial number, oil weight and total weight, cooling type, etc.	EA
PMTX - CPT	Pad-Mounted Transformer Compartment	An element that contains all other spaces enclosed within the transformer. This may include fins, control panels, termination enclosure, etc. The transformer tank is excluded from the compartment.	EA
PMTX – TNK	Pad-Mounted Transformer Tank	An element that houses the winding, insulation and tap changer. This includes any cooling fins that may exist.	EA
PMTX – PAD	Pad-Mounted Transformer Foundation	A partially buried, concrete element that provides a solid foundation to mount the transformer on.	EA
PMTX – GG	Pad-Mounted Transformer Gauges	Necessary monitoring elements (gauges or dials) of the pad-mounted transformer. These elements include, but are not limited to, oil level, temperature, and pressure vacuum gauges.	EA
PMTX – BSH	Pad-Mounted Transformer Bushings	An element that allows a termination point to make electrical connections.	EA
PMTX – OIL	Pad-Mounted Transformer Oil	An element of the transformer insulation (paper-oil combination) and a cooling medium.	EA
PMTX – WDG	Pad-Mounted Transformer Winding	Electrical coils of wire (typically copper) to produce necessary flux.	EA
PMTX – TC	Pad-Mounted Transformer Tap Changer	An element that adjusts the voltage ratio of a transformer. This can be an on-load type (automatic), or an off-load type (manual, only when transformer de-energized, hence locked switch handle).	EA

Table C-1. MV Elements

[1] EA = each, LF = linear foot, SF = square foot,

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Table C-1. MV Elements

Element Code(s)	Element Descriptor	Element Identification	Units[1]
Pad-Mounted Switchgear (PMSG)			
PMSG – CPT	Pad-Mounted Switchgear Compartment	An air-insulated steel or fiberglass reinforced enclosure that houses the busbar, circuit protection device (aka housing), control wiring, and/or other elements.	EA
PMSG – PAD	Pad-Mounted Switchgear Pad	A partially buried concrete element that provides a solid foundation to mount the switchgear on.	EA
PMSG – FUS	Pad-Mounted Switchgear Fuse	An element of a pad-mounted switchgear to disconnect the circuit during the electrical fault.	EA
PMSG – LSW **OR** **PMSG – VSW**	Pad-Mounted Switchgear Load Break Switch OR Pad-mounted Vacuum - Break Switch	An air-insulated gang operated switch that breaks or make the circuit. It may have arc chutes or other arc suppressing components. Vacuum-break switch utilizes a vacuum switch mechanism to break or make the circuit.	EA
MV Power Cables (UGC)			
UGC – INS	Power Cable Insulation	An element that acts as a dielectric between conductors of the cable and conductor to ground. Medium Voltage (MV) cables have a complex insulation system due to the higher electric field.	LF
UGC– JTS	Power Cable Joints, Termination, Splices.	An element that enables the jointing and termination and connection of cables to switchgear transformer, overhead line, and other electrical nodes.	EA
UGC – SH	Power Cable Shielding	A metallic shielding element that provides an adequate uniform electric field within the cable's insulation. It surrounds the cable insulation and is grounded thus basically functioning as an electric stress mitigator.	LF
UGC-CON	Conductor	This element of the MV cable is composed of stranded or solid aluminum or copper to enable the flow of current.	LF

Table C-1. MV Elements

Element Code(s)	Element Descriptor	Element Identification	Units[1]
Metal-Clad Switchgear (MCSG)			
MCSG – CPT	Metal-Clad Switchgear Compartment	An air-insulated, steel or fiberglass reinforced polyester compartment that houses the busbar, breaker assembly, and circuit control and protection device(s) and other associated equipment such as instrument transformers. It also includes any numerical or other displays or indicating devices on the front of the switchgear	EA
MCSG – BRK	Metal-Clad Switchgear Air/Vacuum Circuit Breaker	An element that automatically shuts off power to the feeder during an electrical fault condition. This could be air or vacuum type.	EA
MCSG – INR	Metal-Clad Switchgear Insulator	An element that provides insulation between phase conductors and phase conductor to ground.	EA
MCSG – IT	Metal-Clad Switchgear Instrument Transformer	Instrument transformers (CT and/or PT) transform high ampere and voltage to standardized current and voltage output values, respectively, to be used for measurement (metering) and protection (relays) purposes in distribution system.	EA
MCSG – RL	Metal-Clad Switchgear Relays	Protective elements (typically overcurrent or ground fault relays) that are integrated in the metal-clad switchgear panel to send a trip signal to the circuit breaker during respective abnormal/fault conditions.	EA
MCSG – MET	Metering Equipment	Metering asset consists of revenue class (high accuracy) and non-revenue class (low accuracy) equipment.	EA

Table C-2. LV Elements

Element Code(s)	Element Descriptor	Element Identification	Units
LV panelboards (PSWB)			
PSWB-MCB	Molded-Case Circuit Breaker	This element (air insulated) is the main low voltage breaker that makes or break the circuit during normal, overload or short circuit condition.	EA
PSWB-FUS	Fuse	An element of a power switchboard to disconnect the circuit during the electrical fault.	EA

Table C-2. LV Elements

Element Code(s)	Element Descriptor	Element Identification	Units
PSWB-SWC	Switches	An element to switch on/off branch circuits. It can be used with current limiting fuses as an upstream device.	EA
LV Power Cables (LVPC)			
LVPC-INS	Insulation	An element that acts as a dielectric between conductors of the cable and conductor to ground. XLPE and PVC insulation are the most common insulating medium in LV cables.	LF
LVPC-JTS	Splices and Terminations	An element that enables the jointing and termination to electrical nodes.	EA
LVPC-SH	Shielding	A metallic shielding element that provides an adequate uniform electric field within the cable's insulation to minimize the effect of interference.	LF
LVPC-CON	Conductor	This element of the LV cable is composed of stranded or solid aluminum or copper to enable the flow of current.	LF
LV Metering (LVMT)			
LVMT-MET	Analog and Digital Meters	This element measures the voltage, current, power factor, kW, kVAR, and kWh typically on an hourly or sub-hourly (15 minute) interval level.	EA
LVMT-IT	Instrument Transformers	Instrument transformers (CT and/or PT) transform high ampere and voltage to standardized current and voltage output values, respectively, to be used for measurement (metering) purposes.	EA

Table C-3. Communication Elements

Element Code(s)	Element Descriptor	Element Identification	Units
Fiber Enclosures (CFE)			
CFE-CFE	Fiber Enclosure	A box that contains the devices to connect various fiber optic cables.	EA
Communications Fiber Optic (CFO)			
CFO – JCK	Fiber Optic Cable Jacket	A protective element that protects the cable core and cladding (aka outer jacket). The jacket material depends on the required performance and application but is commonly acrylate or other plastics.	LF

Table C-3. Communication Elements			
Element Code(s)	**Element Descriptor**	**Element Identification**	**Units**
CFO – COR	Fiber Optic Cable Core	This element includes the fiber optic strands, the tubes in which the strands exist, and cladding (not the jacket part) that transmits the light to form the signal.	LF
CFO – CON	Fiber Optic Connector(s)	A mechanical element that terminates an optical fiber strand and allows for the mechanical alignment and coupling of two fiber strands for transmission of light through the cable. Connectors are mechanically joined, usually through a screw-on, snap-in or bayonet mechanism, to allow for quicker coupling and uncoupling. This category also includes the fiber optic cable termination that allows the strands to leave the core of the cable safely.	EA
Termination Points (TER)			
TER – ANT	Antenna (Wide Area or Point-to-Point)	A passive, conductive element that both receives and transmits signals. Antennas may take the form of a rod, wire, parabolic "dish" (e.g. satellite dish) or another device. A point-to-point antenna is an element that contains two (2) or more directional antennas which interface to transmit signals between them.	EA
TER – ROU	Router	A networking element that connects and directs data packets within a network. Routers may receive data via different physical connections (e.g. fiber optic, wireless, copper wires) and facilitate data transmission between these connection types.	EA
TER – SVR	Server	A central network element (computer, device, or system) that provides data, storage, and resources to other users on the network.	EA
TER – SWC	Switch	A network element that connects devices together. This element is like, but distinct from, a router.	EA
TER – OT	Other	This is a placeholder category for other termination point elements that have yet to be determined.	EA
Legacy Communications Components (LCC)			
LCC – CW	Copper Wire	A linear conductive element used to transmit information / data via electricity in communication systems (i.e. instrumentation data connections, radio transmissions, internet, telephone, fax, video communications and security services).	LF

Table C-4. Civil Elements			
Element Code(s)	**Element Descriptor**	**Element Identification**	**Units**
		Manhole (MH)	
CMH – CMH	Manhole	An underground element in which a person may enter to access electrical cables, equipment, etc. Manholes may be prefabricated to reduce construction time. In several places, manholes exist at or below the local water line, so water ingress is a continuous challenge.	EA
		Handhole (HH)	
CHH – CHH	Handhole	A civil element that facilitates access to electrical and communications equipment such as cables, etc. Handholes are distinct from manholes as they are generally shallow and cannot be entered. Handholes may be prefabricated to reduce construction time and is typically accessible from ground level.	EA
		Duct Bank (DB)	
CDB – CDB	Duct Bank	A protective element that contains underground electrical and communication cables. Duct banks (along with MH and HH) provide mechanical protection of the cable, and a well-defined route, allowing for safe construction around the power cable. Duct banks usually contain spare (empty) ducts to facilitate cable replacement.	EA
		Fencing (FG)	
CFG – CFG	Fencing	A physical barrier that surrounds and protects critical electrical components (typically HV, MV, but not always). Fencing typically refers to a classic chain-link fence and associated elements (gates).	LF

APPENDIX D – CONDITION STATES (BY COMPONENT)

Description	
Appendix D-1 MV Components	
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APPENDIX D-1. MV ASSET CLASS

Table D-1.1 - Pad-Mounted Transformer (PMTX) Condition States

Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Nameplate (PMTX – NP)						
PTNP	Damaged/ absent nameplate	Nameplate is missing or illegible. ***Visual Inspection***	Nameplate is intact and easily readable.	Nameplate is intact and information is barely readable	N/A	Nameplate is missing or illegible.
Compartment (PMTX – CPT)						
PTCR	Rusting	Rust on the surfaces. ***Visual Inspection***	No physical deterioration is observed.	Paint grade is more than cosmetic but has not compromised on physical integrity.	Rust is significant (each patch less than the size of a dollar bill), or holes present which are larger than a quarter.	Rust or holes greater than CS3 condition.
PTCG	Poor general condition	Compartment is in generally poor condition due to door misalignment, in-ability to lock, and/or inadequate labelling (i.e. operating designation, arc flash label, as required). ***Visual Inspection***	All elements in good working order; labelling visible and readable.	One of the following elements: • One door not lockable. • One door alignment off.	More than one instance of CS2, but no instance of CS4.	One of the following elements: • Operating labels not present or readable. • Arc flash label missing or not readable where needed.

Table D-1.1 - Pad-Mounted Transformer (PMTX) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Tank (PMTX – TNK)						
PTTC	Corrosion/ paint grade	Rust on the surfaces. ***Visual Inspection***	No physical deterioration is observed.	Paint grade is more than cosmetic but has not compromised on physical integrity.	N/A	Rust is significant.
PTTL	Oil leakage	Oil leakage from tank. ***Visual Inspection***	No evidence of oil spill.	Minimum oil spill.	Moderate oil spill.	Significant oil leakage.
Pad (PMTX – PAD)						
PTPP	Poor physical condition	Age is a good indicator of the physical condition of the pad in the absence of condition assessment results. ***Visual Inspection***	Less than 10 years old pad and no evidence of spalling.	Normal wear with some small cracks present; corner may be broken off. No exposed rebar; no spalling of concrete (crumbling).	Larger cracks present; some leaching of rust. Typical for pad between 20 – 40 years of age.	Large cracks present. Some pieces of concrete missing. Exposed rebar. Significant spalling of concrete (crumbling).

Table D-1.1 - Pad-Mounted Transformer (PMTX) Condition States						
Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
Gauges (PMTX – GG)						
PTGO	Oil level gauge	Abnormal oil level/device not working. ***Visual Inspection***	Device present and appears to be working. Reading visible. Reading appears to be normal.	N/A	Device working but readings are abnormal.	Device not working correctly or broken or missing (and it should be present).
PTGP	Abnormal pressure gauge reading	Abnormal pressure reading/device not working. ***Visual Inspection***	Device present and appears to be working. Reading visible. Reading appears to be normal.	N/A	Device working but readings are abnormal.	Device not working correctly or broken or missing (and it should be present).
PTGT	Temperature gauge	Abnormal oil temperature reading/device not working. ***Visual Inspection***	Device present and appears to be working. Reading visible. Reading appears to be normal.	N/A	Device working but readings are abnormal.	Device not working correctly or broken or missing (and it should be present).

Table D-1.1 - Pad-Mounted Transformer (PMTX) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
PTGC	Core temperature gauge	Core temperature reading/device not working. ***Visual Inspection***	Device working correctly; reading visible. If device not present (and is not required), consider it CS1.	N/A	Device working but readings are abnormal.	Device not working correctly or broken or missing (and it should be present).
Bushing (PMTX – BSH)						
PTBC	Cracking	Cracked or chipped porcelain, or broken polymer or taped insulation. ***Visual Inspection***	No cracks or breaks.	N/A	A few hairline cracks or one tape layer coming loose / off.	Cracks greater than the size of a quarter or more than one layer of tape coming loose / off.
PTBG	Gasket leaks	Bushing gasket deterioration resulting in oil leakage. ***Visual Inspection***	No oil spills.	Minimum oil spill.	Moderate oil spill.	Significant oil leakage.

Table D-1.1 - Pad-Mounted Transformer (PMTX) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
Oil (PMTX – OIL)						
PTOG	High levels of total dissolved combustible gases (TDCG)	High levels of gases in oil could affect the pad-mounted transformer longevity. ***Test: DGA Analysis***	TDCG[2] < 30ppm	30 ppm ≤ TDCG < 50 ppm	50 ppm ≤ TDCG < 80 ppm	TDCG >80 ppm
PTOQ	Poor oil quality	Poor oil quality which will affect its insulation and cooling properties. ***Test: Oil Quality Testing[3]***	The results are in accordance with values specified in Table 100.4 of NETA ATS-2011.	N/A	N/A	Results deviate from the values specified in Table 100.4 of NETA - ATS standard.

[2] DGA values are based on dissolved gas in oil generation rates and come from a combination of standards namely IEEE C57– 104, IEC 60599 and Delta X Research's Transformer Oil Analysis (TOA) software.
[3] Sample of liquid should be taken in accordance with ASTM D 923 standard. The oil quality test includes: Breakdown Voltage (ASTM D877); Neutralization (ASTM D974); Interfacial Tension (ASTM D971); Moisture content (ASTM D533); Power Factor (ASTM D924); Color and Visual (ASTM D1524)

Table D-1.1 - Pad-Mounted Transformer (PMTX) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Winding (PMTX – WDG)						
PTWM	Moisture in insulation	Moisture in insulation affects the insulation life of transformer. ***Test: Dissipation factor***[4]	Dissipation factor results normal. In the absence of manufacturer's published data, Table 100.3 of NETA ATS standard[5] to be used as a guideline.	Dissipation factor results show minor deterioration from the manufacturer's published data. In the absence of manufacturer's data, Table 100.3 of NETA ATS standard to be used as a guideline.	N/A	PF results show significant deterioration as the measured value deviate from the manufacturer's published data. In the absence of manufacturer's data, Table 100.3 of NETA ATS standard to be used as a guideline.
PTWI	Poor insulation integrity	Low insulation resistance as measured by the Megger test. ***Test: Megger Test***	Megger test results greater than the minimum insulation resistance values specified by the manufacturer.	N/A	N/A	Measured insulation resistance below the values specified by the manufacturer.

[4] Dissipation factor at operating frequency (i.e., Power factor Test) is an electrical test to determine the condition of the transformer winding and bushing insulation integrity.
[5] ANSI/NETA ATS-2011 Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems," 2011.

Table D-1.1 - Pad-Mounted Transformer (PMTX) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Tap Changer (PMTX – TC)						
PTTW	Worn tap changer contacts	Worn tap changer contacts due to frequent switching. ***Test: Winding Resistance Test***	The corrected winding resistance is under 1% of the commissioning test or factory test results (NETA-ATS).	The corrected winding resistance is under 1% of the commissioning test or factory test results (NETA-ATS).	N/A	The corrected winding resistance is greater than 1% of the commissioning test or factory test results.
PTTI	Insulation failure between turns	Insulation failure between transformer turns. ***Test: Transformer Turns Ratio (TTR)***[6]	TTR results are within 0.2% from either the adjacent transformer coils or the nameplate voltage ratio.	TTR results are within 0.5% from either the adjacent transformer coils or the nameplate voltage ratio.	N/A	TTR results are higher than 0.5% from either the adjacent transformer coils or the nameplate voltage ratio.

