FILE

54

# PUCO EXHIBIT FILING

Date of Hearing: 5/22/12

Case No. 11-346-EL-SSO, et al.

PUCO Case Caption: Volume IV

Columbus Southern Power

Ohio Power

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List of exhibits being filed:

AEP Ex. 113
FES Exs. 110, 111 and 112
OCC Ex. 106 and 108

Reporter's Signature: Maria DiPaolo Jones
Date Submitted:

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Technician Date Processed JUN 06 2012

1 BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO

2 - - -

3 In the Matter of the :
Application of Columbus :
4 Southern Power Company :
and Ohio Power Company :
5 for Authority to Establish:
a Standard Service Offer : Case No. 11-346-EL-SSO
6 Pursuant to §4928.143, : Case No. 11-348-EL-SSO
Ohio Rev. Code, in the :
7 Form of an Electric :
Security Plan. :
8
In the Matter of the :
9 Application of Columbus :
Southern Power Company : Case No. 11-349-EL-AAM
10 and Ohio Power Company : Case No. 11-350-EL-AAM
for Approval of Certain :
11 Accounting Authority. :

12 - - -

13 PROCEEDINGS

14 before Ms. Greta See and Mr. Jonathan Tauber,
15 Attorney Examiners, and Commissioner Andre Porter, at
16 the Public Utilities Commission of Ohio, 180 East
17 Broad Street, Room 11-A, Columbus, Ohio, called at
18 8:30 a.m. on Tuesday, May 22, 2012.

19 - - -

20 VOLUME IV

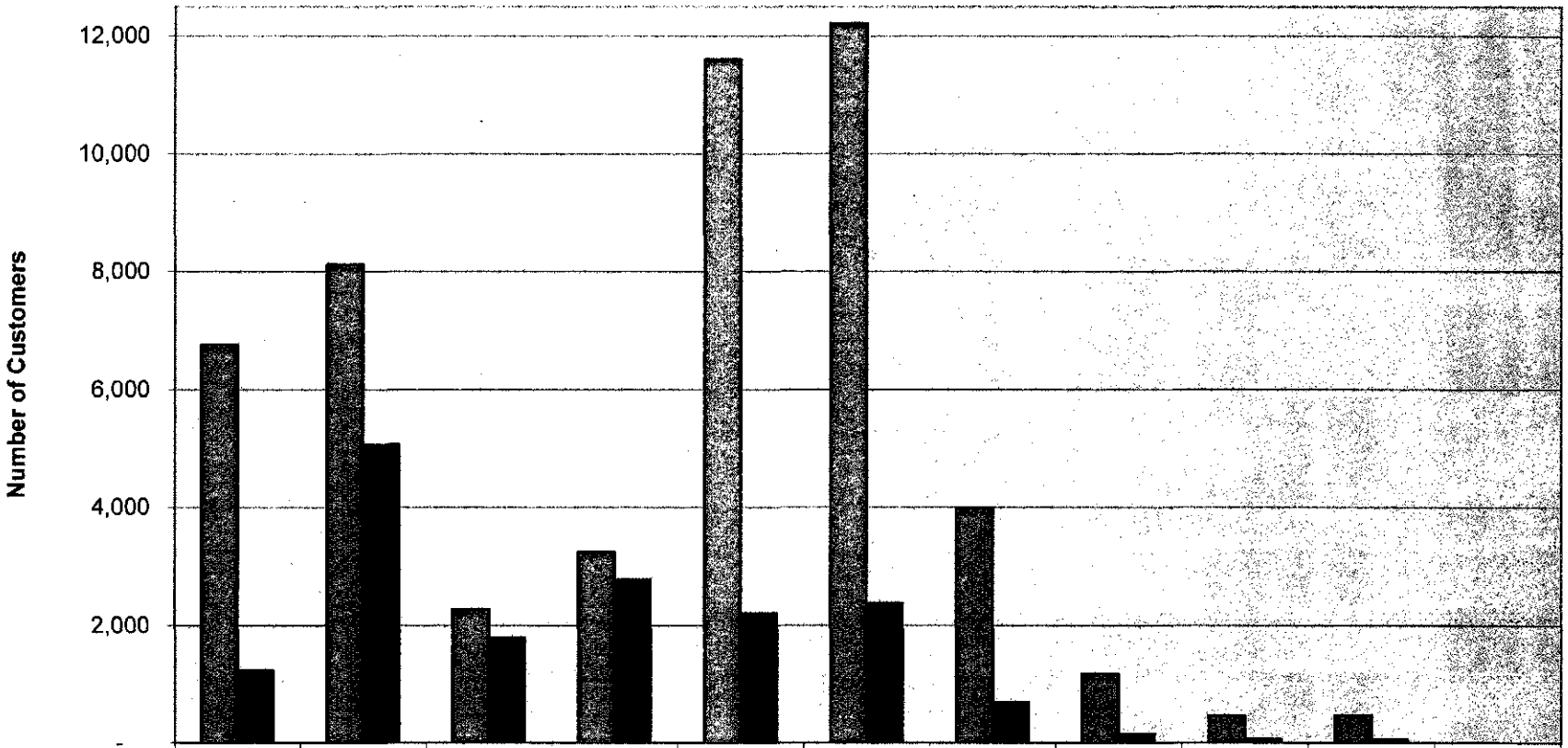
21 - - -

22 ARMSTRONG & OKEY, INC.
222 East Town Street, Second Floor
23 Columbus, Ohio 43215-5201
(614) 224-9481 - (800) 223-9481
24 Fax - (614) 224-5724

25 - - -

AEP Ex 113

## GS-2, GS-3 and GS-4 Customers - 2012

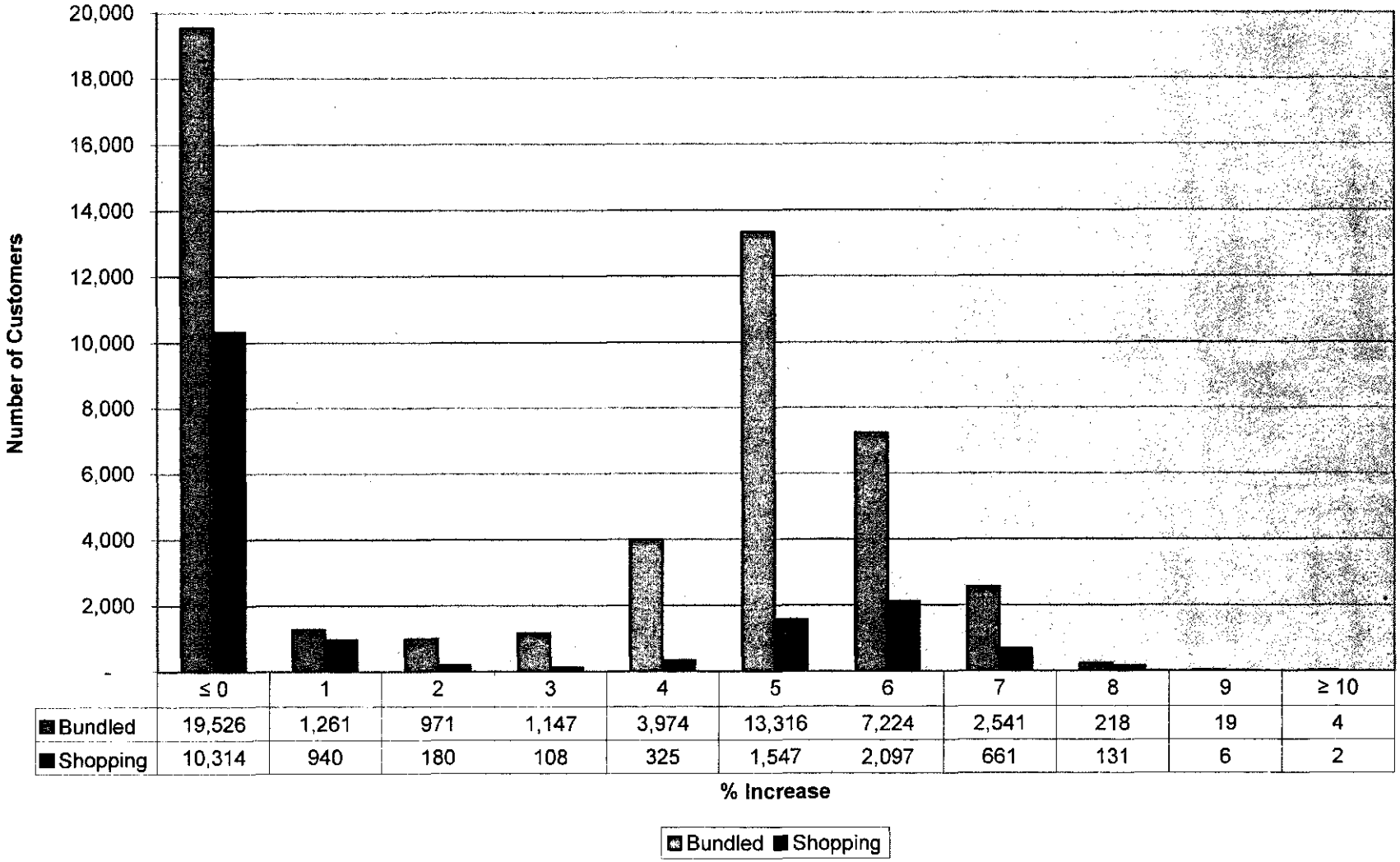



| | ≤ 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | ≥ 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bundled | 6,754 | 8,110 | 2,260 | 3,236 | 11,601 | 12,200 | 3,975 | 1,159 | 446 | 453 | 7 |
| Shopping | 1,223 | 5,051 | 1,781 | 2,764 | 2,202 | 2,371 | 671 | 133 | 58 | 55 | 2 |

% Increase

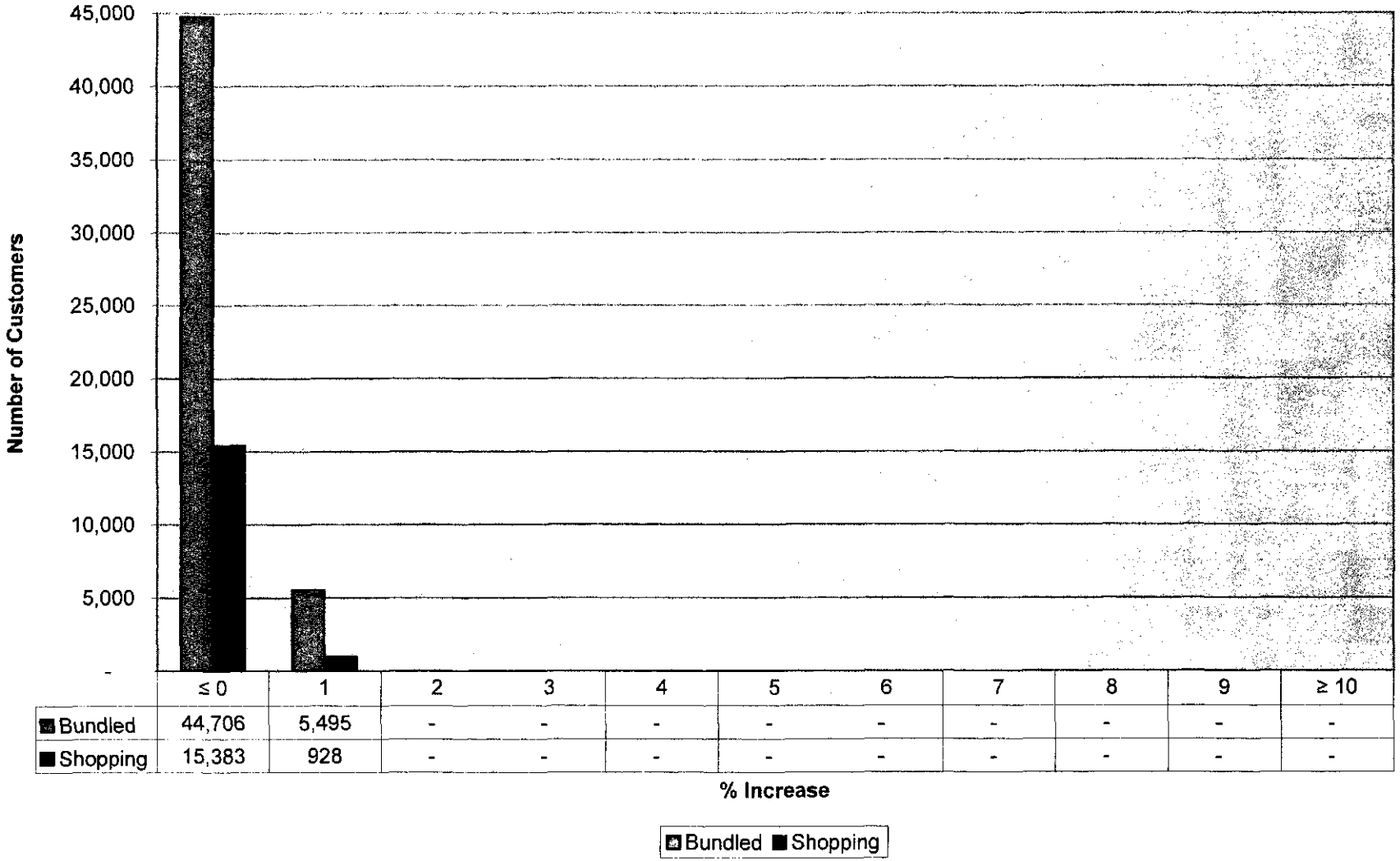
Bundled Shopping

## GS-2, GS-3 and GS-4 Customers - 2013




| | ≤ 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | ≥ 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bundled | 19,526 | 1,261 | 971 | 1,147 | 3,974 | 13,316 | 7,224 | 2,541 | 218 | 19 | 4 |
| Shopping | 10,314 | 940 | 180 | 108 | 325 | 1,547 | 2,097 | 661 | 131 | 6 | 2 |