[6] Transformer turns ratio (TTR) test is performed to detect the insulation failure between the turns.

Table D-1.2 – Pad-Mounted Switchgear (PMSG) Condition States						
Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
Compartment (PMSG – CPT)						
PSCR	Rusting	Rust on the surfaces. ***Visual Inspection***	No physical deterioration is observed.	Paint grade is more than cosmetic but has not compromised on physical integrity (no holes).	Rust is significant (each patch less than the size of a dollar bill), or holes present which are larger than a quarter.	Rust or holes greater than CS3 condition.
PSCG	Poor general condition	Compartment is in generally poor condition due to door misalignment, in-ability to lock compartment, and/or inadequate labelling (i.e., operating designation as required). ***Visual Inspection***	All elements in good working order; labelling visible and readable.	One of the following elements: • One door not lockable • One door alignment off.	More than one instance of CS2, but no instance of CS4.	One of the following elements: • Operating labels not present or readable

Table D-1.2 – Pad-Mounted Switchgear (PMSG) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
Pad (PMSG – PAD)						
PSPP	Poor physical condition	Observable physical damage and/or advanced age. Age is a good indicator of the physical condition of the pad given the absence of an advanced test or evident deterioration. ***Visual Inspection***	Less than 10-years old pad and no evidence of spalling.	Normal wear with some small cracks present; corner may be broken off. No Exposed rebar; no spalling of concrete (crumbling).	Larger cracks present; some leaching of rust. Typically, between 20 – 40 years.	Large cracks present. Some pieces of concrete missing. Exposed rebar. Significant spalling of concrete (crumbling)
Fuse (PMSG – FUS)						
PSFW	Worn fuse contact	Power fuse holder contacts wear out with time, dirt/debris, and contamination. Fuse malfunction can lead to catastrophic failure. ***Test: Contact Resistance,***	Values are in the normal range as specified in the manufacturer's published data.	N/A	N/A	Test fails or test results exceed manufacturer's published values

Table D-1.2 – Pad-Mounted Switchgear (PMSG) Condition States						
Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
		Conductance (m-ohm)				
Switch (PMSG – LSW) or Vacuum-Break Switch (PMSG -VSW)						
PSSA	Poor switch blade alignment	Switch blade misalignment due to switching over time. ***Visual Inspection***	Switch blade alignment is correct.	N/A	N/A	Switch blades are misaligned which can break the insulator during switching.
PSSW	Worn switch blade	Switch blade contacts wear out with time, dirt, and contamination. ***Test: Contact Resistance***	Values are in the normal range as specified in the manufacturer's published data.	N/A	N/A	Test results exceed manufacturer's published values or contact resistance values deviate by more than 50% of the lowest value.
PSII	Poor Insulation	Low Insulation ***Test: Megger test*** ***Dielectric withstand test (PMSG – LSW only)***	Values are in the normal range as specified in the manufacturer's published data.	N/A	N/A	Test results exceed manufacturer's published values.

Table D-1.2 – Pad-Mounted Switchgear (PMSG) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
PSSG	Poor general condition	Switch is generally in poor condition due to the absence of: • Smooth operation of switch and handle. • Ability to lock switch open (or closed). • Switch labelling clear and readable. • Location for working grounds clearly identified, accessible. ***Visual/Mechanical Inspection***	All elements in good working order; labelling visible and readable.	N/A	N/A	One or more elements are not in good condition.

Table D-1.3 – MV Power Cables (UGC) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Insulation (UGC – INS)						
UCID	Dielectric deterioration (Test 1)	Dielectric deterioration due to water treeing, voids, and contamination. ***Test: AC-HiPot (Pass/Fail) Test***	Cable passed the HiPot test.	N/A	N/A	Cable failed the HiPot test.
UCII	Low insulation resistance (Test 2)	Low insulation resistance. ***Test: Megger Test***	Insulation-resistance values are in accordance with manufacturer's published data.	Lower insulation resistance values but above the minimum value as specified by the applicable standard or manufacturer's literature.	N/A	Insulation resistance values lower than the threshold values as specified by the applicable standard or manufacturer's literature.
UCIP	Low polarization index (Test 3)	Ratio of two-time insulation resistance readings.[7] ***Test: Polarization Index Test***[8]	Polarization index greater than 4[9].	Polarization index less than 4 but greater than 2.	Polarization index less than 2 but greater than 1.	Polarization index less than 1.

[7] (e.g., 10-minute insulation resistance reading divided by 1-minute insulation reading)
[8] https://www.instrumart.com/assets/Megger-Guide-to-Insulation-Testing.pdf
[9] The threshold value of polarization index must be considered tentative as they are relative.

Table D-1.3 – MV Power Cables (UGC) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Joints, Termination, Splices (UGC – JTS)						
UCJD	Deteriorated JTS	A poor or defective termination is a common source of cable failure. ***IR scan***	All connections operating within acceptable thermal limits.	One phase / joint operating above allowable temperature by no more than 20 deg F above average.	N/A	More than one joint meeting CS2 condition or one or more joints operating greater than 20 deg F above average.
Shielding (UGC – SH)						
UCSC	Poor continuity	Poor or no continuity of shielding. ***Test: Shield continuity Test***	Cable shielding exhibits good continuity.	N/A	N/A	Cable shielding exhibits poor or no continuity.
Conductor (UGC – CON)						
SWCC	High conductor resistance	High conductor resistance may lead to the premature failure of the cable insulation which subsequently result in short circuit. ***Test: Low-resistance test of each individual cable***	Conductor exhibits good continuity and acceptable resistance values.	N/A	N/A	Cable conductor resistance is higher than manufacturer recommendation or deviations in resistance between parallel conductors.

Table D-1.3 – MV Power Cables (UGC) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**

Table D-1.4 – Metal-Clad Switchgear (MCSG) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Compartment (MCSG – CPT)						
MSCR	Rusting	Rust on the surfaces. ***Visual Inspection***	No physical deterioration is observed.	Paint grade is more than cosmetic but has not compromised on physical integrity (no holes).	Rust is significant (each patch less than the size of a dollar bill), or holes present which are larger than a quarter.	Low confidence in physical integrity. Rust or holes greater than CS3 condition.
MSCG	Poor general condition	Compartment is generally in poor condition, due to door misalignment, loss of ability to lock, inadequate labelling (operating designation and arc flash label, as required). ***Visual Inspection***	All elements in good working order; labelling visible and readable.	One of the following elements: • One door not lockable. • One door alignment off.	More than one instance of CS2, but no instance of CS4.	One of the following elements: • Operating labels not present or readable. • Arc flash label missing or not readable where needed.

Table D-1.3 – MV Power Cables (UGC) Condition States						
Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
MSCD	Malfunctioning display devices	Readouts, meter type displays and indicating lights are not in good functioning order.	All display devices working as expected and pass tests.	N/A	N/A	One or more devices not working correctly.
Breaker (MCSG – BRK) – Vacuum or Air type						
MSBP	Poor physical condition	Observable physical or mechanical damage to the frame, evidence of burn marks and/or presence of debris and other contaminants. ***Visual Inspection***	No visible debris.	Low level of debris or other contaminants.	Significant level of debris, but no burn marks.	Obvious burn marks or mechanical damage to frame.
MSBM	Poor mechanical operation	Inadequate or malfunctioning operating mechanism. ***Test: Breaker Timing Test***	Normal test results.	N/A	N/A	Loose, broken, missing or inoperable parts, or controls which can result in mechanism failure. Timing results exceed the

Table D-1.3 – MV Power Cables (UGC) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
						acceptable threshold level given.
MSBD	Poor dielectric condition	Poor dielectric condition of the breaker due to moisture, contamination, loss of vacuum in the insulation. ***Test: Dissipation factor test or at a minimum HiPot Test***	Normal test result – no evidence of insulation failure.	N/A	N/A	Failed HiPot test or dissipation factor exceeds the manufacturer’s published data.
MSBC	High contact resistance	High contact resistance. ***Test: Contact Resistance***	Values are in the normal range as specified in the manufacturer’s published data.	N/A	N/A	Test results exceed manufacturer published values or measured contact resistance values deviate more than 50% of the lowest value [NETA ATS-2011].
MSII	Poor Insulation	Low Insulation ***Test: Megger test***	Values are in the normal range as specified in the manufacturer’s published data.	N/A	N/A	Test results exceed manufacturer’s published values.

Table D-1.3 – MV Power Cables (UGC) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Insulator (MCSG – INR)						
MSIP	Poor physical condition	Visual inspection of insulation system indicates damage or build-up of debris. ***Visual Inspection***	No visible debris or damage evident.	Low level of dirt or other containment on surfaces.	High level of debris or dirt on surfaces. No tracking or busbar metal visible (if insulated).	Tracking or broken busbar insulation evident (busbar metal visible). Open bus systems have visible bus bar damage.
MSII	Poor insulation integrity	Low insulation resistance results according to the Megger test. ***Test: Megger Test***	Megger Test results greater than the minimum insulation resistance values specified by the manufacturer.	N/A	N/A	Measured insulation resistance values are below the values specified by the manufacturer.
Instrument Transformer (MCSG – IT)						
MSTC	Improper, loose, and/or corroded connections	Improper, loose, and/or corroded connection, and/or missing of illegible labelling of elements. ***IR Scan***	Proper connection. No loose contact observed in the IR scan.	N/A	Some labelling is not readable.	Hot spots identified or inadequate grounding and shorting connections.

Table D-1.3 – MV Power Cables (UGC) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
MSTT	Abnormal turns ratio	Turns ratio error ***Test: Ratio-verification test using the voltage or current method can be performed as a functional test of performance***	Measured ratio agrees with the manufacturer's published data.	N/A	N/A	Measured ratio deviates from the manufacturer's published data.
MSTI	Poor insulation integrity	Low insulation resistance as measured by the Megger test. ***Test: Megger Test***	Megger test results greater than the minimum insulation resistance values specified in Table 100.5 of NETA-ATS.	N/A	N/A	Measured insulation resistance below the values specified in Table 100.5 of NETA-ATS.
Relays (MCSG – RL) – Microprocessor-based						
MSRC	Improper or loose connection	Improper and/or loose connection. ***Visual Inspection***	Proper and tight connections. No loose contact observed.	N/A	N/A	Loose contact observed, wire labels not readable.
MSRP	Poor physical condition	Poor physical condition due to build-up of debris or other damage. ***Visual Inspection***	Relays are free of dirt/dust.	Low level of debris or other containment ingress.	Significant level of debris/dirt.	Relay reporting internal fault. Most likely requires replacement.

Table D-1.3 – MV Power Cables (UGC) Condition States						
Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
MSRS	Relay settings check	Improper relay settings which do not agree with those specified in the protection coordination study. ***Mechanical Inspection***	Relay settings in accordance with protection coordination study.	N/A	N/A	Relay settings do not agree with those specified in the protection coordination study.
MSRU	Relay control has failed	Relay is capable of normal operations. ***Visual Inspection***	Relay is reporting it is working correctly. All digital inputs and outputs operate adequately.	N/A	N/A	Digital operation test failed. Input and expected outputs do not agree. Relay is sending error message.
Metering (MCSG – MET)						
LMMG	Poor general condition	Meter is not working or in very poor condition. ***Visual Inspection***	Meter is present and appear to be working.	N/A	N/A	Meter is not working properly, is damaged or is in poor condition

APPENDIX D-2. LV ASSET CLASS

Table D-2.1 – LV Panelboard (PSWB) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Molded-Case Circuit Breaker (PSWB – MCB)						
SWMM	Poor mechanical operation	Poor mechanical operation (i.e. mechanism does not move smoothly or per the manufacturer's requirements). ***Mechanical Inspection***	Smooth operation.	N/A	N/A	Mechanism appears to be jammed or bound. It does not move smoothly, or trips out immediately, or it fails the timing test if available.
SWMC	Poor contact resistance	High contact resistance caused by contact oxidation, foreign material, loose termination, or eroded contacts. ***Test: Contact Resistance Test***	Meets manufacturer's requirements.	Is within a few percent of low acceptable value	N/A	Does not meet manufacturer's requirements.
SWMI	Poor insulation condition	Low insulation resistance between different phases, and phase to ground. ***Test: Megger Test***	Meets manufacturer requirements.	Is within a few percent of low acceptable value	N/A	Does not meet manufacturer's requirements.

Table D-2.1 – LV Panelboard (PSWB) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
SWMP	Poor physical condition	Observable physical damage including signs of arcing, or build-up of debris and dirt on surfaces. ***Visual Inspection / IR Scan***	No debris or dirt on surfaces. No sign of arcing.	Low level of debris or dirt on surfaces. No sign of arcing.	N/A	Significant level of debris and dirt parts, and/or sign of arcing.
Fuse (PSWB – FUS)						
SWFG	Poor general condition	Fuse size and type verification ***Mechanical Inspection***	Fuse size and type not in accordance with short circuit and coordination study.	N/A	N/A	Fuse size and type not in accordance with short circuit and coordination study.
SWFC	Poor contact integrity	Fuse is blown due to a short circuit. ***Visual Inspection /Conductance Test***	Fuse is in good condition.	N/A	N/A	Blown fuse or test values deviates from manufacturer published data
Switches (PSWB – SWC)						
SWSR	Rusting	Rust on the surfaces. ***Visual Inspection***	No physical deterioration is observed.	N/A	Rust is significant.	Low confidence in physical integrity.

Table D-2.2 – LV Power Cables (LVPC) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Insulation (LVPC – INS)						
SWII	Low insulation resistance	Low insulation resistance. ***Test: Megger Test***	Insulation-resistance values are in accordance with manufacturer's published data.	Lower insulation resistance values but above the minimum value as specified by the applicable standard or manufacturer's literature.	N/A	Insulation resistance values lower than the threshold values as specified by the applicable standard or manufacturer's literature.
Splices and Terminations (LVPC – JTS)						
SWJD	Deteriorated splices and termination	A poor or defective termination is a common source of cable failure. ***IR scan***	No damage found.	Some damage found but termination and splices can continue to operate.	N/A	Significant damage at termination and splices found.
Shielding (LVPC – SH)						
SWSH	Poor continuity	Poor or no continuity of shielding. ***Test: Shield continuity Test***	Cable shielding exhibits good continuity.	N/A	N/A	Cable shielding exhibits poor or no continuity.

Table D-2.2 – LV Power Cables (LVPC) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Conductor (LVPC – CON)						
SWCC	High conductor resistance	High conductor resistance may lead to the premature failure of the cable insulation which subsequently result in short circuit or fire. ***Test: Low-resistance test of each individual cable***	Conductor exhibits good continuity and acceptable resistance values.	N/A	N/A	Cable conductor resistance is higher than manufacturer recommendation or deviations in resistance between parallel conductors.

Table D-2.3 – LV Metering (LVMT) Condition States						
Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
Meter (LVMT – MET)						
LMMG	Poor general condition	Meter is not working or in very poor condition. ***Visual Inspection***	Meter is present and appear to be working.	N/A	N/A	Meter is not working properly, is damaged or is in poor condition
Instrument Transformer (LVMT – IT)						
LMIC	Improper, loose, and/or corroded connections	Improper, loose, and/or corroded connection, IR scan can be performed to assess and locate any of the above. ***IR Scan***	Proper connection. No loose contact observed in the IR scan.	N/A	N/A.	Hot spots identified.
LMIA	Abnormal turns ratio	Turns ratio error ***Test: Ratio-verification test using the voltage or current method can be performed as a functional test of performance***	Measured ratio agrees with the manufacturer's published data.	N/A	N/A	Measured ratio deviates from the manufacturer's published data.

Table D-2.3 – LV Metering (LVMT) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
LMII	Poor insulation integrity	Low insulation resistance as measured by the Megger test. ***Test: Megger Test***	Megger test results greater than the minimum insulation resistance values specified by the manufacturer	N/A	N/A	Measured insulation resistance below the values specified by the manufacturer

APPENDIX D-3. COMMUNICATIONS ASSET CLASS

Table D-3.1 – Fiber Enclosures (CFE) Condition States						
Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
Fiber Enclosures (CFE-CFE)						
CFER	Rusting	Rust on the surfaces. ***Visual Inspection***	No physical deterioration is observed.	Paint grade is more than cosmetic but has not compromised on physical integrity.	Rust is significant.	Low confidence in physical integrity.
CFEM	Moisture	Presence of moisture inside the enclosure. ***Visual Inspection***	No indication of moisture.	N/A	N/A	Indication of moisture, condensate or puddling inside equipment.