## GS-2, GS-3 and GS-4 Customers - 2014




| | ≤ 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | ≥ 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bundled | 44,706 | 5,495 | - | - | - | - | - | - | - | - | - |
| Shopping | 15,383 | 928 | - | - | - | - | - | - | - | - | - |

FES110

| Rate Change for Transmission Voltage Customers | | |
|---|---|---|
| $/MWh | CSP Rate Zone | OPCo Rate Zone |
| Second Quarter 2012 FAC Rates - Unmerged | 38.440 | 32.405 |
| Second Quarter 2012 FAC Rates - Merged | 34.793 | 34.793 |
| Change Associated with Merging FAC | -3.65 | 2.39 |
| PIRR begins June 2013 | 3.0410 | 3.0410 |
| Change Associated with PIRR Implementation | 3.04 | 3.04 |
| **Net Impact over 2 years** | **-0.61** | **5.43** |

| Rate Change for Secondary Voltage Customers | | |
|---|---|---|
| $/MWh | CSP Rate Zone | OPCo Rate Zone |
| Second Quarter 2012 FAC Rates - Unmerged | 40.504 | 34.436 |
| Second Quarter 2012 FAC Rates - Merged | 36.776 | 36.776 |
| Change Associated with Merging FAC | -3.73 | 2.34 |
| PIRR begins June 2013 | 3.214 | 3.214 |
| Change Associated with PIRR Implementation | 3.21 | 3.21 |
| **Net Impact over 2 years** | **-0.51** | **5.55** |

FES III

## Market Comparable Generation Prices

| | Energy | Current | 2012 Proposed | Energy | Current | 2013-May 2014 Proposed | Energy | Current | 2012-May 2014 Proposed |
|---|---|---|---|---|---|---|---|---|---|
| CSP | 17,474,000,002 | $353,167,957 | $424,169,752 | 24,435,300,000 | $492,011,772 | $658,908,517 | 41,909,300,002 | $845,179,729 | $1,083,078,269 |
| OP | 26,029,500,007 | $561,129,845 | $555,356,582 | 36,566,000,000 | $784,643,158 | $861,750,932 | 62,595,500,007 | $1,345,773,003 | $1,417,107,514 |
| AEP Ohio | 43,503,500,009 | $914,297,802 | $979,526,334 | 61,001,300,000 | $1,276,654,930 | $1,520,659,449 | 104,504,800,009 | $2,190,952,732 | $2,500,185,783 |
| **Tariff Generation Prices** | | | | | | | | | |
| CSP | | $20.21 | $24.27 | | $20.14 | $26.97 | | $20.17 | $25.84 |
| OP | | $21.56 | $21.34 | | $21.46 | $23.57 | | $21.50 | $22.64 |
| AEP Ohio | | $21.02 | $22.52 | | $20.93 | $24.93 | | $20.97 | $23.92 |
| **Transmission Adjustment** | | | | | | | | | |
| CSP | | $2.20 | $2.20 | | $2.20 | $2.20 | | $2.20 | $2.20 |
| OP | | $2.10 | $2.10 | | $2.09 | $2.09 | | $2.09 | $2.09 |
| AEP Ohio | | $2.14 | $2.14 | | $2.14 | $2.14 | | $2.14 | $2.14 |
| **Market Comparable Base G** | | | | | | | | | |
| CSP | | $22.41 | $26.48 | | $22.34 | $29.17 | | $22.37 | $28.05 |
| OP | | $23.65 | $23.43 | | $23.55 | $25.66 | | $23.59 | $24.73 |
| AEP Ohio | | $23.16 | $24.65 | | $23.08 | $27.06 | | $23.10 | $26.06 |
| **2011 Environmental Costs** | | | | | | | | | |
| CSP | | $1.15 | $0.97 | | $1.15 | $0.97 | | $1.15 | $0.97 |
| OP | | $0.73 | $0.85 | | $0.73 | $0.85 | | $0.73 | $0.85 |
| AEP Ohio | | $0.90 | $0.90 | | $0.90 | $0.90 | | $0.90 | $0.90 |
| **2011 Fuel Costs** | | | | | | | | | |
| CSP | | $35.92 | $33.04 | | $35.92 | $33.04 | | $35.92 | $33.04 |
| OP | | $30.81 | $32.75 | | $30.80 | $32.73 | | $30.80 | $32.74 |
| AEP Ohio | | $32.86 | $32.86 | | $32.85 | $32.85 | | $32.86 | $32.86 |
| **Market Comparable Total G** | | | | | | | | | |
| CSP | | $59.49 | $60.49 | | $59.40 | $63.18 | | $59.44 | $62.06 |
| OP | | $55.20 | $57.03 | | $55.08 | $59.24 | | $55.13 | $58.32 |
| AEP Ohio | | $56.92 | $58.42 | | $56.81 | $60.82 | | $56.86 | $59.82 |

FES 112



AEP Ohio
Electric Security Plan
Competitive Benchmark Prices
by Component and Customer Class

Capacity Cost $255/MW-day

Planning Year 2012/2013
$/MWh

| | | Residential | Commercial | Industrial |
|---|---|---|---|---|
| 1 | Simple Swap | 32.68 | 32.68 | 32.68 |
| 2 | Basis Adjustment | 0.49 | 0.49 | 0.49 |
| 3 | Load Following/Shaping Adjustment | 4.94 | 2.19 | 1.64 |
| 4 | Capacity | 21.52 | 16.49 | 12.39 |
| 5 | Ancillary Services | 0.85 | 0.85 | 0.85 |
| 6 | Alternative Energy Requirement | 0.55 | 0.54 | 0.54 |
| 7 | ARR Credit | (1.54) | (1.11) | (0.97) |
| 8 | Losses | 2.45 | 1.43 | 0.63 |
| 9 | Transaction Risk Adder | 3.35 | 2.93 | 2.66 |
| 10 | Retail Administration | 5.00 | 5.00 | 5.00 |
| | Class Total | 70.28 | 61.50 | 55.93 |
| | Weighted Total | | 61.94 | |

Planning Year 2013/2014
$/MWh

| | | Residential | Commercial | Industrial |
|---|---|---|---|---|
| 1 | Simple Swap | 35.34 | 35.34 | 35.34 |
| 2 | Basis Adjustment | 0.49 | 0.49 | 0.49 |
| 3 | Load Following/Shaping Adjustment | 5.24 | 2.37 | 1.67 |
| 4 | Capacity | 20.53 | 15.70 | 11.16 |
| 5 | Ancillary Services | 0.85 | 0.85 | 0.85 |
| 6 | Alternative Energy Requirement | 0.71 | 0.71 | 0.71 |
| 7 | ARR Credit | (1.44) | (1.04) | (0.89) |
| 8 | Losses | 2.63 | 1.54 | 0.68 |
| 9 | Transaction Risk Adder | 3.47 | 3.05 | 2.75 |
| 10 | Retail Administration | 5.00 | 5.00 | 5.00 |
| | Class Total | 72.83 | 64.00 | 57.77 |
| | Weighted Total | | 64.15 | |