Table D-3.2 – Fiber Optic Cable (FO) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Jacket (FO – JCK)						
FOJC	Cracking	Cracking in the coating may allow water or dirt / debris to into the cable and can damage the cladding and core. ***Visual Inspection***	No sign of deterioration.	There are hairline cracks which do not impact the integrity of the coating; damage is only cosmetic.	There are small cracks (less than ½ inch) which may allow water in.	Cracks are longer than ½ inch. May include significant tears or pieces missing due to animal damage (e.g. gnawing on cables).
FOJW	Water ingress	Evidence of water inside the coating which may damage the core and cladding. ***Visual Inspection***	No sign of water ingress.	N/A	N/A	Sign of water ingress. Includes tracking, ballooning, or other deformations.
Core (FO – COR)						
FOLS	Attenuation loss	Cable attenuation loss measurement.	Tests indicate the same performance	Tests indicate some change,	There is significant deterioration in	There is significant deterioration in

Table D-3.2 – Fiber Optic Cable (FO) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
		The manufacturer will provide acceptable values. ***Test: Cable loss attenuation test***	as factory or site testing.	within acceptable values.	performance, but adjustments may be made to return the equipment to within acceptable values.	performance and significant repairs, or replacement are required to return the equipment to within acceptable values. Alternatively, the cable cannot be repaired or is non-functional.
Connectors (FO – CON)						
FOCP	Poor physical condition	Observable physical damage (including cracking in the plastic). ***Visual Inspection***	No observable damage.	Signs of slight wear or damage but does not appear to impact the physical integrity of the connectors.	Obvious signs of wear or other damage, which may impact physical integrity of the connectors.	Significant deterioration, which may include cracks in the plastic or other obvious signs of wear.
FOCA	Poor connector alignment	Connector misalignment. ***Visual Inspection and Testing***	Connector is in place and fibers are aligned.	N/A	N/A	Connector is missing, or connector is misaligned. If mechanically sound, insertion loss testing shows poor connection and cannot be corrected.

Table D-3.2 – Fiber Optic Cable (FO) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
FOCD	Dirt / debris	Presence of dirt and debris at the connectors. ***Visual Inspection***	No indication of dirt and debris.	Trace amounts of dirt or other debris.	N/A	Significant dirt and debris.

Table D-3.3 – Termination Points (TER) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Antenna (TER – ANT)						
TANB	Bending / deformation	Change in physical form / shape of antenna. ***Visual Inspection***	No visible change in form.	Slight change in form; does not impact antenna functionality.	Change in physical form that impacts antenna functionality. Deformation may be easily corrected (wire antenna may be re-bent).	Change in physical form that results in low confidence in physical or electrical integrity.
TANR	Rusting	Rust on the surfaces. ***Visual Inspection***	No physical deterioration is observed.	Paint grade is more than cosmetic but has not compromised on physical integrity.	Rust is significant.	Low confidence in physical integrity.
TANM	Misalignment	Antenna is misaligned. This may be due to adjustment by a physical object, a physical obstruction, or environmental factors. ***Visual Inspection***	Antenna alignment is correct.	N/A	N/A	Antenna is misaligned impacting data transmission and quality.

Table D-3.3 – Termination Points (TER) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
Router (TER – ROU)						
TRAF	Air filter clogging	Build-up of dirt, dust or debris on the air filter which can restrict air flow and lead to overheating. The air filter should be checked and replaced routinely, per the manufacturer's guidelines. ***Visual Inspection***	Air filter is free of visible dirt, dust, and debris. Air filter has been replaced more recently than the manufacturer's recommendation.	No visible build-up of dirt, dust, or debris, but air filter replacement is overdue by manufacturer's recommendation.	Visible build-up of dirt, dust, or debris.	Significant build-up of dirt, debris, and dust at air filter, which is restricting air flow and may lead to unit overheating. Alternatively, air filter is missing, or not functional.
TRMO	Moisture	Presence of moisture inside the router. ***Visual Inspection***	No indication of moisture.	N/A	N/A	Indication of moisture, condensate or puddling inside equipment.
TRLW	Loose wires / cables	Wires or cables are not firmly secured at their connection points. ***Visual Inspection***	All cables / wires are firmly secured.	One or more cables are loose and may be easily secured. Wires are firmly secured.	One or more wires are loose and may be secured with minimal effort	Cables / wires are loose due to damage to the cable or connection points and may not be easily secured.

Table D-3.3 – Termination Points (TER) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
TRDC	Damaged cables / wires	Damage or deterioration to cables / wires including visible wear, exposed wiring, damage to the cable insulation, signs of burning / overheating (smell, scorching, discoloration, or other indications). ***Visual Inspection***	No damage to cables / wires.	Damage is more than cosmetic but has not yet compromised physical integrity; fiber optic strands are not visible.	Damage is significant though cables are still functioning. Physical integrity is reduced. One fiber optic strand is visible.	Damage has yielded low confidence in physical integrity. More than one fiber optic strand is visible, or one / more strands are visibly broken.
TRCA	Alarm triggered	Router alarms which monitor key parameters such as power supply, temperature, etc. are triggered indicating failure, loss of functionality or other alter. The type of alarm will determine the severity.	All functional; no alarms triggered.	N/A	N/A	Major alarm triggered, rendering one or more router components not functional or indicating a critical warning.

Table D-3.3 – Termination Points (TER) Condition States						
Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
Server (TER – SVR) [10]						
TSLW	Loose wires / cables	Wires or cables are not firmly secured at their connection points. ***Visual Inspection***	All cables / wires are firmly secured.	One or more cables are loose and may be easily secured. Wires are firmly secured.	One or more wires are loose and may be secured with minimal effort.	Cables / wires are loose due to damage to the cable or connection points and may not be easily secured.
TSDC	Damaged cables / wires	Damage or deterioration to cables / wires including visible wear, exposed wiring, damage to the cable insulation, signs of burning / overheating (smell, scorching, discoloration, or other indications). ***Visual Inspection***	No damage to cables / wires.	Damage is more than cosmetic but has not yet compromised electrical or physical integrity.	Damage is significant though cables are still functioning. Electrical and physical integrity are reduced.	Damage has yielded low confidence in electrical or physical integrity.

[10] The condition states listed here address the physical condition of the room and connections, but do not address the software or other functional aspects that may be the responsibility of the IT department. It is assumed that routine maintenance of the servers (data management, restarts, analytics of performance, is completed by the IT department and not part of the basic communications scope of work).

Table D-3.3 – Termination Points (TER) Condition States						
Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
TSLC	Lack of cleanliness (server interior)	Build-up of dust and debris on the interior surfaces of the server can lead to overheating and damage to the server. ***Visual Inspection***	No presence of dust and debris.	Minimal presence of dust and debris (smattering of dust and debris, not a complete layer)	Moderate build-up of dust and debris (surfaces are covered in thin layer).	Moderate build-up of dust and debris (surfaces are covered in thick layer).
Switch (TER – SWC)						
TSWL	Loose wires / cables	Wires or cables are not firmly secured at their connection points. ***Visual Inspection***	All cables / wires are firmly secured.	One or more cables are loose and may be easily secured. Wires are firmly secured.	One or more wires are loose and may be secured with minimal effort	Cables / wires are loose due to damage to the cable or connection points and may not be easily secured.
TSWD	Damaged cables / wires	Damage or deterioration to cables / wires including visible wear, exposed wiring, damage to the cable insulation, signs of burning / overheating. ***Visual Inspection***	No damage to cables / wires.	Damage is more than cosmetic but has not yet compromised electrical, optical, or physical integrity.	Damage is significant though cables are still functioning. Electrical, optical, and/or physical integrity are reduced.	Damage is extensive exposing electrical or fiber optic components. Low confidence in electrical or physical integrity. Device may have stopped functioning.

Table D-3.4 – Legacy Communications Components (LCC) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Copper Wire (LCC – CW)						
LCWB	Bending / deformation	Deviation from the wire's original form. ***Visual Inspection***	No bending or deformation.	Bending or deformation has not compromised physical integrity.	Bending or deformation is significant.	Low confidence in physical integrity.
LCWC	Corrosion	Rust on the surfaces. ***Visual Inspection***	No physical deterioration is observed.	Paint grade is more than cosmetic but has not compromised on physical integrity.	Rust is significant.	Low confidence in physical integrity.

APPENDIX D-4. CIVIL ASSET CLASS

Table D-4.1 – Manhole (CMH) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
Manhole (CMH – CMH)						
MHAA	Advanced age	Age (in lieu of condition) can measure physical condition of manholes.	Age is 10 years or less.	Greater than 10 years but less than 20 years old.	Between 20 and 40 years old.	Greater than 40 years old.
MHPG	Poor general condition	Manhole is generally in poor condition due to cracks, lack of labelling, physical damage to the frame and/or installation aid, and/or a poorly fitting cover. ***Visual Inspection***	• Manhole cover can be removed and restored. • Duct bank faces are labelled. • Cables are labelled. • Frame material (concrete) in good condition.	One or more of the following exists: • Small cracks visible needing engineer review. • One cable not labelled. • One duct bank not labelled.	One or more of the following exists: • Manhole cover does not fit on collar properly. • Large visible cracks needing engineer review. • Two or more cables not labelled. • Two or more DB not labelled. • One of the installation aids is broken and not functional.	One or more conditions that are worse than CS3, or, the installation aids (more than one) are broken and not functional.

Table D-4.2 – Handhole (CHH) Condition States

Code	Condition	Definition	Condition States			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Handhole (CHH – CHH)						
HHAA	Advanced age	Age is good indicator of the physical condition of the handholes in the absence of condition assessment results.	Age is 10 years or less.	Greater than 10 years but less than 20 years old.	Between 20 and 40 years old.	Greater than 40 years old.
HHPG	Poor general condition	Handhole is generally in poor condition due to cracks, lack of labelling, physical damage to the frame and/or installation aid, and/or a poorly fitting cover. ***Visual Inspection***	• Handhole cover can be removed and restored. • Duct bank faces are labelled. • Cables are labelled. • Frame material (concrete) in good condition.	One or more of the following exists: • Small cracks visible (roof or wall) needing engineer review. • One cable not labelled. • One duct bank not labelled.	One or more of the following exists: • Handhole cover does not fit on collar properly. • Large cracks visible (roof or wall) needing engineer review. • Two or more cables or duct not labelled. • One of the installation aids is broken and not functional.	One or more conditions that are worse than CS3, or, the installation aids (more than one) are broken and not functional.

Table D-4.3 – Duct Bank (CDB) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Duct Bank (CDB – CDB)						
DBAA	Advanced age	Age is good indicator of the physical condition of the duct bank in the absence of condition assessment results.	Age is 10 years or less.	Greater than 10 years but less than 20 years old.	Between 20 and 40 years old.	Greater than 40 years old.
DBPF	Poor functional condition	Ducts are in-adequate due to their poor condition, or are inaccessible, un-usable, and/or are insufficient in number. ***Visual Inspection***	All ducts are in good condition, usable, and accessible.	One or two ducts (no more than 20%) are not usable (due to blockage, etc.).	Less than 50% of the ducts are blocked or not usable. There are sufficient ducts available to address a future cable failure.	Ducts are in worse state than CS3.

Table D-4.4 – Fencing (CFG) Condition States						
Code	**Condition**	**Definition**	**Condition States**			
			CS1 (Good)	**CS2 (Fair)**	**CS3 (Poor)**	**CS4 (Severe)**
Fencing (CFG – CFG)						
FGAA	Advanced age	In addition to a visual inspection, age is a good indicator of the physical condition of fencing and will indicate that the fencing is approaching the end of its useful life.	Less than 20 years old.	Between 20 and 30 years old.	Between 30 and 50 years old.	Greater than 60 years old.
FGPC	Poor physical condition	Damage to or operation of the fencing or gates compromising security of the installed equipment or safety. This could be in the form of physical damage (holes in the fencing) or due to operation (i.e. not closing or locking the gate). ***Visual Inspection***	• Gates closed and locked. • Fence fabric integral. • Metal fence portions bonded to ground. • If no fence present by design, log CS1.	One of the following: • Small hole(s) in fence (less than 6-inch diameter). • Gate closed, but not locked.	N/A	One of the following: • More than one substandard condition. • Gate not locked and open. • Big hole(s) in fence. • No grounding of metal fence parts.

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APPENDIX E – PLACEHOLDER

This appendix has been left deliberately blank to preserve the same appendix numbering scheme as the Inspection and Condition Assessment Manual for structural and non-structural component of the PHA's maritime assets.

APPENDIX F

TEMPLATE DOCUMENTATION AND REPORTING FORMS

As described in Chapter 8, the following documentation and reporting forms, as listed in Table F.1, are part of the FICAP program. These forms are completed at the individual component level with a summary form at the asset class level for each location/terminal. The requirements, purpose and an example title of each form is also provided in Table F.1.

Table F.1. FICAP Documentation and Reporting Summary Table

Documentation / Form	Purpose	Reporting requirement	Example Form
F.1 Inventory Record	To record the baseline asset static data and testing results (first test results on file, field commissioning test results and factory test results) for each component to facilitate future maintenance work.	▪ One per asset class *(i.e. MV, LV, civil, communications)* ▪ One per component *(e.g., PMTX-1, UGC-13, etc.)*	▪ Inventory Record – MV asset class, Bayport Terminal ▪ Inventory Record – Pad-Mounted Transformer 1, MV asset class, Bayport Terminal
F.2 Inspection History	To record the component and asset class ratings over time to identify when the inspections were completed and observe trends.	▪ One per asset class *(i.e. MV, LV, civil, communications)*	▪ Inspection History – MV asset class, Bayport Terminal
F.3 Element Inspection Form	To record the condition states of each element which are used to identify the follow-up actions and develop the component rating.	▪ One per component *(e.g., PMTX-1, UGC-13, etc.)*	▪ Element Inspection Form – Pad-Mounted Transformer 1, MV asset class, Bayport Terminal
F.4 Inspection Summary	To summarize the results of the inspection including the component and asset class ratings.	▪ One per asset class *(i.e. MV, LV, civil, communications)* ▪ One per component *(e.g., PMTX-1, UGC-13, etc.)*	▪ Inventory Summary – MV asset class, Bayport Terminal ▪ Inventory Summary – Pad-Mounted Transformer 1, MV asset class, Bayport Terminal
F.5 Follow-Up Actions Form	To record the follow-up actions that were identified during the inspection and must be completed.	▪ One per component *(e.g. PMTX-1, UGC-13, etc.)*	▪ Follow-Up Actions Form – Pad-Mounted Transformer 1, MV asset class, Bayport Terminal

Important Notice Regarding the Use of These Forms: These forms are designed to provide guidance and a template to a qualified inspection team member and <u>do not</u> replace the judgement of qualified personnel. The forms may indicate certain tests, condition states and items to look for but are not exhaustive and rely on the experience and judgement of an experienced inspection team. Where available, references are provided to the NETA standard for maintenance testing specifications (MTS).

APPENDIX F-1.
INVENTORY RECORD

Representative forms provided for each Asset Class
Representative forms provided for select Components

APPENDIX F-1.1.

INVENTORY RECORD – MV ASSET CLASS & COMPONENTS

Inventory Record – MV Asset Class

Location:	____________________	**Asset ID:**	____________________
Asset Class:	MV	**Year of Original Construction:**	____________________
Asset Usage:	____________________	**Year(s) of Significant Modifications or Repairs:**	____________________
Inspection Frequency:	____________________	**Date of Last Inventory Record Update:**	____________________

Asset History

Provide an overview of the asset class history including date built, any major modifications/repairs/expansions since the asset was installed, and events that may have impacted the component. Provide brief overview of the asset and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List relevant reference drawings for the entire asset class (i.e. plan-view drawings, single line diagrams). A list of drawings associated with each component is provided in the related component inventory record.

Drawing Set	Title	Date	Description

Components

List of all components within the asset class, organized by component type. The description should provide relevant information that allows for easy field identification of the components (i.e. manufacturer, size, material, etc.)

Refer to the individual component inventory records for more information. Individual elements are listed on the component inventory record. Add additional pages if more items present.

Component ID	Component Count	Description	Component Inventory Record Reference and Date
Pad-Mounted Transformer (PMTX)			
PMTX-1			
PMTX-2			
PMTX-3			
Pad-Mounted Switchgear (PMSG)			
PMSG-1			
PMSG-2			
PMSG-3			
MV Power Cables (UGC)			
UGC-1			
UGC-2			
UGC-3			
Metal-Clad Switchgear (MCSG)[1]			
MCSG-1			
MCSG-2			
MCSG-3			

[1] In addition, inventory record for MV Breakers / Power Fuses for each Metal-Clad Switchgear lineup should be completed as required.

Revision History

Record all revisions made to the Asset Class Inventory Record in the table below.

Rev. No.	Reported by	Date	Verified by	Date	Comments

Inventory Record – MV Asset Class
Pad-Mounted Transformer

Location:		**Asset ID:**	
Asset Class:	MV	**Component:**	Pad-Mounted Transformer
Original Date of Construction:		**Year(s) of Significant Modifications or Repairs:**	
Inspection Frequency:		**Date of Last Inventory Record Update:**	
Local Operating Designation:			

Component Static Data

Manufacturer:		**Model Number:**	
Installation Year:		**Serial Number:**	
Phase:		**HV/LV:**	
KVA Rating:		**Vector Group:**	
Dry/Oil type:		**Oil Volume (if applicable):**	
Applicable Standard/Guide:		**BIL Rating (Primary):**	
Reference OEM information package:		**% Impedance:**	
Reference Drawing List:		**PCB (if applicable):**	

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List all relevant reference drawings in the table below. These typically include. Sketches can be appended:

- *Plan-view drawing*
- *Single-line diagram*
- *Specifications and any relevant manufacturer's drawings/data*
- *Relevant OEM packages*

Drawing Set	**Title**	**Date**	**Description**

Elements

List of all elements in the component and provide a description of the element that will allow for easy field identification.

Element(s)	**Description**

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	**Description**
	Digital photos of equipment exist. If so, add note as to where they are (network)
	Commissioning testing reports exist. If so, add note as to where they are (network)
	Baseline inspection reports exist. If so, attach or add note as to where they are (network)
	Does a picture / drawing of the nameplate exist? If so, where (on the network)

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	**Reported by**	**Date**	**Verified by**	**Date**	**Comments**

Inventory Record – MV Asset Class – Pad-Mounted Switchgear

Location:	____________________	**Asset ID:**	____________________
Asset Class:	MV	**Component:**	Pad-Mounted Switchgear
Original Date of Construction:	____________________	**Year(s) of Significant Modifications or Repairs:**	____________________
Inspection Frequency:		**Date of Last Inventory Record Update:**	
Local Operating Designation	____________________		

Component Static Data

Manufacturer:	____________________	**Model Number:**	____________________
Installation Year:	____________________	**Serial Number:**	____________________
Phase:	____________________	**Voltage Class:**	____________________
Switch continuous rating:	____________________	**Fuse Type:**	____________________
BIL:	____________________	**Interrupting rating:**	____________________
Applicable Standard/Guide:	____________________	**Reference Drawing Set:**	____________________
Reference OEM Information Package:	____________________		

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List all relevant reference drawings in the table below. These typically include. Sketches can be appended:

- *Plan-view drawing*
- *Single-line diagram*
- *Specifications and any relevant manufacturer's drawings/data*
- *Relevant OEM packages*

Drawing Set	**Title**	**Date**	**Description**

Elements

List of all elements in the component and provide a description of the element that will allow for easy field identification.

Element(s)	**Description**

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	**Description**
	Digital photos of equipment exist. If so, add note as to where they are (network)
	Commissioning testing reports exist. If so, add note as to where they are (network)
	Baseline inspection reports exist. If so, attach or add note as to where they are (network)
	Does a picture / drawing of the nameplate exist? If so, where (on the network)

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	**Reported by**	**Date**	**Verified by**	**Date**	**Comments**

Inventory Record – MV Asset Class
MV Power Cables

Location:	______	**Asset ID:**	______
Asset Class:	MV	**Component:**	MV Power Cables
Original Date of Construction:	______	**Year(s) of Significant Modifications or Repairs:**	______
Inspection Frequency:	______	**Date of Last Inventory Record Update:**	______

Component Static Data

Manufacturer:	______	**Installation Year:**	______
Phase:	______	**Rated Voltage:**	______
Cables per Feeder:	______	**Jacketed/Non-Jacketed:**	______
Conductor Type:	______	**Installation Type:**	______
No. of Cores (per cable):	______	**Conductors per Phase:**	______
Feeder Length:	______	**Cross-sectional Area:**	______
Insulation Type:	______	**Temperature Rating:**	______
Cable Shield wire size:	______	**External Ground Wire Size:**	______
Cable Grounding Method:	______		

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List all relevant reference drawings in the table below. These typically include. Sketches can be appended:

- *Plan-view drawing*
- *Single-line diagram*
- *Specifications and any relevant manufacturer's drawings/data*
- *Relevant OEM packages*

Drawing Set	**Title**	**Date**	**Description**

Elements

List of all elements in the component and provide a description of the element that will allow for easy field identification.

Element(s)	**Description**

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	**Description**
	Digital photos of equipment exist. If so, add note as to where they are (network)
	Commissioning testing reports exist. If so, add note as to where they are (network)
	Baseline inspection reports exist. If so, attach or add note as to where they are (network)
	Are there details of the markings on the cable (picture, handwritten note)?

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	Reported by	Date	Verified by	Date	Comments

Inventory Record – MV Asset Class – Metal-Clad Switchgear

Location:	____________________	**Asset ID:**	____________________
Asset Class:	MV	**Component:**	Metal-Clad Switchgear
Original Date of Construction:	____________________	**Year(s) of Significant Modifications or Repairs:**	____________________
Inspection Frequency:	____________________	**Date of Last Inventory Record Update:**	____________________
Local Operating Designation:	____________________		

Component Static Data

Manufacturer:	____________________	**Model Number:**	____________________
Installation Year:	____________________	**Serial Number:**	____________________
Phase:	____________________	**Rated Voltage:**	____________________
Busbar Ampacity:	____________________	**Short Circuit Capacity:**	____________________
BIL:	____________________	**Weight:**	____________________
Control Voltage:	____________________	**Size/Structure:**	____________________
Operation (Manual/Electrical):	____________________	**Sensor(s):**	____________________
Reference Drawing set:	____________________	**Applicable Standard/Guide:**	____________________
Compartmentalization (Open/Barriered)	____________________	**Reference OEM Information Package:**	____________________

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List all relevant reference drawings in the table below. These typically include. Sketches can be appended:

- *Plan-view drawing*
- *Single-line diagram*
- *Specifications and any relevant manufacturer's drawings/data*
- *Relevant OEM packages*

Drawing Set	**Title**	**Date**	**Description**

Elements

List of all elements in the component and provide a description of the element that will allow for easy field identification.

Element(s)	**Description**

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	**Description**
	Digital photos of equipment exist. If so, add note as to where they are (network)
	Commissioning testing reports exist. If so, add note as to where they are (network)
	Baseline inspection reports exist. If so, attach or add note as to where they are (network)
	Does a picture / drawing of the nameplate exist? If so, where (on the network)

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	**Reported by**	**Date**	**Verified by**	**Date**	**Comments**

Inventory Sheets – MV Breaker

Provide separate inventory sheet for each MV Breaker

Location:	____________	**Asset ID:**	____________
Asset Class:	MV	**Component:**	Metal-Clad Switchgear – MV Breaker
Original Date of Construction:	____________	**Year(s) of Significant Modifications or Repairs:**	____________
Inspection Frequency:	____________	**Date of Last Inventory Record Update:**	____________
Local Operating Designation:	____________		

Component Static Data

Manufacturer:	____________	**Model Number:**	____________
Installation Year:	____________	**Serial Number:**	____________
Phase:	____________	**Rated Voltage:**	____________
Rated Ampacity:	____________	**Short Circuit Capacity:**	____________
BIL:	____________	**Type (Vacuum, Oil, Air):**	____________
Reference Drawing set:	____________	**Control voltage:**	____________
Applicable Standard/Guide:	____________	**Reference OEM Information Package:**	____________

Inventory Sheets – Power Fuse (If applicable)

Provide separate inventory sheet for each Power Fuse

Location:	______	**Asset ID:**	______
Asset Class:	MV	**Component:**	Metal-Clad Switchgear – MV Fuse
Original Date of Construction:	______	**Year(s) of Significant Modifications or Repairs:**	______
Inspection Frequency:	______	**Date of Last Inventory Record Update:**	______
Local Operating Designation:	______		

Component Static Data

Manufacturer:	______	**Model Number:**	______
Installation Year:	______	**Serial Number:**	______
Phase:	______	**Rated Voltage:**	______
Rated Ampacity:	______	**Interrupting Rating:**	______
BIL:	______	**Fuse Type:**	______
Reference Drawing set:	______	**Reference OEM Information Package:**	______
Applicable Standard/Guide:	______		

Inventory Sheets – Revenue Meter (If applicable)

Provide separate inventory sheet for each revenue meter

Location:	______________________	**Asset ID:**	______________________
Asset Class:	MV	**Component:**	______________________
Original Date of Installation:	______________________	**Date of Last Inventory Record Update:**	______________________
Local Operating Designation:	______________________		

APPENDIX F-1.2.

INVENTORY RECORD – LV ASSET CLASS & COMPONENTS

Inventory Record – LV Asset Class

Location:	____________	**Asset ID:**	____________
Asset Class:	LV	**Year of Original Construction:**	____________
Asset Usage:	____________	**Year(s) of Significant Modifications or Repairs:**	____________
Inspection Frequency:	____________	**Date of Last Inventory Record Update:**	____________

Asset History

Provide an overview of the asset class history including date built, any major modifications/repairs/expansions since the asset was installed, and events that may have impacted the component. Provide brief overview of the asset and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List relevant reference drawings for the entire asset class (i.e. plan-view drawings, single line diagrams). A list of drawings associated with each component is provided in the related component inventory record.

Drawing Set	**Title**	**Date**	**Description**

Components

List of all components within the asset class, organized by component type. The description should provide relevant information that allows for easy field identification of the components (i.e. manufacturer, size, material, etc.)

Refer to the individual component inventory records for more information. Individual elements are listed on the component inventory record.

Component ID	Component Count	Description	Component Inventory Record Reference and Date
LV Panelboard (PSWB)			
PSWB-1			
PSWB-2			
PSWB-3			
LV Power Cables (LVPC)			
LVPC-1			
LVPC-2			
LVPC-3			
LV Metering (LVMT)			
LVMT-1			
LVMT-2			
LVMT-3			

Revision History

Record all revisions made to the Asset Class Inventory Record in the table below.

Rev. No.	**Reported by**	**Date**	**Verified by**	**Date**	**Comments**

Inventory Record – LV Asset Class
LV Panelboard

Location:		**Asset ID:**	
Asset Class:	LV	**Component:**	LV Panelboard
Original Date of Construction:		**Year(s) of Significant Modifications or Repairs:**	
Inspection Frequency:		**Date of Last Inventory Record Update:**	
Local Operating Designation:			

Component Static Data

Manufacturer:	______________	**Model Number:**	______________
Installation Year:	______________	**Serial Number:**	______________
AC or DC:	______________	**Rated Class:**	______________
Main Circuit Breaker Rating (AF/AT):	______________	**Ampacity (Busbar):**	______________
No of Poles (Main Breaker):	______________	**Ampere interrupting capacity (AIC):**	______________
Enclosure Type:	______________	**Arc Flash Rating:**	______________
Number of outgoing breakers:	______________	**Reference Drawing set:**	______________
Reference OEM information Package:	______________	**NEMA Rating:**	______________
Applicable Standard/Guide:	______________		

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List all relevant reference drawings in the table below. These typically include. Sketches can be appended:

- *Plan-view drawing*
- *Single-line diagram*
- *Specifications and any relevant manufacturer's drawings/data*
- *Relevant OEM packages*

Drawing Set	**Title**	**Date**	**Description**

Elements

List of all elements in the component and provide a description of the element that will allow for easy field identification.

Element(s)	**Description**

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	**Description**
	Digital photos of equipment exist. If so, add note as to where they are (network)
	Commissioning testing reports exist. If so, add note as to where they are (network)
	Baseline inspection reports exist. If so, attach or add note as to where they are (network)
	Does a picture / drawing of the nameplate exist? If so, where (on the network)

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	Reported by	Date	Verified by	Date	Comments

Inventory Record – LV Asset Class
LV Power Cables

Location:	____________	**Asset ID:**	____________
Asset Class:	LV	**Component:**	LV Power Cables
Original Date of Construction:	____________	**Year(s) of Significant Modifications or Repairs:**	____________
Inspection Frequency:	____________	**Date of Last Inventory Record Update:**	____________

Component Static Data

Manufacturer:	____________	**Right of way location (duct bank, cable tray, etc.)**	____________
Installation Year:	____________	**Rated Voltage:**	____________
Cables per Feeder:	____________	**Conductor Material:**	____________
Temperature Rating:	____________	**Insulation Type (code on jacket):**	____________
Cross-sectional area (sq. mm, or KCMIL or AWG)	____________	**Installation Type (conduit, cable tray, etc.):**	____________
Armored/Non-Armored:	____________	**Reference Drawing set**	____________

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List all relevant reference drawings in the table below. These typically include. Sketches can be appended:

- *Plan-view drawing*
- *Single-line diagram*
- *Specifications and any relevant manufacturer's drawings/data*
- *Relevant OEM packages*

Drawing Set	**Title**	**Date**	**Description**

Elements

List of all elements in the component and provide a description of the element that will allow for easy field identification.

Element(s)	**Description**

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	**Description**
	Digital photos of equipment exist. If so, add note as to where they are (network)
	Commissioning testing reports exist. If so, add note as to where they are (network)
	Baseline inspection reports exist. If so, attach or add note as to where they are (network)

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	**Reported by**	**Date**	**Verified by**	**Date**	**Comments**

Inventory Record – LV Asset Class
LV Metering

Location:	____________	**Asset ID:**	____________
Asset Class:	LV	**Component:**	LV Metering
Original Date of Construction:	____________	**Year(s) of Significant Modifications or Repairs:**	____________
Inspection Frequency:	____________	**Date of Last Inventory Record Update:**	____________

Component Static Data

Manufacturer:	____________	**Location:**	____________
Installation Year:	____________	**Serial Number:**	____________
Communication Capability (Y/N):	____________	**Type (Electromechanical / Digital)**	____________
Measuring Parameters:	____________	**Communication Medium (PLC/GSM/etc.)**	____________
Meter Rating:	____________	**Reference Connection Diagram:**	____________
Reference Standard:	____________		

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List all relevant reference drawings in the table below. These typically include. Sketches can be appended:

- *Plan-view drawing*
- *Single-line diagram*
- *Specifications and any relevant manufacturer's drawings/data*
- *Relevant OEM packages*

Drawing Set	**Title**	**Date**	**Description**

Elements

List of all elements in the component and provide a description of the element that will allow for easy field identification.

Element(s)	Description

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	Description
	Digital photos of equipment exist. If so, add note as to where they are (network)
	Commissioning testing reports exist. If so, add note as to where they are (network)
	Baseline inspection reports exist. If so, attach or add note as to where they are (network)

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	**Reported by**	**Date**	**Verified by**	**Date**	**Comments**

APPENDIX F-1.3.

INVENTORY RECORD – COMMUNICATIONS ASSET CLASS & SELECT COMPONENTS

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Inventory Record – Communications Asset Class

Location:	______________	**Asset ID:**	______________
Asset Class:	Communications	**Year of Original Construction:**	______________
Asset Usage:	______________	**Year(s) of Significant Modifications or Repairs:**	______________
Inspection Frequency:	______________	**Date of Last Inventory Record Update:**	______________

Asset History

Provide an overview of the asset class history including date built, any major modifications/repairs/expansions since the asset was installed, and events that may have impacted the component. Provide brief overview of the asset and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List relevant reference drawings for the entire asset class (i.e. plan-view drawings, single line diagrams). A list of drawings associated with each component is provided in the related component inventory record.

Drawing Set	Title	Date	Description

Components

List of all components within the asset class, organized by component type. The description should provide relevant information that allows for easy field identification of the components (i.e. manufacturer, size, material, etc.)

Refer to the individual component inventory records for more information. Individual elements are listed on the component inventory record.

Component ID	Component Count	Description	Component Inventory Record Reference and Date
Fiber Enclosures (CFE)			
CFE-1			
CFE-2			
CFE-3			
Fiber Optic Cable (CFO)			
CFO-1			
CFO-2			
CFO-3			
Termination Points (TER)			
TER-1			
TER-2			
TER-3			
Legacy Communications Components (LCC)			
LCC-1			
LCC-2			
LCC-3			

Revision History

Record all revisions made to the Asset Class Inventory Record in the table below.