AEP Ohio
Electric Security Plan
Competitive Benchmark Prices
by Component and Customer Class

Capacity Cost $255/MW-day

Planning Year 2014/2015
$/MWh

| | | Residential | Commercial | Industrial |
|---|---|---|---|---|
| 1 | Simple Swap | 37.75 | 37.75 | 37.75 |
| 2 | Basis Adjustment | 0.49 | 0.49 | 0.49 |
| 3 | Load Following/Shaping Adjustment | 5.48 | 2.48 | 1.77 |
| 4 | Capacity | 20.67 | 16.09 | 11.34 |
| 5 | Ancillary Services | 0.85 | 0.85 | 0.85 |
| 6 | Alternative Energy Requirement | 0.92 | 0.91 | 0.92 |
| 7 | ARR Credit | (1.46) | (1.08) | (0.92) |
| 8 | Losses | 2.80 | 1.64 | 0.73 |
| 9 | Transaction Risk Adder | 3.62 | 3.21 | 2.90 |
| 10 | Retail Administration | 5.00 | 5.00 | 5.00 |
| | Class Total | 76.12 | 67.34 | 60.82 |
| | Weighted Total | | 67.34 | |

OCC. EX NO. 106

**COLUMBUS SOUTHERN POWER COMPANY'S**
**AND OHIO POWER COMPANY'S RESPONSE TO**
**THE OFFICE OF THE OHIO CONSUMERS' COUNSEL'S**
**DISCOVERY REQUEST**
**PUCO CASE NO. 11-346-EL-SSO AND 11-348-EL-SSO**
**EIGHTH SET**

**INTERROGATORY**

INT-211 Please identify all of the potential distribution assets "detailed in the FERC Chart of Accounts" that the DIR is structured to provide capital funding for. Identify these by FERC Account and category of expenditure (See Kirkpatrick Testimony at 10, lines 8-9).

**RESPONSE:**

The FERC Chart of Accounts that will be used in the DIR are only those that related to distribution plant These include
360- Land and Land Rights
361- Structures and Improvements
362- Station Equipment
363- Storage Battery Equipment
364- Poles, Towers and Fixtures
365- Overhead Conductors and Devices
368- Line Transformers
369- Services
370- Meters
371- Installation on Customer Premises
372- Leased Property on Customer Premises
373 Street Lighting and Signal Systems
374- Asset Retirement Costs for Distribution Plant..

Prepared By: Andrea E Moore

OCC EX NO. 108

AMERICAN ELECTRIC POWER

American Electric Power
1 Riverside Plaza
Columbus OH 43215-2373
AEP.com

October 27, 2010

John Williams
Director, Service Monitoring and Enforcement Department
Public Utilities Commission of Ohio
180 East Broad Street
Columbus, Ohio 43215

Anne Vogel
Legal Counsel –
Regulatory Services
(614) 716-2936 (T)
(614) 716-2014 (F)
amvogel@aep.com

**Re: Case No. 10-2385-EL-ESS**

Dear Director Williams:

Please find attached an update to Columbus Southern Power Company's and Ohio Power Company's program for maintenance, repair, and inspection of transmission and distribution lines as required by 4901:1-10-27(E), originally last filed October 19, 2009 The only changes are on page one of Attachment A, and page one of Attachment E; a redlined version of those two pages are attached hereto, along with the complete clean version of the updated plan

This update was originally filed on October 6, 2010, in case number 09-795-EL-ESS. By Entry dated October 20, 2010, the Attorney Examiner requested that Columbus Southern Power Company and Ohio Power Company refile this update under case number 10-2385-EL-ESS

Please feel free to contact me if there are any questions.

Sincerely,

Anne Vogel, Legal Counsel

**Attachment A**

**Distribution: Poles**

**Program Details**

The primary objective of AEP Ohio's distribution pole inspection and maintenance program is to maintain the mechanical integrity of its wood pole infrastructure necessary for the safety of employees and the public under the conditions specified in the NESC and for system reliability. This objective is accomplished by maintenance treatment to extend the service life of poles, by identifying and mechanically reinforcing weak poles to strengthen them and by identifying and replacing poles that have reached the end of their service life. This program will be performed such that every pole meeting the in service criteria will be inspected and maintained as required on a ten-year cycle ~~for poles in service 18 years or longer~~ based on the initial pole treatment types (i.e., CCA, Penta, and Creosote) for poles in service that were installed 1985 and before (pre-1986) and for Penta and Creosote treated poles in service 15 years and longer.

The majority of AEP Ohio's poles installed during the 1986 through 2003 timeframe were southern yellow pine treated with the wood preservative copper chromate arsenate (CCA). The CCA-treated poles have a projected service life of 60 to 80 years. Poles with treatment other than CCA have an expected service life of 40 to 60 years. However, due to some expressed dissatisfaction with difficulty in climbing, higher incidence of breakage in handling, and some tool and equipment operational savings, it was determined that Penta-treated poles are preferred from a total ownership perspective and have been utilized going forward. Some other pole species types would include Western Red Cedar, Douglas Fir and Western Fir with assorted treatments of Creosote, Penta and Copper Napthenate. AEP Ohio conducts pole and remedial ground-line treatment as required on a 10-year cycle ~~for poles that have been in service 18 years or longer~~ for all poles meeting the in service criteria as mentioned above. The above ground portion of the pole and its attachments are inspected visually and problems such as decayed pole tops and crossarms are noted. However, in a given year, the number of poles in the program may be somewhat greater or less than 10 percent of the total poles in the program depending on the mix of urban, suburban and rural pole locations selected. ~~CCA-treated poles 18 years or older are visually inspected as a requirement of this program.~~ The electric power industry has not established a recommended inspection cycle schedule for CCA poles because of their superior resistance to decay. However, AEP Ohio continues to monitor early vintage CCA poles for future inspection cycle requirements.

This 10-year cycle program for pole inspection/treatment has proven to adequately maintain the pole assets on an ongoing basis. Shorter or longer inspection cycles have not proven to be warranted or economically justifiable. AEP Ohio's existing pole inspection contractor indicates a 10-year inspection cycle is the average range for pole inspection among US utilities.

**Analysis/Assessment**

The contractor who is responsible for pole inspections provides weekly results including information about poles identified for reinforcement or replacement and whether the identified poles need immediate attention. This information is disseminated to the local area office where engineering personnel become involved to prioritize and prepare necessary work orders to take care of any deficiencies noted from the contractor's assessment.

**Attachment E**

**Distribution: Line Capacitors**

**Program Details**

The objective of this program is to ensure reliable and accurate capacitor bank operations through inspection and maintenance activities on an ongoing basis. Individual capacitor units are typically 150, 200 or 300 KVAR with the three-phase banks typically 450, 600, 900, 1200 or 1,350 KVAR. Capacitor banks can be of either a fixed or switched type. The fixed bank remains in service all the time whereas a switched bank has a control to turn the bank on or off depending on circuit parameters at the bank location. These parameters include such items as current, voltage or power factor. Fixed capacitor banks and switched capacitor banks are inspected annually. ~~and switched capacitor banks are inspected semi-annually.~~ Capacitor bank inspections provide the necessary information to ensure effective utilization of the capacitor assets on an ongoing basis.

The line capacitor inspection results are documented in AEP Ohio's work management system for field employees (SPECTRUM) which interfaces with PMIS and any problems identified during the inspections are documented in an Internal Work request which is stored in AEP Ohio's work management system (DWMS). The Internal Work requests are reviewed by the local area offices. The Internal Work requests indicate the inspection results on equipment where problems were found and the required repairs needed to return the equipment back to service. Engineering personnel would then prepare necessary work orders to take care of any unresolved deficiencies noted during the inspections and this work is prioritized based on the documented observations.

Inspection documentation is maintained in PMIS. This information details the operational condition of the capacitor bank as well as any items found to be deficient and/or defective during the inspections.

**Analysis/Assessment**

The process for reviewing the progress and effectiveness of each program includes a monthly status report that provides inspection and maintenance units completed as well as associated cost information. This data is pulled from AEP Ohio's work management system (DWMS) based on job completion dates or from AEP Ohio's work order system based on when individual capacitor units were replaced in the field.

Based on the current year results of the inspection/maintenance program regarding the number of capacitor installation deficiencies found requiring correction, the capital budgeting process for the following year is refined to accommodate any changes in the estimated number of units that will need attention. The local offices maintain the flexibility to schedule specific capacitor bank inspections/maintenance based on current and historical reliability results. This scheduling is done in conjunction with the overall guideline of this inspection/maintenance program.

# Columbus Southern Power Company's
# and
# Ohio Power Company's
# Distribution and Transmission
# Rule 4901:1-10-27(E) Programs

## Table of Contents

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2. Circuit and Line Inspections **(Attachment B)**
3. Primary and Secondary Enclosures **(Attachment C)**
4. Line Reclosers **(Attachment D)**
5. Line Capacitors **(Attachment E)**
6. Right-of-way Vegetation Control **(Attachment F)**
7. Substation **(Attachment G)**

**II. Other Distribution Program(s):**

1. Network Systems **(Attachment H)**

**III. Other Transmission Programs:**

1. Line Inspections **(Attachment I)**
2. Line Maintenance **(Attachment J)**

# Attachments

**Attachment A**

**Distribution: Poles**

**Program Details**

The primary objective of AEP Ohio's distribution pole inspection and maintenance program is to maintain the mechanical integrity of its wood pole infrastructure necessary for the safety of employees and the public under the conditions specified in the NESC and for system reliability This objective is accomplished by maintenance treatment to extend the service life of poles, by identifying and mechanically reinforcing weak poles to strengthen them and by identifying and replacing poles that have reached the end of their service life This program will be performed such that every pole meeting the in service criteria will be inspected and maintained as required on a ten-year cycle based on the initial pole treatment types (i e , CCA, Penta, and Creosote) for poles in service that were installed 1985 and before (pre-1986) and for Penta and Creosote treated poles in service 15 years and longer

The majority of AEP Ohio's poles installed during the 1986 through 2003 timeframe were southern yellow pine treated with the wood preservative copper chromate arsenate (CCA) The CCA-treated poles have a projected service life of 60 to 80 years Poles with treatment other than CCA have an expected service life of 40 to 60 years However, due to some expressed dissatisfaction with difficulty in climbing, higher incidence of breakage in handling, and some tool and equipment operational savings, it was determined that Penta-treated poles are preferred from a total ownership perspective and have been utilized going forward Some other pole species types would include Western Red Cedar, Douglas Fir and Western Fir with assorted treatments of Creosote, Penta and Copper Napthenate. AEP Ohio conducts pole and remedial ground-line treatment as required on a 10-year cycle for all poles meeting the in service criteria as mentioned above. The above ground portion of the pole and its attachments are inspected visually and problems such as decayed pole tops and crossarms are noted However, in a given year, the number of poles in the program may be somewhat greater or less than 10 percent of the total poles in the program depending on the mix of urban, suburban and rural pole locations selected The electric power industry has not established a recommended inspection cycle schedule for CCA poles because of their superior resistance to decay. However, AEP Ohio continues to monitor early vintage CCA poles for future inspection cycle requirements

This 10-year cycle program for pole inspection/treatment has proven to adequately maintain the pole assets on an ongoing basis Shorter or longer inspection cycles have not proven to be warranted or economically justifiable. AEP Ohio's existing pole inspection contractor indicates a 10-year inspection cycle is the average range for pole inspection among US utilities

**Analysis/Assessment**

The contractor who is responsible for pole inspections provides weekly results including information about poles identified for reinforcement or replacement and whether the identified poles need immediate attention This information is disseminated to the local area office where engineering personnel become involved to prioritize and prepare necessary work orders to take care of any deficiencies noted from the contractor's assessment.

Based on the annual results of the inspection/treatment program regarding the number of poles requiring reinforcement or replacement, the capital budgeting process for the following year is refined to include any changes in the estimated number of poles requiring attention

The process for reviewing the progress and effectiveness of each program includes a monthly status report that provides inspection units completed This data is pulled from AEP Ohio's work management system based on job completion dates or from AEP Ohio's work order system based on when facilities were placed in service Maintaining flexibility within the program to make adjustments enhances the program effectiveness. An example of this would be performing more pole reinforcements versus replacements, as the inspection data results dictate

**Maintenance**

The above ground portion of the pole and its attachments are inspected visually and problems such as decayed pole tops and crossarms are noted Minor work such as repairing broken ground wires and replacing deteriorated guy guards is also included. Replacement of pole location (grid) tags and property ownership tags is performed as needed When the condition of the above ground portion of the pole is checked to be adequate, then the strength of the wood at the ground line is determined by partial excavation of the pole and by core samples taken from the pole around the ground line. If the pole strength is determined to be adequate, with no internal or external decay present, the pole is reported as satisfactory with no internal treatment applied If the pole strength is determined to be adequate, with internal or external decay present, the pole would be fully excavated to a depth of 18 inches and the exposed area below ground would receive an application of EPA-registered treatment materials, consisting of a pesticide and preservatives, in a bandage arrangement around the base of the wood pole Additionally, if the pole meets certain conditions, it is to be internally fumigant treated as appropriate with EPA-registered materials If the ground line area of the pole does not have sufficient strength, then the pole is evaluated for either pole reinforcement or replacement Information is compiled regarding the poles inspected, poles treated, the poles needing reinforcement and the poles needing to be replaced The poles needing reinforcement or replacement are marked with a special tag Any defects found that pose a safety risk are brought to the attention of the local office and are corrected immediately, if warranted In rare instances the inspector may be required to guard the site of a safety hazard until qualified personnel arrive to correct the hazard.