Rev. No.	Reported by	Date	Verified by	Date	Comments

Inventory Record – Communications Asset Class
Fiber Enclosures

Location:	____________________	**Asset ID:**	____________________
Asset Type:	Communications	**Component:**	Fiber Enclosures
Date of Original Construction/ Installation:	____________________	**Year(s) of Significant Modifications or Repairs:**	____________________
Inspection Frequency:	____________________	**Date of Last Inventory Record Update:**	____________________

Component Static Data

Manufacturer:	_________________________
Model/Part Number:	_________________________
Serial Number:	_________________________
Enclosure type:	_________________________
Size of Enclosure:	_________________________
Copper Cable (Y/N):	_________________________

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List all relevant reference drawings in the table below. These typically include. Sketches can be appended:

- *Plan-view drawing*
- *Single-line diagram*
- *Specifications and any relevant manufacturer's drawings/data*
- *Relevant OEM packages*

Drawing Set	Title	Date	Description

Elements

List of all elements in the component. For the fiber enclosure, there is only one element (i.e. CFE-CFE).

Element(s)	**Description**
CFE-CFE	*Description of the elements that facilitates easy identification (e.g. material, model, type, etc.)*

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	**Description**
	Digital photos of equipment exist. If so, add note as to where they are (network)
	Commissioning testing reports exist. If so, add note as to where they are (network)
	Baseline inspection reports exist. If so, attach or add note as to where they are (network)

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	Reported by	Date	Verified by	Date	Comments

Inventory Record – Communications Asset Class
Fiber Optic Cables

Location:	______________	**Asset ID:**	______________
Asset Type:	Communications	**Component:**	Fiber Optic Cable
Date of Original Construction/ Installation:	______________	**Year(s) of Significant Modifications or Repairs:**	______________
Inspection Frequency:	______________	**Date of Last Inventory Record Update:**	______________

Component Static Data

Manufacturer:	______________	**Length of cabling:**	______________
Model/Part Number:	______________	**Cable diameter:**	______________
Serial Number:	______________	**Number of tubes:**	______________
Fiber type:	______________	**Number of fibers (strands) per tube:**	______________
Jacket material:	______________	**Allocation of strands:**	______________
Depth below grade (if applicable):	______________	**Connector types:**	______________
Location of cables:	______________		

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List all relevant reference drawings in the table below. These typically include. Sketches can be appended:

- *Plan-view drawing*
- *Single-line diagram*
- *Specifications and any relevant manufacturer's drawings/data*
- *Relevant OEM packages*

Drawing Set	**Title**	**Date**	**Description**

Elements

List of all elements in the component and provide a description of the element that will allow for easy field identification.

Element(s)	**Description**

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	**Description**
	Digital photos of equipment exist. If so, add note as to where they are (network)
	Commissioning testing reports exist. If so, add note as to where they are (network)
	Baseline inspection reports exist. If so, attach or add note as to where they are (network)

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	**Reported by**	**Date**	**Verified by**	**Date**	**Comments**

APPENDIX F-1.4.

INVENTORY RECORD – CIVIL ASSET CLASS & COMPONENTS

Representative forms provided for Civil Asset Class

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Inventory Record – Civil Asset Class

Location:	____________________	**Asset ID:**	____________________
Asset Class:	Civil Asset Class	**Year of Original Construction:**	____________________
Asset Usage:	____________________	**Year(s) of Significant Modifications or Repairs:**	____________________
Inspection Frequency:	____________________	**Date of Last Inventory Record Update:**	____________________

Asset History

Provide an overview of the asset class history including date built, any major modifications/repairs/expansions since the asset was installed, and events that may have impacted the component. Provide brief overview of the asset and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List relevant reference drawings for the entire asset class (i.e. plan-view drawings, single line diagrams). A list of drawings associated with each component is provided in the related component inventory record.

Drawing Set	**Title**	**Date**	**Description**

Components

List of all components within the asset class, organized by component type. The description should provide relevant information that allows for easy field identification of the components (i.e. manufacturer, size, material, etc.)

Refer to the individual component inventory records for more information. Individual elements are listed on the component inventory record.

Component ID	Component Count	Description	Component Inventory Record Reference and Date
Manholes (CMH)			
CMH-1			
CMH-2			
CMH-3			
Handholes (CHH)			
CHH-1			
CHH-2			
CHH-3			
Duct Banks (CDB)			
CDB-1			
CDB-2			
CDB-3			
Fencing (CFG)			
CFG-1			
CFG-2			
CFG-3			

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	Reported by	Date	Verified by	Date	Comments

Inventory Record – Civil Asset Class
Manhole

Location:	____________	**Asset ID:**	____________
Asset Class:	Civil	**Component:**	Manhole
Original Date of Construction:	____________	**Year(s) of Significant Modifications or Repairs:**	____________
Inspection Frequency:	See note below	**Date of Last Inventory Record Update:**	____________

If the manhole regularly accumulates water, then it should be removed, and/or have increased pump capacity installed (sump pump). Manholes that are regularly dry can be inspected on a frequency of up to 3 years; inspection cycle may be decreased depending on operational requirements.

Component Static Data

Installation Year:	____________	**Nominal wall thickness:**	____________
Construction material:	____________	**Depth below grade:**	____________
Construction method (cast in place / precast):	____________	**Manhole cover thickness:**	____________
Manhole cover Material (Metal, plastic, etc.)	____________	**Hidden Cover (Y/N):**	____________
Reference Drawings exist:	____________	**Manhole Dimensions (L X W X H):**	____________

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system (e.g. provides access to cables 123 etc.)

Reference Drawing List

List all relevant reference drawings in the table below. For manholes, these typically includes:

- *Plan-view drawing (showing floor layout)*
- *Drawings showing wall view and all duct banks, including layout of ducts, and viewing directions (north, south, east, west)*
- *Drawings showing the inside of the face, top view of the manhole/handhole face*
- *Detail drawings showing any wall mounting, splicing, racking details, and cable routing details*
- *Specifications and any relevant manufacturer's drawings/data*

Drawing Set	**Title**	**Date**	**Description**

Elements

List of all elements in the component. For the manhole, there is only one element (i.e. CMH-CMH).

Element(s)	**Description**
CMH-CMH	*Description of the elements that facilitates easy identification (e.g. material, model, type, etc.)*

Connected Duct Banks and Cables

List of all duct Banks connected to the Manhole
On a separate page, for each duct bank, identify the cable entering
If duct bank is empty, is there a pulling rope present? Is the duct abandoned (blocked?)?

Duct Bank	**Heading (N-E-W -S)**	**Duct Count (Row x Col)**	**Comments**

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	Description
	Digital photos of equipment exist. If so, add note as to where they are (network)
	Commissioning / Baseline inspection reports exist. *If so, attach or add note as to where they are (network)*

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	Reported by	Date	Verified by	Date	Comments

Inventory Record – Civil Asset Class
Handhole

Location:	____________	**Asset ID:**	____________
Asset Class:	Civil	**Component:**	Handhole
Original Date of Construction:	____________	**Year(s) of Significant Modifications or Repairs:**	____________
Inspection Frequency:	See note below	**Date of Last Inventory Record Update:**	____________

If the handhole regularly accumulates water, then it should be removed, and/or have increased pump capacity installed (sump pump). Handholes that are regularly dry can be inspected on a frequency of up to 3 years; inspection cycle may be decreased depending on operational requirements.

Component Static Data

Installation Year:	____________	**Construction material:**	____________
Construction method (cast in place / precast)	____________	**Nominal wall thickness:**	____________
Handhole cover thickness:	____________	**Handhole Dimensions (L X W X H):**	____________
Reference Drawings Exist:	____________	**Interior Pictures Exist:**	____________

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system (e.g. provides access to cables xyz, etc.)

Reference Drawing List

List all relevant reference drawings in the table below. For handholes, these typically includes:

- *Plan-view drawing (showing floor layout)*
- *Drawings showing wall view and all duct banks, including layout of ducts, and viewing directions (north, south, east, west)*
- *Drawings showing the inside of the face, top view of the handhole face*
- *Detail drawings showing any wall mounting, splicing, racking details, and cable routing details*
- *Specifications and any relevant manufacturer's drawings/data*

Drawing Set	**Title**	**Date**	**Description**

Elements

List of all elements in the component. For the handhole, there is only one element (i.e. CHH-CHH).

Element(s)	**Description**
CHH-CHH	*Description of the elements that facilitates easy identification (e.g. material, model, type, etc.)*

Connected Duct Banks and Cables

List of all duct Banks connected to the Manhole
On a separate page, for each duct bank, identify the cable entering
If duct bank is empty, is there a pulling rope present? Is the duct abandoned (blocked?)?

Duct Bank	**Heading (N-E-W -S)**	**Duct Count (Row x Col)**	**Comments**

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	Description
	Digital photos of equipment exist. If so, add note as to where they are (network)
	Commissioning / Baseline inspection reports exist. *If so, attach or add note as to where they are (network)*

Revision History

Record all revisions made to the Component Inventory Record in the table below.

Rev. No.	Reported by	Date	Verified by	Date	Comments

Inventory Record – Civil Asset Class
Duct Bank

Location:	____________	**Asset ID:**	____________
Asset Class:	Civil	**Component:**	Duct Bank
Original Date of Construction:	____________	**Year(s) of Significant Modifications or Repairs:**	____________
Inspection Frequency:	3 Years	**Date of Last Inventory Record Update:**	____________

Component Static Data

Installation year:	____________	**Configuration (Column x Rows):**	____________
Duct Bank length:	____________	**Configuration Drawing, if applicable:**	____________
Termination Points (MH, HH):	____________		

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List all relevant reference drawings in the table below. These typically include:

- *Plan-view drawing*
- *Duct bank drawings*
- *Drawings showing wall view and all duct banks, including layout of ducts, and viewing directions (north, south, east, west)*
- *Detail drawings showing any wall mounting, splicing, racking details, and cable routing details*
- *Specifications and any relevant manufacturer's drawings/data*

Drawing Set	Title	Date	Description

Elements

List of all elements in the component. Under the FICAP hierarchy, there is only one element in the duct bank (i.e. CDB-CDB).

Element(s)	Description
CDB-CDB	*Description of the elements that facilitates easy identification (e.g. material, model, type, etc.)*

Duct Bank Ends

Identify where the ends of the duct bank connect

End Location (N-E-W -S)	**End Description / Comments**

Checklist

Answer Y/N, and if YES, identify where information is located.

Answer	**Description**
	Digital photos of duct bank construction? *If so, add note as to where they are (network)*
	Commissioning / Baseline inspection reports exist. *If so, attach or add note as to where they are (network)*

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	Reported by	Date	Verified by	Date	Comments

Inventory Record – Civil Asset Class
Fencing

Location:	______	**Asset ID:**	______
Asset Class:	Civil	**Component:**	Fencing
Original Date of Construction:	______	**Year(s) of Significant Modifications or Repairs:**	______
Inspection Frequency:	______	**Date of Last Inventory Record Update:**	______

Component Static Data

Manufacturer:	______	**Installation Year:**	______
Fencing Material:	______	**Length of Fence (including gates):**	______
Height (with barbs):	______	**Are Metal parts bonded to ground?**	______
Barbs Present (Y/N):	______	**Locks present on Gates?**	______
Location (which asset):	______		

Component History

Provide an overview of the component's history including installation date, any major modifications/repairs/expansions since the component was installed, events that may have impacted the component. Provide brief overview of the component and how it integrates into the electrical/communications distribution system.

Reference Drawing List

List all relevant reference drawings in the table below. These typically include:

- *Plan-view drawing*
- *Specifications and any relevant manufacturer's drawings/data*
- *Relevant OEM packages*

Drawing Set	**Title**	**Date**	**Description**

Revision History

Record all revisions made to the Inventory Record in the table below.

Rev. No.	**Reported by**	**Date**	**Verified by**	**Date**	**Comments**

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APPENDIX F-2.

INSPECTION HISTORY

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Inspection History – MV Asset Class

Location:	____________	**Asset ID:**	____________
Asset Class:	MV Asset Class	**Year of Original Construction:**	____________
Inspection Frequency:	____________	**Year(s) of Significant Modifications or Repairs:**	____________

Dates of Inspections, Asset, and Component Ratings
(Part 1)

Date				
Inspection Type				
Inspection Firm				
Asset Condition Rating (ACR)				
Component Rating (CR)				
Pad-Mounted Transformer Overall Component Rating				
PMTX-1				
PMTX-2				
PMTX-3				
Pad-Mounted Switchgear Overall Component Rating				
PMSG-1				
PMSG-2				
PMSG-3				
Metal-Clad Switchgear Overall Component Rating				
MCSG-1				
MCSG -2				
MCSG-3				

Dates of Inspections, Asset, and Component Ratings
(Part 2)

Date				
Inspection Type				
Inspection Firm				
Asset Condition Rating (ACR)				
MV Power Cables Overall Component Rating				
UGC-1				
UGC-2				
UGC-3				

Inspection History – LV Asset Class

Location:	____________	**Asset ID:**	____________
Asset Class:	LV Asset Class	**Year of Original Construction:**	____________
Inspection Frequency:	____________	**Year(s) of Significant Modifications or Repairs:**	____________

Dates of Inspections, Asset, and Component Ratings

Date				
Inspection Type				
Inspection Firm				
Asset Condition Rating (ACR)				
Component Rating (CR)				
Panelboard Overall Component Rating				
PSWB-1				
PSWB-2				
PSWB-3				
LV Power Cables Overall Component Rating				
LVPC-1				
LVPC-2				
LVPC-3				
LV Metering Overall Component Rating				
LVMT-1				
LVMT-2				
LVMT -3				

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Inspection History – Communication Asset Class

Location:	____________	**Asset ID:**	____________
Asset Class:	Communications Asset Class	**Year of Original Construction:**	____________
Inspection Frequency:	____________	**Year(s) of Significant Modifications or Repairs:**	____________

Dates of Inspections, Asset, and Component Ratings

Date				
Inspection Type				
Inspection Firm				
Asset Condition Rating (ACR)				
Component Rating (CR)				
Fiber Enclosures Overall Component Rating				
CFE-1				
CFE-2				
CFE-3				
Fiber Optic Cable Overall Component Rating				
CFO-1				
CFO-2				
CFO-3				
Termination Points Overall Component Rating				
TER-1				
TER-2				
TER-3				

Legacy Communications Components Overall Component Rating				
LCC-1				
LCC-2				
LCC-3				

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Inspection History – Civil Asset Class

Location:	____________	**Asset ID:**	____________
Asset Class:	Civil Asset Class	**Year of Original Construction:**	____________
Inspection Frequency:	____________	**Year(s) of Significant Modifications or Repairs:**	____________

Dates of Inspections, Asset, and Component Ratings
(Part 1)

Date				
Inspection Type				
Inspection Firm				
Asset Condition Rating (ACR)				
Civil Components Combined Rating (CR)				
Manhole Overall Component Rating				
CMH-1				
CMH-2				
CMH-3				
Handhole Overall Component Rating				
CHH-1				
CHH-2				
CHH-3				
Duct Bank Overall Component Rating				
CDB-1				
CDB-2				
CDB-3				

Dates of Inspections, Asset, and Component Ratings
(Part 2)

Date				
Inspection Type				
Inspection Firm				
Asset Condition Rating (ACR)				
Fencing Overall Component Rating				
CFG-1				
CFG-2				
CFG-3				

APPENDIX F-3.

INSPECTION FORMS

APPENDIX F-3.1.

INSPECTION FORMS

MV ASSET CLASS & COMPONENTS

Inspection Form – Pad-Mounted Transformer

Asset ID: **Serial Number:**

Location: **Local Operating Designation:**

Basic Testing

Reference information can be found in NETA MTS section 7.2. If a on load tap changer is present, see NETA 7.16. Infrared tests can be found at NETA MTS section 9. Use only the relevant attached forms.