Pole replacement priority is established based on the pole's structural integrity as determined by the inspection contractor. Normal reject poles are those that are determined not to be able to last until the next cycle inspection (approximately 10 years) and are a function of insufficient shell thickness at the ground line. Normal reject poles are generally replaced within three years of the inspection. Priority reject poles are defined as those poles with internal decay and an average shell thickness of 1 inch or less or with external decay and with 50% or less of the original circumference remaining The inspection contractor notifies Company personnel of priority reject poles within 24 hours or sooner as conditions require. Priority reject poles are replaced within one year of the inspection unless they are determined to be an immediate safety risk. Poles determined to be reinforceable are generally reinforced within two years of the inspection

**Records/Reporting**

The inspection/treatment contractors collect the data electronically and provide the Company periodic updates during the program. A final electronic file is provided at year-end. AEP Ohio maintains and updates a pole database in conjunction with the graphics information and the contractor inspection/treatment results.

AEP Ohio has a work management system, DWMS, that is used to schedule and track pole replacements and reinforcements. Orders are created within DWMS for all poles requiring replacement and reinforcement. Backlog reports from the system list the orders available for the districts to schedule replacements. Normal reject poles are tracked separately from priority reject poles. Following construction, this work-order information is posted in graphics files, which will also update the pole database. Necessary reports are generated from the database systems to provide program completion statistics as well as analysis/planning information.

**Attachment B**

## Distribution: Circuit and Line Inspections

### Program Details

AEP Ohio conducts an overhead circuit inspection based on a 5-year cycle that results in an annual inspection of at least 20% of the overhead distribution facilities All facilities are inspected at least once every five years. This inspection program overlaps other targeted inspection/maintenance programs such as pole inspections Coupled with the annual inspections for recloser and capacitor installations, which are scattered across all the distribution circuits and with service upgrades and new extensions, there are many opportunities to view company facilities on a routine basis to identify areas requiring attention. As a result, a 5-year inspection cycle is more than adequate to assess the general condition of distribution circuits In some cases additional circuit inspections will be performed over and above this program in order to address specific reliability concerns and/or to assess some worst performing circuit mitigation requirements For example, some Rule 11 worst performing circuits may require an inspection as part of the remedial action plan Underground cable is not inspected as part of this program per se because it is only visible at terminations These cable terminations in padmount equipment historically have had a very low failure rate

### Analysis/Assessment

Company or contract employees perform selected overhead circuit inspections on an annual basis for this program and record their findings on Circuit Inspection and Repair Records The circuit inspection results are recorded electronically and then turned over to the local area offices indicating the findings, any action taken during the inspections, and any follow up work requirements This would include specific information about materials and/or equipment observations such as missing or blown lightning arresters, defective crossarms, equipment not protected from animal contact, a large number of splices in wire spans, or conductor clearance problems that could make the line susceptible to wind-caused outages Two-pole conditions are also noted during the inspections Engineering personnel then prioritize and prepare necessary work orders to take care of any deficiencies requiring attention noted during the inspections This may include follow-up analysis utilizing outage cause codes to determine circuit areas that are prone to animal contacts and lightning strikes and which can be targeted for additional animal and lightning mitigation efforts.

Based on the annual results of the inspection/maintenance program the capital budgeting process for the following year is refined to accommodate any changes in the estimated number of items requiring attention. The local offices maintain the flexibility to schedule individual circuit inspections based on current and historical reliability results, still maintaining the overall guideline of the 5-year cycle program An example of this would be substituting one circuit to be inspected for another, based on reliability performance, taking into account the requirement that all distribution circuits and equipment must be inspected at least once every five years.

The process for reviewing the progress and effectiveness of each program includes a monthly status report that provides inspection units completed as well as cost information for a

descriptive per unit summary This data is pulled from AEP Ohio's work management system based on job completion dates or from AEP Ohio's work order system based on when facilities were placed in service

AEP Ohio also evaluates for possible replacement small size (#2 and below) overhead conductor installations based on age, condition and reliability history The smaller size conductors are more prone to deterioration due to weather and environmental contamination. AEP Ohio also maintains records that indicate when individual underground cable sections may require replacement due to repeated cable faults. Records also show when cable replacement projects are initiated

**Maintenance**

Maintenance activities are identified during the circuit inspection process and follow up work scheduled as appropriate Situations that pose an immediate safety risk are corrected immediately. Situations that do not pose an immediate risk but are likely to create an outage, such as a floating phase conductor, will be corrected when found or will be referred to local management for priority assignment and scheduling Lower priority deficiencies, such as a lightning arrester with a blown isolator, or double-wood conditions ,are to be corrected within 12 months of identification

**Records/Reporting**

The basic circuit information is maintained as a part of AEP Ohio's facility/graphics database AEP Ohio utilizes its work management system (DWMS) to record inspection results electronically in the field Circuit inspection results are maintained at the Region and local District/Area offices. This documentation includes what if any follow up action was required and when the follow up action was completed.

**Attachment C**

**Distribution: Primary and Secondary Enclosures**

**Program Details**

AEP Ohio conducts underground primary and secondary enclosure inspections based on a 5-year cycle with at least one-fifth of all enclosures inspected annually The objective of this program is to proactively visually inspect the external, above ground portions of underground facilities on a 5-year cycle to identify and correct deficiencies necessary for the safety of employees and the public under the conditions specified in the NESC and for system reliability The program consists of an external, visual inspection of the above ground portion of underground systems including pad-mounted equipment (transformers, switches, primary metering enclosures, junction cabinets, etc), pedestals and the underground associated components of primary riser poles The inspection is conducted to determine if the equipment is locked and secure, that there are no open appurtenances that might allow access to the interior of the equipment via soil erosion, cabinet or conduit deterioration or by other means such as vandalism. If the enclosure is designed to have both a lock and penta-head bolt for securing the enclosure and the penta-head bolt is missing, the inspector will replace the bolt If for some reason the inspector is unable to install the penta-head bolt due to misalignment of the enclosures interfaces or some other reason, then the inspector will ensure the unit is secure with a padlock and make a record of this in the inspection record Oil filled equipment is also checked for any external leaks Any defects observed that need attention will be identified and the information will be collected so appropriate corrective action can be taken. The 5-year cycle provides a reasonable check for facilities that exhibit minimal change following installation

**Analysis/Assessment**

AEP Ohio and/or contractor employees perform the underground primary and secondary enclosure inspections selected on an annual basis for this program. The inspections are maintained by map section on a 5-year cycle The underground enclosure inspection results are documented electronically.