Item	Description	Dry		Oil	
		Small	Large	Small	Large
0	NETA MTS Reference	7.2.1.1	7.2.1.2	---	7.2.2
1	Visual and Mechanical Inspection	Y	Y	Y	Y
2	Insulation resistance test	Y	Y	Y	Y
3	TTR Test	Y	Y	Y	Y
4	Capacitance & Power Factor Test	---	Y	---	Y
5	Winding resistance test	---	Y	---	Y
6	DGA Test	---	---	---	Y
7	Oil Quality	---	---	---	Y

Visual Inspection	
Activity / Description	**Comment:**
Physical and mechanical condition including evidence of moisture & corona	
Anchorage (foundation), and Alignment	
Grounding	
Perform AS FOUND tests prior to cleaning	
Verify control / alarm setting on temperature indicators as specified (optional)	
Verify cooling fan operation (if present)	
Inspect bolted connections	

(add extra comments on a separate page)

Visual / Mechanical Inspection

Record the results of the visual inspection including observations on the general condition, functionality, mechanical operation, and electrical and physical integrity. Consider the following aspects when completing the inspection:

Check	Inspection Activity	Observations
	Alignment and Grounding Check	
	Nameplate Check	
	Compartment (paint condition, etc.)	
	Security locks present / functional	
	Bushing	
	Tank	
	Cooling fins	
	Oil Leaks	
	Concrete Pad	
	Gauges	
	Oil Level	
	PCB labelling check	
	Tap changer	
	Arc flash rating check	
	IR Scan – Tank and Bushing	
	Digital pictures taken during site visit / maintenance?	
	Other	

Insulation Resistance Test		
	Test performed?	**Comment:**
Test Standard and Test plan:		
Test Voltage:		
Test Conditions:		
HV to LV + Ground (Ω):		
LV to HV + Ground (Ω):		
HV to LV (Ω):		
Core to Ground (Ω):		

☐ Test results / report attached?

☐ Test plan attached?

Transformer Turns Ratio (TTR) Test (Off Load Tap Changer, if present)			
☐ **Test performed?**	**Comment:**		
Test Standard / Test Plan:			
Test Conditions:			
Tap Position	***H1 – H2; X0 – X1***	***H2-H3; X0-X2***	***H3-H1; X0-X3***
	(Ratio/Deviation / mA)	***(Ratio/Deviation / mA)***	***(Ratio/Deviation / mA)***
1			
2			
3			
4			
5			
Comments:			

☐ Test results / report attached?

☐ Test plan attached?

Capacitance & Power Factor Test		
☐ **Test performed?**	**Comment:**	
Test Standard and Test Plan:		
Test Voltage:		
Test Conditions:		
Test Results	***Between the windings (C_{HL})***	***Windings to the tanks (C_H, C_L)***
Measured Capacitance:		
Power factor (corrected to …… degrees)		
Comments:		

☐ Test results / report attached?

☐ Test plan attached?

Winding Resistance Test		
☐ **Test performed?**	**Comment:**	
Test Standard / Test Plan:		
Test Conditions:		
Tap Position	***H1-H2 / H2-H3/ H3/H1***	***X1-X2 / X2-X3/ X3-X1***
1		
2		
3		
4		
5		
Comments:		

☐ Test results / report attached?

☐ Test plan attached?

DGA Test		
☐ **Test performed?**	**Comment:**	
Test Standard		
Test Conditions:		
Gas Type	**Result, Concentration in oil (ppm)**	**Acceptable Limits (ppm)**
Hydrogen (H2)		
Methane (CH4)		
Acetylene (C2H4)		
Ethylene (C2H4)		
Ethane (C2H6)		
Carbon monoxide (CO)		
Carbon dioxide (CO_2)		
Other		
Total Combustibles Gases (TDCG)		
Comments:		

☐ Test results / report attached?

☐ Diagnostic report attached?

Oil Quality Test

	Test performed?	Comment:

Tests:

	Breakdown Voltage (ASTM D877)
	Interfacial Tension (ASTM D971)
	Power Factor (ASTM D924)
	Color and visual (ASTM D1524)
	Neutralization (ASTM D974)
	Moisture content (ASTM D533)

Comments / Results:

☐ Test results / report attached?

Inspection Form – Pad-Mounted Switchgear

Asset ID:

Serial Number:

Location:

Local Operating Designation:

Key Baseline Data

Relevant NETA MTS sections include the following. Not every section may apply to each switchgear

- *7.1 Switchgear and Switchboard Assemblies*
- *7.4 Metal enclosed busways (conduit and EMT)*
- *7.5.1 Switches, Air, (LV, MV)*
- *7.5.2 Switches, MV, Oil*
- *7.5.3 Switches, MV, Vacuum*
- *7.5.4 Switches, MV, SF6*
- *7.5.5 Switches, Cutouts*
- *7.6.1 Circuit Breakers, Air (LV and MV)*
- *7.6.2 Circuit Breakers, MV, Oil*
- *7.6.3 Circuit Breakers, MV, Vacuum*
- *7.6.4 Circuit Breakers, MV, SF6*
- *7.9 Protective Relays*
- *7.10 Instrument Transformers*
- *7.19 Surge arrestors (LV and MV)*

Visual Inspection & Functional Tests	
Activity / Description	**Comment:**
Physical and mechanical condition including evidence moisture & corona	
Anchorage (foundation), and Alignment	
Grounding:	
Physical Clearance around Switchgear	
IR Scan - (CO_2 wash, if required, to remove contamination before the IR scan)	
Perform AS FOUND tests prior to cleaning	
Verify fuse and/or circuit breaker sizes and types per drawings and coordination studies	
Verify instrument transformer ratios (CT, PT) per drawings	
Inspect bolted connections	
Confirm correct operation & sequencing of electrical and mechanical interlocks	
Exercise all parts; lubricate as required	
Inspect control power transformers	

Visual / Mechanical Inspection

Record the results of the visual inspection including observations on the general condition, functionality, mechanical operation, and electrical and physical integrity. Consider the following aspects when completing the inspection:

Check	Inspection Activity	Observations
	Alignment and Grounding Check	
	Nameplate Check	
	Compartment (paint condition, etc.)	
	Clearance Check	
	Switch Mechanical Operation	
	Connections (check for tightness)	
	Cable Terminations	
	Fuse and Fuse holder	
	Pad Foundation	
	Digital pictures taken during inspection	

Insulation Resistance Test (Switchgear control wiring)	
Test performed?	**Comment:**
Test Standard / Test Plan:	
Test Voltage:	
Test Conditions:	
Phase A to Ground:	
Phase B to Ground:	
Phase C to Ground:	

Insulation Resistance Test (control power transformer)	
Test performed?	**Comment:**
Test Standard / Test Plan:	
Test Voltage:	
Test Conditions:	
Phase A to Ground:	
Phase B to Ground:	
Phase C to Ground:	

Pad-Mounted Switchgear
Electrical tests - Switching Devices

Record the results of the electrical tests in the relevant tables.

Device Information	
Device Name	
Device Type:	

Contact Resistance Test		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Phase A (Ω):		
Phase B (Ω):		
Phase C (Ω):		

Dielectric Withstand Test (Insulation Resistance)	
Test performed?	Comment:
Test Standard / Test Plan:	
Test Voltage:	
Test Conditions:	
Phase A to Ground (Ω):	
Phase B to Ground (Ω):	
Phase C to Ground (Ω):	
Phase A to B (Ω):	
Phase B to C (Ω):	
Phase C to A (Ω):	
Comments:	

Inspection Form – MV Power Cables

Asset ID:

Feeder number:

Location (manholes):

Local Operating Designation:

Key Baseline Data

Relevant NETA MTS sections include the following. Not every section may apply to each power cables

- *7.3.3 Cables, MV*
- *7.4 Metal Enclosed bus ways*
- *7.19.2 Surge Arrestors, MV*
- *9 Thermographic Study*

Reference any figures, drawings, and photographs as appropriate.

Visual Inspection (part 1)	
Activity / Description	**Comment:**
Physical and mechanical condition including evidence damage, moisture & corona	
IR Scan of Joint, Termination and Splices	
Fire-proofing in place/condition	
Digital photos taken during inspection	

Visual / Mechanical Inspection (Part 2)

Record the results of the visual inspection including observations on the general condition, functionality, mechanical operation, and electrical and physical integrity. Consider the following aspects when completing the inspection:

Check	Inspection Activity	Observations
	Exposed Section of Cable Segment	
	Termination	
	Splices	
	Electrical Connections (tightness)	
	Shield Grounding	
	Cable Jacket	
	Bending Radius	
	Cable Supports	
	Grounding Surge Arrestor (if present)	

Insulation Resistance Test		
☐ **Test performed?**	**Comment:**	
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Test Results:	**Insulation Resistance (10 min)**	**Insulation Resistance (1 min)**
Phase A to Phase B and Phase C + Ground (Ω):		
Phase C to Phase C and Phase A + Ground (Ω):		
Phase C to Phase B and Phase B + Ground (Ω):		

☐ Test results / report attached?

Sheath Resistance	
☐ **Test performed?**	**Comment:**
Test Standard / Test Plan:	
Test Voltage:	
Test Conditions:	
Test Results:	
Insulation Resistance, Outermost metallic layer to Ground (Ω):	

☐ Test results / report attached?

Dielectric Withstand Test (Insulation Resistance Test)		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Phase A to Ground (Ω):		
Phase B to Ground (Ω):		
Phase C to Ground (Ω):		

Insulation Resistance Test (Surge Arrestor)		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Phase A to Ground:		
Phase B to Ground:		
Phase C to Ground:		

Sheath Continuity Test		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Test Result: Good Continuity? (Value and Y/N)		

☐ Test results / report attached?

VLF AC Hi-Pot Test		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Test Result		**Value and Pass/Fail**
Phase A		
Phase B		
Phase C		

☐ Test results / report attached?

Partial Discharge (PD) Test			
☐ **Test performed?**	**Comment:**		
Test Standard / Test Plan:			
PF Test Type:			
Test Voltage:			
Test Conditions:			
Test Results	**Phase A**	**Phase B**	**Phase C**
Inception Voltage			
Extinction Voltage			
Extinction PD (pC)			
Mean PD amplitude			
Maximum PD amplitude			

☐ Test results / report attached?

Reference any PD pattern recordings file:

Inspection Form – Metal-Clad Switchgear

Asset ID: **Serial number:**

Location: **Local Operating Designation:**

Key Baseline Data

Relevant NETA MTS sections include the following. Not every section may apply to each switchgear

- *7.1 Switchgear and Switchboard Assemblies*
- *7.4 Metal enclosed busways (conduit and EMT)*
- *7.5.1 Switches, Air, (LV, MV)*
- *7.5.2 Switches, MV, Oil*
- *7.5.3 Switches, MV, Vacuum*
- *7.5.4 Switches, MV, SF6*
- *7.5.5 Switches, Cutouts*
- *7.6.1 Circuit Breakers, Air (LV and MV)*
- *7.6.2 Circuit Breakers, MV, Oil*
- *7.6.3 Circuit Breakers, MV, Vacuum*
- *7.6.4 Circuit Breakers, MV, SF6*
- *7.9 Protective Relays*
- *7.10 Instrument Transformers*
- *7.19 Surge arrestors (LV and MV)*

The following data tables are grouped into

a) General for the switchgear
b) For switching devices (fill out one form per device)

☐	Photos taken during inspection?
☐	Other reference material attached?

Visual Inspection & Functional Tests	
Activity / Description	**Comment:**
Nameplate check (picture)	
Arc Flash Labels in place	
Physical and mechanical condition including evidence moisture & corona	
Anchorage (foundation), and Alignment	
Grounding	
Physical clearance around Switchgear	
IR Scan	
Perform AS FOUND tests prior to cleaning	
Verify fuse and/or circuit breaker sizes and types per drawings and coordination studies	
Verify instrument transformer (CT, PT) ratios per drawings	
Inspect Relays	
Inspect bolted connections (tightness, etc.)	
Inspect control wiring	
Confirm correct operation & sequencing of electrical and mechanical interlocks	
Exercise all parts; lubricate as required; verify alignment	
Inspect control power transformers	
Mechanical interlocks functional	

Insulation Resistance Test (Switchgear control wiring)		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Phase A to Ground:		
Phase B to Ground:		
Phase C to Ground:		

Insulation Resistance Test (control power transformer)		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Phase A to Ground:		
Phase B to Ground:		
Phase C to Ground:		

Insulation Resistance Test (Bus Bar)		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Test Results		
Phase A to Ground (Ω):		
Phase B to Ground (Ω):		
Phase C to Ground (Ω):		
Phase A to B (Ω):		
Phase B to C (Ω):		
Phase C to A (Ω):		

:

Metal Clad Switchgear
Electrical tests - Switching and Protective Devices

The following Table indicates the electrical test(s) applicable to different switching and protection devices included in Metal-Clad Switchgear

Item	Electrical Test	Switching/Interrupting and Protection Devices			
		Breaker	Relay	Interrupter Switch	Power Fuse
1	Contact Resistance	X	-	X	X
2	Dielectric Withstand Test (Insulation Resistance)	X	-	-	-
3	Breaker Timing Test	X	-	-	-
4	Protection Relay Testing	-	X	-	-

Device Information	
Device Name	
Device Type:	
Device Serial Number:	
Device Local Operating Designation:	
Asset ID:	

☐ Test results / report attached? (List all applicable)

☐ Test plan attached? (list all applicable)

Contact Resistance Test	
Test performed?	**Comment:**
Test Standard / Test Plan:	
Test Voltage:	
Test Conditions:	
Phase A (Ω):	
Phase B (Ω):	
Phase C (Ω):	

Dielectric Withstand Test (Insulation Resistance)	
Test performed?	**Comment:**
Test Standard / Test Plan:	
Test Voltage:	
Test Conditions:	
Phase A to Ground (Ω):	
Phase B to Ground (Ω):	
Phase C to Ground (Ω):	
Comments:	

Breaker Timing Test		
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Test Results:		
Phase	**Closing Time (milli seconds)**	**Opening Time (milli seconds)**
Phase A:		
Phase B:		
Phase C:		

Protection Relay Testing	
Uploaded Program Name:	
Reference P&C Report:	
Commissioning Test Form:	

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APPENDIX F-3.2.

INSPECTION FORMS

LV ASSET CLASS & COMPONENTS

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Inspection Form – LV Panelboard

Asset ID:

Serial Number:

Location:

Local Operating Designation:

Relevant NETA MTS sections include the following. Not every section may apply to each switchgear

- *7.1 Switchgear and Switchboard Assemblies*
- *7.4 Metal enclosed busways (conduit and EMT)*
- *7.5.1 Switches, Air, (LV, MV)*
- *7.5.5 Switches, Cutouts*
- *7.6.1 Circuit Breakers, Air (LV and MV)*

Visual Inspection & Functional Tests, Part 1	
Activity / Description	**Comment:**
Nameplate verification (Picture)	
Arc flash Label	
IR Scan Results	
Physical and mechanical condition including evidence of damage, rust, arching, moisture & corona	
Anchorage (foundation), and Alignment	
Grounding	
Physical Clearance around Switchgear	
Perform AS FOUND tests prior to cleaning	

Visual Inspection & Functional Tests, Part 2	
Activity / Description	**Comment:**
Inspect compartments for rust, corona, water, burn marks, and other indicators of degradation	
Verify fuse sizes and types per drawings and coordination studies	
Verify circuit breaker sizes and types per drawings and coordination studies	
Verify contactor sizes and types per drawings and coordination studies	
Verify relay settings and types per drawings and coordination studies (protection settings)	
Inspect bolted connections and tightness	
Confirm correct operation & sequencing of electrical and mechanical interlocks	
Digital pictures taken during maintenance activity	
Exercise all parts; lubricate as required	
Verify interlocks are operating correctly	
Other	

Switching Device Tests
(Per Device Tested)

Contact Resistance Test (Main Breaker)		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Test Report Attached (Y/N)		
Phase A (Ω):		
Phase B (Ω) (if applicable):		
Phase C (Ω) (if applicable):		

Insulation Resistance Test (Main Breaker)		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Phase A to Ground (Ω):		
Phase B to Ground (Ω):		
Phase C to Ground (Ω):		
Phase A to B (Ω):		
Phase B to C (Ω):		
Phase C to A (Ω):		

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Inspection Form – LV Power Cables

Asset ID: **Feeder name:**

Location:

Relevant NETA MTS sections include the following. Not every section may apply to each switchgear

- *7.3.1 Cables, LV, Low Energy*
- *7.3.2 Cables, LV, 600V maximum*
- *7.4 Metal Enclosed bus ways*
- *7.19.1 Surge Arrestors, LV*
- *9 Thermographic Study*

Visual Inspection	
Activity / Description	**Comment:**
IR Scan of joint, termination and splices (JTS)	
Physical and mechanical condition including evidence of damage, rust, arching, moisture & corona	
Visual Inspect Terminations and splices	
Cable Jacket	
Compare cable data with drawings and specifications	
Electrical connections (tightness, resistance)	
Shield Grounding & cable support	
Surge Arrestors (power and shield)	
Bending Radius	
Fire-proofing	
Digital pictures taken during inspections	

Electrical Testing

Asset ID: **Feeder name:**

Location:

Insulation Resistance Test (Dielectric withstand)			
	Test performed?	**Comment:**	
Test Standard / Test Plan:			
Test Voltage:			
Test Conditions:			
Tests Results		**Insulation Resistance (10 min)**	**Insulation Resistance (1 min)**
Phase A to (Phase B and Phase C + Ground (Ω)):			
Phase B to (Phase C and Phase A + Ground (Ω)):			
Phase C to (Phase A and Phase B + Ground (Ω)):			

Insulation Resistance Test (Surge Arrestor)		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
Phase A to Ground:		
Phase B to Ground:		
Phase C to Ground:		

Resistance Check Parallel Cables (per feeder section)				
Test Standard / Test Plan:				
Test Conditions:				
Test results	Conductor 1	Conductor 2	Conductor 3	Conductor 4
Phase A (mΩ):				
Phase B (mΩ):				
Phase C (mΩ):				

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Inspection Form – LV Metering

Asset ID: **Serial Number:**

Location: **Local Operating Designation:**

Relevant NETA MTS sections include the following. Not every section may apply to each switchgear

- *7.10 Instrument Transformers*
- *7.11.1 Metering Devices, Electromechanical and Solid State*
- *7.11.2 Metering Devices, microprocessor based*
- *9 Thermographic Scan*

Visual Inspection	
Activity / Description	**Comment:**
Check for any tampering (if metered compartment)	
Infrared Scan	
Connection Diagram present	
Physical and mechanical condition including evidence of damage, rust, arching, moisture & corona	
Inspect Terminations	
Prior to cleaning, perform AS FOUND tests	
Electrical connections (tightness, resistance)	
Visual Grounding Check	
Verify all required grounding & shorting connections make good contact	
Verify transformer withdrawal mechanism and grounding (if applicable)	
Verify correct primary and secondary fusing	
Check all moving parts and lubricate as needed	
Pictures taken during the inspections	

Bolted Connection - Resistance Test	
Test Standard / Test Plan:	
Device Name	
Test Voltage:	
Test Conditions:	
Phase A (mΩ):	
Phase B (mΩ):	
Phase C (mΩ):	

Instrument Transformer Testing
Note, instrument transformer tests depend on type of instrument transformer present, and applicable ANSI/IEEE standards (i.e. C57.13.1 and C57.13.3).