Based on the annual results of the inspection/maintenance program regarding the number of items found needing repairs or replacement, the capital budgeting process for the following year is refined to accommodate those changes.

The process for reviewing the progress and effectiveness of each program includes a monthly status report that provides inspection units completed. This data is pulled from AEP Ohio's work management system (DWMS) based on job completion dates or from AEP Ohio's work order system based on when facilities were replaced Maintaining flexibility within the program for the local areas to make adjustments enhances program effectiveness An example of this would include superseding one group of primary and secondary enclosure installations to be inspected for another based on reliability performance, taking into account the requirement that all enclosures must be inspected at least once every five years

**Maintenance**

Defects found during the inspection requiring attention are either repaired on-site during the inspection or are turned over to the local area office for corrective action This may include specific information about the equipment observations such as grading work requirements surrounding the structures and security of the structures and other maintenance Engineering personnel would then prioritize and prepare necessary work orders to take care of any deficiencies noted during the inspections

**Records/Reporting**

The basic primary and secondary enclosure information is maintained as a part of AEP Ohio's facility/graphics database The inspection details are stored centrally in the Region Office along with the record of inspections and repairs by year and map section. This documentation includes what if any follow up action was required and when the follow up action was completed

**Attachment D**

**Distribution: Line Reclosers**

**Program Details**

AEP Ohio's in-service line recloser inventory ranges in age from 0-50+ years with the newer ones being vacuum interrupting types with electronic controls The objective of this program is to inspect the in-service recloser units and to maintain/replace those units that meet specific program criteria. An annual inspection is made of both the hydraulic and electronic control type reclosers Six-month battery inspections for the electronically controlled reclosers are also included within this program.

The maintenance cycle for reclosers is based upon the type of recloser (hydraulic or vacuum interruption), number of operations and duty cycle, and as such, this cycle can vary from operating unit to operating unit The maintenance cycles for line reclosers, based upon type of recloser and number of operations or years is as follows:

Oil-interrupting reclosers (such as 4H, L, DV, WE) **100 Operations or 6 Years**
(since last maintenance or original installation)

Oil-insulated vacuum interrupting reclosers
(such as V4H, V4L, VWE, VXE) **200 Operations or 8 Years**
(since last maintenance or original installation)

Solid dielectric-insulated vacuum interrupting reclosers
(such as Nova and Viper) **2500 Operations or 10 Years**
(since last maintenance or original installation)

Recloser units in known high fault duty locations may require more frequent maintenance

Annual recloser inspections provide the necessary information to ensure effective scheduling of the maintenance program The approximate 6+-year cycle for recloser maintenance has proven to adequately maintain the recloser assets on an ongoing basis The Company also targets some older hydraulic recloser units for replacement with newer vacuum interruption units The overall average maintenance cycle will be extended as the percentage of vacuum units increases because of their reduced maintenance cycle requirements

AEP Ohio personnel and contractors inspect line reclosers annually with a visual check and record the counter readings Electronically controlled recloser units also receive a six-month battery inspection to confirm an acceptable battery status for recloser operability Batteries are replaced as necessary in conjunction with the inspections Three-phase electronically controlled units also have their settings verified through a calibration test annually.

The recloser unit inspection documentation is maintained in the PMIS (Preventative Maintenance Inspection System) data base The PMIS data base is a software tool developed to

assist field personnel in scheduling and tracking preventative maintenance inspections on various categories of distribution equipment and facilities. This information details the operational condition of the recloser unit as well as any items found to be deficient and/or defective during the inspections

**Analysis/Assessment**

In addition to addressing specific repairs needed as a result of annual and semi-annual inspections, specific recloser units are selected for maintenance with an overall average maintenance cycle of 6+ years This cycle basis has been established over time based on the annual maintenance results/findings and the level of repairs required This program also targets some older hydraulic recloser units for replacement The newer units with vacuum interruption provide for longer insulating medium life (no carbon build-up in oil), which in turn leads to extended maintenance cycles with a corresponding reduction in life cycle maintenance costs

Based on the annual results of the inspection/maintenance program regarding the number of recloser units that are approaching the need for maintenance, the capital budgeting process for the following year is refined to accommodate any changes in the estimated number of units that will require attention The local areas maintain the flexibility to schedule specific recloser units for maintenance, based on current and historical reliability results This scheduling is done in conjunction with the overall guideline of this inspection/maintenance program

The process for reviewing the progress and effectiveness of the program includes a monthly status report that provides inspection and maintenance units completed This data is pulled from AEP Ohio's work management system (DWMS) based on job completion dates or from AEP Ohio's work order system based on when recloser units were replaced in the field for maintenance.

**Maintenance**

Recloser maintenance normally consists of replacement of the in-service units with similar type units Maintenance of removed units is performed in AEP Ohio's repair facilities where a specific listing of items is checked such as the internal interruption mechanism The oil is replaced as needed and the calibration of the unit is verified Once the maintenance work is completed and the unit meets specifications it becomes available as a replacement for maintenance to be performed on another unit A few units may not meet the unit specifications during this process and are scrapped.

**Records/Reporting**

The basic recloser information is maintained as a part of AEP Ohio's facility/graphics database The line recloser inspection results are documented in AEP Ohio's work management system for field employees (SPECTRUM) which interfaces with PMIS and any problems identified during the inspections are documented in an Internal Work request which is stored in AEP Ohio's work management system (DWMS) The Internal Work requests are reviewed by the local area offices. The Internal Work requests indicate the inspection results on equipment where problems were found and the required repairs needed to return the equipment back to service. This would include specific information about the equipment observations such as ground wire continuity and ground resistance readings, lightning protection issues, battery condition for control units,

and other maintenance needs Engineering personnel would then prioritize and prepare necessary work orders to take care of any outstanding issues noted during the inspections

**Attachment E**

**Distribution: Line Capacitors**

**Program Details**

The objective of this program is to ensure reliable and accurate capacitor bank operations through inspection and maintenance activities on an ongoing basis. Individual capacitor units are typically 150, 200 or 300 KVAR with the three-phase banks typically 450, 600, 900, 1200 or 1,350 KVAR. Capacitor banks can be of either a fixed or switched type. The fixed bank remains in service all the time whereas a switched bank has a control to turn the bank on or off depending on circuit parameters at the bank location. These parameters include such items as current, voltage or power factor. Fixed capacitor banks and switched capacitor banks are inspected annually. Capacitor bank inspections provide the necessary information to ensure effective utilization of the capacitor assets on an ongoing basis.

The line capacitor inspection results are documented in AEP Ohio's work management system for field employees (SPECTRUM) which interfaces with PMIS and any problems identified during the inspections are documented in an Internal Work request which is stored in AEP Ohio's work management system (DWMS). The Internal Work requests are reviewed by the local area offices. The Internal Work requests indicate the inspection results on equipment where problems were found and the required repairs needed to return the equipment back to service. Engineering personnel would then prepare necessary work orders to take care of any unresolved deficiencies noted during the inspections and this work is prioritized based on the documented observations.