CT Polarity Test		
	Test performed?	**Comment:**
Test Standard / Test Plan:		
Test Voltage:		
Test Conditions:		
TEST RESULTS		
Unit 1:		
Unit 2:		
Unit 3:		
Unit 4:		

Ratio Verification Test	
Test performed?	Comment:
Test Standard / Test Plan:	
Test Voltage:	
Test Conditions:	
TEST RESULTS	
Unit 1:	
Unit 2:	
Unit 3:	
Unit 4:	

Excitation test (relaying transformers)	
Test performed?	Comment:
Test Standard / Test Plan:	
Test Voltage:	
Test Conditions:	
TEST RESULTS	
Unit 1:	
Unit 2:	
Unit 3:	
Unit 4:	

CT Circuit – Burden Measurement			
Test performed?	**Comment:**		
Test Standard / Test Plan:			
Test Voltage:			
Test Conditions:			
TEST RESULTS	**PHASE A**	**PHASE B**	**PHASE C**
CT 1 (Ω):			
CT 2 (Ω):			
CT 3 (Ω):			
CT 4 (Ω):			

Instrument Transformer Tests – dielectric withstand (Insulation Resistance)	
Test performed?	**Comment:**
Test Standard / Test Plan:	
Test Voltage:	
Test Conditions:	
TEST RESULTS	
Unit 1:	
Unit 2:	
Unit 3:	
Unit 4:	

APPENDIX F-3.3.

INSPECTION FORMS (Select Components)
COMMUNICATIONS

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Inspection Form – Fiber Enclosure

Component ID: ____________________ **To/ From:** ____________________

Location: ____________________ **Enclosure type:** ____________________

Visual Inspection	
Activity / Description	**Comment:**
Physical and mechanical condition including evidence damage & moisture	
Prior to cleaning, perform AS FOUND tests and visual inspections	
Cabinet rating	
Seal condition	
Cable ports & grommets condition	
Correct number of ports present	
Splice trays availability and condition	
Splice trays count	
Splice trays spares	
Bonding & grounding connection points	
Extra hardware for aerial connections (if required) or wall mount	
Punchout locations (if equipped) and grommets	
Rails supplied and in good condition	
Sketches made during inspection	
Photos taken during inspection	

Inspection Form – Fiber Optic Cable

Component ID: ______________________ **To/ From:** ______________________

Location: ______________________ **Cable type (Number of Strands):** ______________________

Cable attenuation loss measurement: ______________________ **Units:** ______________________

Visual Inspection	
Activity / Description	**Comment:**
Physical and mechanical condition including evidence damage & moisture	
Prior to cleaning, perform AS FOUND tests and visual inspections	
Fiber Optic cable Jacket	
Fiber Optic Connectors and terminations	
Sketches made during inspection	
Photos taken during inspection	

Loss Attenuation Tests	
Activity / Description	**Comment:**
Test Standard / Test Plan:	
Test Frequency	
Test Conditions and Equipment	
Loss Measured Between	**Attenuation Loss Measurement**
Loss 1 (Point A to B)	
Loss … (Point x to y)	
Loss *n* (Point y to z)	

Add extra pages as required

Fiber Optic Cable Tests	
Use Optical Time domain reflectometer and complete: a) Cable length measurement	
b) Fiber fracture inspection	
c) Construction defect inspection	
Connector and splice integrity test	
Use an Optical power loss test set to measure cable attenuation lost measurement	
Perform connector and splice attenuation loss measurement with optical power loss test set (from both ends)	

Attach test reports as required

APPENDIX F-3.4.

INSPECTION FORMS
CIVIL ASSET CLASS

Inspection Form – Civil / Manhole

Asset ID: **Local Operating Designation:**

Location:

Visual Inspection

Record results of visual inspection here including:

- *Condition of manhole cover and fit*
- *General condition of the frame material noting any damage such as cracking, spalling, etc.*
- *Condition of the installation aids*
- *Water level*
- *Appropriate labelling of the cables and duct banks*
- *Compliance with relevant standards including installation standards*

Visual Inspection	
Activity / Description	**Comment:**
Check for form and fit of manhole cover.	
CO_2, CO test pass	
Water in the manhole	
General condition of concrete (entrance, walls, roof, floor, etc.)	
Labelling of duct banks, and cables readable	
Prior to cleaning, perform AS FOUND inspections	
Verify all required grounding is in place	
Pictures taken during the inspections	

Reference any figures, drawings, and photographs as appropriate.

Inspection Form – Civil / Handhole

Asset ID: **Local Operating Designation:**

Location:

Visual Inspection

Record results of visual inspection here including:

- *Condition of manhole cover and fit*
- *General condition of the frame material noting any damage such as cracking, spalling, etc.*
- *Condition of the installation aids*
- *Water level*
- *Appropriate labelling of the cables and duct banks*
- *Compliance with relevant standards including installation standards*

Visual Inspection	
Activity / Description	**Comment:**
Check for form and fit of manhole cover	
CO_2, CO test pass	
Water in the manhole	
General condition of concrete (entrance, walls, roof, floor, etc.)	
Labelling of duct banks, and cables readable	
Prior to cleaning, perform AS FOUND inspections	
Verify all required grounding is in place	
Pictures taken during the inspections	

Reference any figures, drawings, and photographs as appropriate.

Handhole Age:

Inspection Form – Duct Bank

Asset ID:

Local Operating Designation:

Location:

From/To:

Visual Inspection

Record results of visual inspection here including, but not limited to:

- *General condition of the duct banks*
- *Number of available / blocked / spare ducts*
- *Accessibility to the ducts*
- *Availability of ducts to address a future cable failure*
- *Compliance with relevant standards*

Visual Inspection	
Activity / Description	**Comment:**
Each duct is clearly labelled	
Number of blocked ducts (in each bank)	
Number of spare ducts	
Prior to cleaning, perform AS FOUND tests and inspections	
Sketches made during inspection	
Pictures taken during the inspections	

Reference any figures, drawings, and photographs as appropriate.

Inspection Form – Fencing

Asset ID: **Local Operating Designation:**

Location:

Visual / Mechanical Inspection

Record the results of the visual inspection including observations on the general condition, functionality, mechanical operation, and electrical and physical integrity. Consider the following aspects when completing the inspection:

Visual Inspection	
	Comment:
Fencing paint / rust check	
Check for any opening/gaps in the fence fabric	
Fence Post Alignment Check	
Grounding Check (fence fabric)	
Grounding Check (door/gate)	
Fence Fabric Touching Ground (gap size)	
Graffiti Check	
Prior to cleaning, perform AS FOUND tests	
Check all moving parts and lubricate as needed	
Sketches made during inspection	
Pictures taken during the inspections	

Reference any photographs as appropriate.

APPENDIX F-4.

INSPECTION SUMMARY FORMS

APPENDIX F-4.1.

INSPECTION SUMMARY FORMS
MV ASSET CLASS & COMPONENTS

Inspection Summary – MV Asset Class

Location: ____________________ **Asset ID:** ____________________

Inspection Type:
- ☐ **Baseline**
- ☐ **Routine**
- ☐ **Special**

Inspection Date(s): ____________________

Scope of Inspection: ____________________

Asset Class: MV Asset Class

Inspection Firm(s): ____________________

Reported by: ____________________ **Report Date:** ____________________

FICAP Manual Version/Date: ____________________ **Variances from FICAP Procedure:** ____________________

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ____________ Name: ____________ Texas License No.: ____________ Date: ____________ Expires: ____________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Asset Class Condition

This section summarizes the findings of the condition assessment at the asset class level. This section should describe the condition of the components at a high level and note any interactions between the components. This section should be read in conjunction with the individual component inspection summary forms.

Asset Condition Rating (ACR):

Component Ratings and Summary

Summarize the individual component ratings including the calculation of the overall component rating. Refer to the individual component inspection summary forms for more information.

Component ID	Component	Component Rating (1 – 6)	Comments
Pad-Mounted Transformer (PMTX)			
PMTX-1	Pad-Mounted Transformer		
PMTX -2	Pad-Mounted Transformer		
PMTX -3	Pad-Mounted Transformer		
Pad-Mounted Transformer Overall Component Rating:			
Pad-Mounted Switchgear (PMSG)			
PMSG-1	Pad-Mounted Switchgear		
PMSG -2	Pad-Mounted Switchgear		
PMSG -3	Pad-Mounted Switchgear		
Pad-Mounted Switchgear Overall Component Rating:			
MV Power Cables (UGC)			
UGC-1	MV Power Cables		
UGC-2	MV Power Cables		
UGC-3	MV Power Cables		
MV Power Cables Overall Component Rating:			
Metal-Clad Switchgear (MCSG)			
MCSG-1	Metal-Clad Switchgear		
MCSG -2	Metal-Clad Switchgear		
MCSG -3	Metal-Clad Switchgear		
Metal-Clad Switchgear Overall Component Rating:			

Checklist

Verify that all relevant information is attached or archived on the network

Answer	**Description**
	Verify that if digital pictures have been taken at site, that they are archived on the network in a suitable manner
	Attach any relevant inspection forms that require further action.
	Confirm that all site inspection forms, and 3rd party reports are archived on the network in a suitable manner.
	Check with site team on any lessons learned or continuous improvement ideas

Inspection Summary – Pad-Mounted Transformer

Location:	____________	**Asset ID:**	____________
Asset Class:	MV Asset Class	**Component Type:**	Pad-Mounted Transformer
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	____________
Scope of Inspection:	____________		
Inspection Firm(s):	____________		
Reported by:	____________	**Report Date:**	____________
FICAP Manual Version/Date:		**Variances from FICAP Procedure:**	
Applicable Standard / Test Plan:	____________	**Variances from standard procedures:**	____________

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ____________ Name: ____________ Texas License No.: ____________ Date: ____________ Expires: ____________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the inspection results, follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form – Pad-Mounted Transformer

Element Condition Summary, Part 1

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
PMTX-NP								
PMTX-CPT								
PMTX-GG								
PMTX-BSH								

Element Condition Summary, Part 2

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
PMTX-TNK								
PMTX-PAD								
PMTX-OIL								
PMTX-WDG								
PMTX-TC								
PMTX-OTH								

Checklist

Verify that all relevant information is attached or archived on the network

Answer	**Description**
	Verify that if digital pictures have been taken at site, that they are archived on the network in a suitable manner
	Attach any relevant inspection forms that require further action.
	Confirm that all site inspection forms, and 3rd party reports are archived on the network in a suitable manner.
	Check with site team on any lessons learned or continuous improvement ideas. Attach list of ideas as required.

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Inspection Summary – Pad-Mounted Switchgear

Location:	______	**Asset ID:**	______
Asset Class:	MV Asset Class	**Component Type:**	Pad-Mounted Switchgear
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	______
Scope of Inspection:	______		
Inspection Firm(s):	______		
Reported by:	______	**Report Date:**	______
FICAP Manual Version/Date:	______	**Variances from FICAP Procedure:**	______
Applicable Standard / Test Plan:	______	**Variances from standard procedures:**	______

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ______ Name: ______ Texas License No.: ______ Date: ______ Expires: ______	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the inspection results, follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form – Pad-Mounted Switchgear

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
PMSG-CPT								
PMSG-PAD								
PMSG-FUS								
PMSG-SW								

Checklist

Verify that all relevant information is attached or archived on the network

Answer	Description
	Verify that if digital pictures have been taken at site, that they are archived on the network in a suitable manner
	Attach any relevant inspection forms that require further action.
	Confirm that all site inspection forms, and 3rd party reports are archived on the network in a suitable manner.
	Check with site team on any lessons learned or continuous improvement ideas. Attach list of ideas as required.

Inspection Summary – MV Power Cables

Location:		**Asset ID:**	
Asset Class:	MV Asset Class	**Component Type:**	MV Power Cables
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	
Scope of Inspection:			
Inspection Firm(s):			
Reported by:		**Report Date:**	
FICAP Manual Version/Date:		**Variances from FICAP Procedure:**	
Applicable Standard / Test Plan:		**Variances from standard procedures:**	

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ________ Name: ________ Texas License No.: ________ Date: ________ Expires: ________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the inspection results, follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form – MV Power Cables

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
UGC-INS								
UGC-JTS								
UGC-SH								
UGC-CON								

Checklist

Verify that all relevant information is attached or archived on the network

Answer	**Description**
	Verify that if digital pictures have been taken at site, that they are archived on the network in a suitable manner
	Attach any relevant inspection forms that require further action.
	Confirm that all site inspection forms, and 3rd party reports are archived on the network in a suitable manner.
	Check with site team on any lessons learned or continuous improvement ideas. Attach list of ideas as required.

Inspection Summary – Metal-Clad Switchgear

Location:		**Asset ID:**	
Asset Class:	MV Asset Class	**Component Type:**	Metal-Clad Switchgear
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	
Scope of Inspection:			
Inspection Firm(s):			
Reported by:		**Report Date:**	
FICAP Manual Version/Date:		**Variances from FICAP Procedure:**	
Applicable Standard / Test Plan:		**Variances from standard procedures:**	

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** __________ Name: __________ Texas License No.: __________ Date: __________ Expires: __________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the inspection results, follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form – Metal-Clad Switchgear

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
MCSG-CPT								
MCSG-BRK								
MCSG-INR								
MCSG-IT								
MCSG-RL								
MCSG-OTHER								

Checklist

Verify that all relevant information is attached or archived on the network

Answer	**Description**
	Verify that if digital pictures have been taken at site, that they are archived on the network in a suitable manner
	Attach any relevant inspection forms that require further action.
	Confirm that all site inspection forms, and 3rd party reports are archived on the network in a suitable manner.
	Check with site team on any lessons learned or continuous improvement ideas. Attach list of ideas as required.

APPENDIX F-4.2.

INSPECTION SUMMARY FORMS
LV ASSET CLASS & COMPONENTS

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Inspection Summary – LV Asset Class

Location: ____________________ **Asset ID:** ____________________

Inspection Type: ☐ **Baseline** ☐ **Routine** ☐ **Special** **Inspection Date(s):** ____________________

Scope of Inspection: ____

Asset Class: LV Asset Class

Inspection Firm(s): ____

Reported by: ____________________ **Report Date:** ____________________

FICAP Manual Version/Date: ____________________ **Variances from FICAP Procedure:** ____________________

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ____________________ Name: ____________________ Texas License No.: ____________________ Date: ____________________ Expires: ____________________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Asset Class Condition

This section summarizes the findings of the condition assessment at the asset class level. This section should describe the condition of the components at a high level and note any interactions between the components. This section should be read in conjunction with the individual component inspection summary forms.

Asset Condition Rating (ACR):

Component Ratings and Summary

Summarize the individual component ratings including the calculation of the overall component rating. Refer to the individual component inspection summary forms for more information.

Component ID	Component	Component Rating (1 – 6)	Comments
LV Panelboard (PSWB)			
PSWB-1	PSWB		
PSWB -2	PSWB		
PSWB -3	PSWB		
PSWB Overall Component Rating:			
LV power cable (LVPC)			
LVPC -1	LVPC		
LVPC -2	LVPC		
LVPC -3	LVPC		
LVPC Overall Component Rating:			
LV metering (LVMT)			
LVMT -1	LVMT		
LVMT -2	LVMT		
LVMT -3	LVMT		
LVMT Overall Component Rating:			

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Inspection Summary – LV Panelboard

Location:		**Asset ID:**	
Asset Class:	LV Asset Class	**Component Type:**	LV Panelboard
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	
Scope of Inspection:			
Inspection Firm(s):			
Reported by:		**Report Date:**	
FICAP Manual Version/Date:		**Variances from FICAP Procedure:**	
Applicable Standard / Test Plan:		**Variances from standard procedures:**	

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ________ Name: ________ Texas License No.: ________ Date: ________ Expires: ________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the inspection results, follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form – Panelboard

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
PSWB-MCB								
PSWB-FUS								
PSWB-SWC								

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Inspection Summary – LV Power Cables

Location:		**Asset ID:**	
Asset Class:	LV Asset Class	**Component Type:**	LV Power Cables
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	
Scope of Inspection:			
Inspection Firm(s):			
Reported by:		**Report Date:**	
FICAP Manual Version/Date:		**Variances from FICAP Procedure:**	
Applicable Standard / Test Plan:		**Variances from standard procedures:**	

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ______ Name: ______ Texas License No.: ______ Date: ______ Expires: ______	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the inspection results, follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form – LV Power Cables

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
LVPC-INS								
LVPC-JTS								
LVPC-SH								
LVPC-CON								

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Inspection Summary – LV Metering

Location:	______________	**Asset ID:**	______________
Asset Class:	LV Asset Class	**Component Type:**	LV Metering
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	______________
Scope of Inspection:	______________		
Inspection Firm(s):	______________		
Reported by:	______________	**Report Date:**	______________
FICAP Manual Version/Date:		**Variances from FICAP Procedure:**	
Applicable Standard / Test Plan:	______________	**Variances from standard procedures:**	______________

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ______________ Name: ______________ Texas License No.: ______________ Date: ______________ Expires: ______________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the inspection results, follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form – LV Metering

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
LVMT-MET								
LVMT-IT								

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APPENDIX F-4.3.

INSPECTION SUMMARY FORMS
COMMUNICATIONS ASSET CLASS & COMPONENTS

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Inspection Summary – Communications Asset Class

Location: ______________________ **Asset ID:** ______________________

Inspection Type:
- □ **Baseline**
- □ **Routine**
- □ **Special**

Inspection Date(s): ______________________

Scope of Inspection: ______________________

Asset Class: Communications Asset Class

Inspection Firm(s): ______________________

Reported by: ______________________ **Report Date:** ______________________

FICAP Manual Version/Date: ______________________ **Variances from FICAP Procedure:** ______________________

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ______________________ Name: ______________________ Texas License No.: ______________________ Date: ______________________ Expires: ______________________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Asset Class Condition

This section summarizes the findings of the condition assessment at the asset class level. This section should describe the condition of the components at a high level and note any interactions between the components. This section should be read in conjunction with the individual component inspection summary forms.

Asset Condition Rating (ACR):

Component Ratings and Summary

Summarize the individual component ratings including the calculation of the overall component rating. Refer to the individual component inspection summary forms for more information.

Component ID	Component	Component Rating (1 – 6)	Comments
Fiber Enclosures (CFE)			
CFE-1	Fiber Enclosure		
CFE-2	Fiber Enclosure		
CFE-3	Fiber Enclosure		
Fiber Enclosures Overall Component Rating:			
Fiber Optic Cables (CFO)			
CFO-1	Fiber Optic Cable		
CFO-2	Fiber Optic Cable		
CFO-3	Fiber Optic Cable		
Fiber Optic Cable Overall Component Rating:			
Termination Points (TER)			
TER-1	Termination Points		
TER-2	Termination Points		
TER-3	Termination Points		
Termination Points Overall Component Rating:			
Legacy Communication Components (LCC)			
LCC-1	Legacy Components		
LCC-2	Legacy Components		
LCC-3	Legacy Components		
Legacy Components Overall Component Rating:			

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Inspection Summary – Fiber Enclosures

Location:	____________	**Asset ID:**	____________
Asset Class:	Communications	**Component Type:**	Fiber Enclosures
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	____________
Scope of Inspection:	____________		
Inspection Firm(s):	____________		
Reported by:	____________	**Report Date:**	____________
FICAP Manual Version/Date:		**Variances from FICAP Procedure:**	
Applicable Standard / Test Plan:	____________	**Variances from standard procedures:**	____________

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ____________ Name: ____________ Texas License No.: ____________ Date: ____________ Expires: ____________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	EA/ SF/ LF	Value	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
CFER									
CFEM									

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Inspection Summary – Fiber Optic Cables

Location:		**Asset ID:**	
Asset Class:	Communications	**Component Type:**	Fiber Optic Cables
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	
Scope of Inspection:			
Inspection Firm(s):			
Reported by:		**Report Date:**	
FICAP Manual Version/Date: **Applicable Standard / Test Plan:**		**Variances from FICAP Procedure:** **Variances from standard procedures:**	

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** __________ Name: __________ Texas License No.: __________ Date: __________ Expires: __________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	EA/ SF/ LF	Value	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
CFO-JCK									
CFO-COR									
CFO-CON									

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APPENDIX F-4.4.

INSPECTION SUMMARY FORMS
CIVIL ASSET CLASS & COMPONENTS

Representative form provided for Civil Asset Class

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Inspection Summary – Civil Asset Class

Location: __________________ **Asset ID:** __________________

Inspection Type:
- □ **Baseline**
- □ **Routine**
- □ **Special**

Inspection Date(s): __________________

Scope of Inspection: __________________

Asset Class: Civil Asset Class

Inspection Firm(s): __________________

Reported by: __________________ **Report Date:** __________________

FICAP Manual Version/Date: __________________ **Variances from FICAP Procedure:** __________________

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ____________ Name: ____________ Texas License No.: ____________ Date: ____________ Expires: ____________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Asset Class Condition

This section summarizes the findings of the condition assessment at the asset class level. This section should describe the condition of the components at a high level and note any interactions between the components. This section should be read in conjunction with the individual component inspection summary forms.

Asset Condition Rating (ACR):

Component Ratings and Summary

Summarize the individual component ratings including the calculation of the overall component rating. Refer to the individual component inspection summary forms for more information.

Component ID	Component	Component Rating (1 – 6)	Comments
Manholes (CMH)			
CMH-1	Manhole		
CMH-2	Manhole		
CMH-3	Manhole		
Manhole Overall Component Rating:			
Handholes (CHH)			
CHH-1	Handhole		
CHH-2	Handhole		
CHH-3	Handhole		
Handhole Overall Component Rating:			
Duct Banks (CDB)			
CDB-1	Duct Bank		
CDB-2	Duct Bank		
CDB-3	Duct Bank		
Duct Bank Overall Component Rating:			
Fencing (CFG)			
CFG-1	Fencing		
CFG-2	Fencing		
CFG-3	Fencing		
Fencing Overall Component Rating:			

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Inspection Summary – Manhole

Location:	______________	**Asset ID:**	______________
Asset Class:	Civil	**Component Type:**	Manhole
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	______________

Scope of Inspection: ______________________________

Inspection Firm(s): ______________________________

Reported by: ______________ **Report Date:** ______________

FICAP Manual Version/Date: ______________ **Variances from FICAP Procedure:** ______________

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ______________ Name: ______________ Texas License No.: ______________ Date: ______________ Expires: ______________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
CMH-CMH	***1***							

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Inspection Summary – Handhole

Location:	____________	**Asset ID:**	____________
Asset Class:	Civil	**Component Type:**	Handhole
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	____________

Scope of Inspection: ______________________________

Inspection Firm(s): ______________________________

Reported by:	____________	**Report Date:**	____________
FICAP Manual Version/Date:	____________	**Variances from FICAP Procedure:**	____________

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ____________ Name: ____________ Texas License No.: ____________ Date: ____________ Expires: ____________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
CHH-CHH	***1***							

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Inspection Summary – Duct Bank

Location:	__________	**Asset ID:**	__________
Asset Class:	Civil	**Component Type:**	Duct Bank
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	__________

Scope of Inspection: ____________________

Inspection Firm(s): ____________________

Reported by:	__________	**Report Date:**	__________
FICAP Manual Version/Date: **Applicable Standard / Test Plan:**	__________	**Variances from FICAP Procedure:** **Variances from standard procedures:**	__________

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** __________ Name: __________ Texas License No.: __________ Date: __________ Expires: __________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form – Duct Bank

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
CDB-CDB	***1***							

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Inspection Summary – Fencing

Location:	______________	**Asset ID:**	______________
Asset Class:	Civil Asset Class	**Component Type:**	Fencing
Inspection Type:	□ **Baseline** □ **Routine** □ **Special**	**Inspection Date(s):**	______________
Scope of Inspection:	______________		
Inspection Firm(s):	______________		
Reported by:	______________	**Report Date:**	______________
FICAP Manual Version/Date:		**Variances from FICAP Procedure:**	
Applicable Standard / Test Plan:	______________	**Variances from standard procedures:**	______________

Seal of Responsible Engineer

I hereby certify that this inspection was performed under my direct supervision and control, and to the best of my professional knowledge complies with the FICAP Manual and applicable codes. **Signed:** ______________ Name: ______________ Texas License No.: ______________ Date: ______________ Expires: ______________	*affix Professional Engineer seal here*

Inspection Team Members

Project Manager:

Inspection Team Leader(s):

Inspection Team Members:

Overall Component Condition

This section summarizes the findings of the condition assessment at the component level. This section should be read in conjunction with the inspection results, follow-up action form and element summary.

Overall Component Rating (out of 6):

Element Inspection Form – Fencing

Element Condition Summary

Score each element against the condition states for that element. This information will be used to identify the Follow-Up Actions required in the Follow-Up Actions form and will be used with a competent person's judgement to assign a component rating.

Element	Qty	Condition State Code	Condition State	Inaccessible/ Not checked	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4 (Severe)
CFG-CFG								

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APPENDIX F-5.

FOLLOW-UP ACTION FORM

Representative form provided for all component types

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FOLLOW-UP ACTION FORM - Item

Location: ____________________ **Asset ID:** ____________________

Asset Class: ____________________ **Component Type:** ____________________

Inspection Type: □ **Baseline** □ **Routine** □ **Special** **Inspection Date(s):** ____________________

Scope of Inspection: ____

Inspection Firm(s): ____

Reported by: ____________________ **Report Date:** ____________________

Follow-Up Actions

Item No.:		**Priority:**	□ **Priority** □ **Routine**
Component:			
Element Type:		**Element ID(s):**	
Condition Identified:			
Reason for Action:			
Recommended Action:			
{insert photographs of area of action}			

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FOLLOW-UP ACTION LOG

Item No.	Priority	Recommended Action	Assigned To	Assigned By	Date

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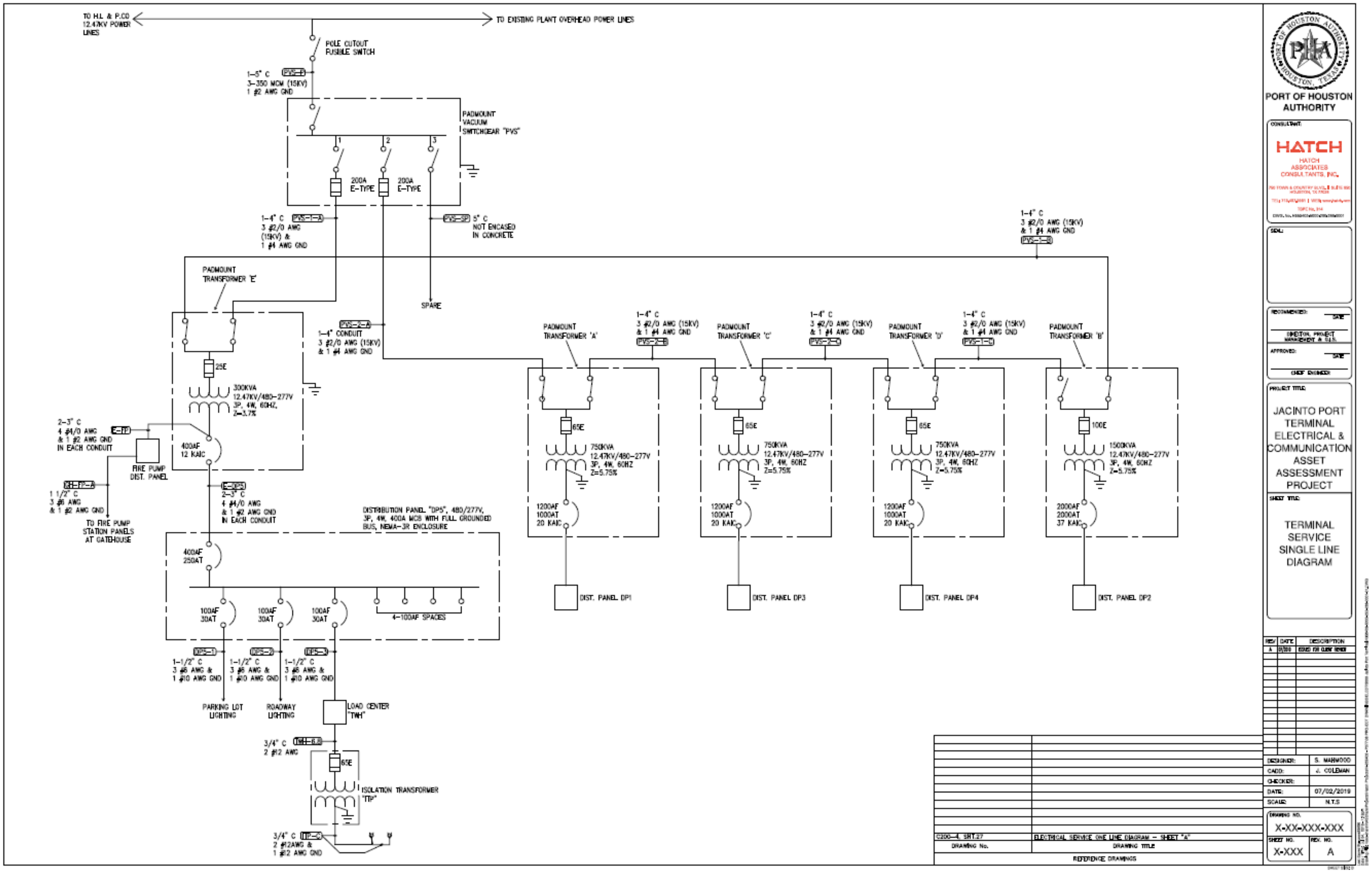
APPENDIX G

REFERENCE DRAWINGS


TO H.L & P.CO 12.47KV POWER LINES
TO EXISTING PLANT OVERHEAD POWER LINES
POLE CUTOUT FUSIBLE SWITCH
PADMOUNT VACUUM SWITCHGEAR "PVS"
PADMOUNT TRANSFORMER 'E'
SPARE
PADMOUNT TRANSFORMER 'A'
PADMOUNT TRANSFORMER 'C'
PADMOUNT TRANSFORMER 'D'
PADMOUNT TRANSFORMER 'B'
FIRE PUMP DIST. PANEL
TO FIRE PUMP STATION PANELS AT GATEHOUSE
DISTRIBUTION PANEL "DP5", 480/277V, 3P, 4W, 400A MCB WITH FULL GROUNDED BUS, NEMA-3R ENCLOSURE
4-100AF SPACES
PARKING LOT LIGHTING
ROADWAY LIGHTING
LOAD CENTER "TWH"
ISOLATION TRANSFORMER "TP"
DIST. PANEL DP1
DIST. PANEL DP3
DIST. PANEL DP4
DIST. PANEL DP2
PORT OF HOUSTON AUTHORITY
HATCH
JACINTO PORT TERMINAL ELECTRICAL & COMMUNICATION ASSET ASSESSMENT PROJECT
TERMINAL SERVICE SINGLE LINE DIAGRAM
S. MAHMOOD
J. COLEMAN
07/02/2019
N.T.S
X-XX-XXX-XXX
X-XXX
A
ELECTRICAL SERVICE ONE LINE DIAGRAM - SHEET "A"
REFERENCE DRAWINGS