Inspection documentation is maintained in PMIS. This information details the operational condition of the capacitor bank as well as any items found to be deficient and/or defective during the inspections.

**Analysis/Assessment**

The process for reviewing the progress and effectiveness of each program includes a monthly status report that provides inspection and maintenance units completed as well as associated cost information. This data is pulled from AEP Ohio's work management system (DWMS) based on job completion dates or from AEP Ohio's work order system based on when individual capacitor units were replaced in the field.

Based on the current year results of the inspection/maintenance program regarding the number of capacitor installation deficiencies found requiring correction, the capital budgeting process for the following year is refined to accommodate any changes in the estimated number of units that will need attention. The local offices maintain the flexibility to schedule specific capacitor bank inspections/maintenance based on current and historical reliability results. This scheduling is done in conjunction with the overall guideline of this inspection/maintenance program.

**Maintenance**

Maintenance activities are identified during the inspection process and in many cases are done in conjunction with the inspection Maintenance activities would include replacing a defective switch control Otherwise, the local area offices schedule follow-up work as appropriate

**Records/Reporting**

The basic line capacitor bank information is maintained as a part of AEP Ohio's facility/graphics database The line capacitor inspection results are documented in AEP Ohio's work management system for field employees (SPECTRUM) which interfaces with PMIS Any problems requiring follow-up identified during the inspections are documented in an Internal Work request which is stored in AEP Ohio's work management system (DWMS) The Internal Work requests are reviewed by the local area offices. The Internal Work requests indicate the inspection results on equipment where problems were found and the required repairs needed to return the equipment back to service This would include specific information about the equipment observations such as ground wire continuity and ground resistance readings, lightning protection issues and other maintenance needs Engineering personnel would then prepare necessary work orders to take care of any unresolved deficiencies noted during the inspections and this work is prioritized based on the documented observations

**Attachment F**

**Distribution: Right-of-Way Vegetation Control**

**Program Details**

The objective of AEP Ohio's vegetation management program is to address public safety and service reliability in a cost effective manner A well-planned vegetation management program should be long-term and should address vegetation issues through three key components The first component is cyclic right-of-way clearing which proactively maintains vegetation on all circuits Second is a reactive component that addresses immediate outage and safety concerns. The third aspect of the program is a quality of service component that is reliability based and includes breaker zone clearing, remediation of Rule 11 worst performing circuit vegetation issues, and correction of intermediate cycle vegetation issues caused by fast growing tree species, also known as cycle busters

An effective vegetation management program will prescribe a maintenance plan for each circuit being addressed The program should utilize best practices and prescriptions should take into account the location of rights-of-way, the types of vegetation present, the environmental impact of the work being performed and any restrictions in the program plan This approach is referred to as an integrated vegetation management plan or IVM. The considerations to be taken into account include, but are not limited to:

- Type of maintenance treatment, i.e mechanical clearing with mowers or mechanical pruning, manual climbing and pruning, herbicide application, etc., based on right-of-way and environmental conditions;
- A priority and schedule of treatment by line/circuit or section within a circuit;
- Cost of treatment

As the plan progresses over time, these work prescriptions will change based on the size and type of vegetation. The initial prescription for clearing an easement may include several types of activity such as: pruning, removing, mowing and herbicide treatment In four years that same easement's work prescription may only require herbicide treatment AEP Ohio's Forestry staff and contractors continuously work to insure the appropriate prescription is utilized to increase effectiveness and efficiency.

AEP Ohio Vegetation Management Program Elements

- Forestry's annual work plan
- Rule 11 Worst Performing Circuits
- Unscheduled Work
- New Construction
- Storm Work

Annual Work Plan - With approval in March 2009 of AEP Ohio's Enhanced Vegetation Management Program, AEP Ohio is moving to a 4-year full circuit vegetation clearing program In order to put the systems in position for the wholesale move to a 4-year cycle, AEP Ohio, over the 5-year period 2009-2013, will prepare the distribution systems for the move to a 4-year cycle This 5-year preparatory period will allow AEP Ohio to prepare the systems through end-

to-end clearing of all circuits and gathering of necessary data to implement an effective 4-year program End-to-end clearing of circuits involves the clearing of vegetation from all overhead primary lines, from the start of the circuit at the substation to the end of the primary line AEP Ohio's line clearance guidelines are attached as Exhibit A

In 2008, AEP Ohio began a 4-year program to clear circuit breaker zones of vegetation in order to reduce tree related circuit breaker lockouts and improve reliability and customer satisfaction. A circuit's breaker zone is the section of distribution line from the circuit breaker in the substation to the circuit's first downstream automatic sectionalizing device A fault in the breaker zone will interrupt service to all customers served by that circuit

When the breaker zone program began in 2008, a 4-year plan was laid out that prioritized the circuits based upon historical tree related outage performance. The circuits with the worst performance were scheduled to have their breaker zones cleared early on in the cycle 2009 is the second year of the 4-year breaker zone program.

During this first year (2009) of the 5-year preparatory period AEP Ohio will begin completing end-to-end clearing on the circuits that had their breaker zones cleared in 2008 In the second year AEP Ohio will begin end-to-end clearing of the circuits that had their breaker zones cleared in 2009. It should be noted that, as part of the work going forward for end-to-end clearing of the 2008 and 2009 breaker zone circuits, AEP Ohio will inspect the breaker zones again and clear any vegetation necessary to make it through the cycle

The 4-year breaker zone program started in 2008 is to be modified in 2010 In 2010 and 2011 AEP Ohio will do minimal clearing of the breaker zones of the remaining circuits Vegetation within the breaker zones of these circuits will be addressed as necessary to carry them through to the planned end-to-end clearing of the circuit. Full end-to-end clearing will occur within one to two years of initially trimming the breaker zone

The circuits are prioritized and work plans are developed based on historical tree related reliability performance and grouping of circuits served from the same substation for cost effectiveness AEP Ohio's work plans consist of removing or pruning trees in and out of right-of-way, pruning mature trees not in the line but that could be within a 4-year period, mowing overgrown right-of-way with a follow up herbicide application and removing overhang above multiphase lines Overhang above single phase lines is either totally removed or removed to provide 10 feet of hinge or swing clearance above the conductor

Tree removals are emphasized to promote long-term vegetation control This requires a collaborative effort with property owners and community leaders Soft wooded, fast growing tree species are removed where possible Where removal permission is not obtained, fast growing species are pruned to greater clearances than slower growing varieties Young trees of any species that have sprouted up naturally, commonly referred to as volunteer trees, are controlled with herbicides Stump grinding/removal and/or tree replacements are offered on a limited basis as a tool to aid in securing permission for tree removals where there are easement related restrictions

Once the annual work plan is developed, graphics personnel provide copies of the necessary detailed circuit maps to be used for the program In addition, AEP Ohio personnel identify tree conditions through the course of their everyday work.

During planned clearing, each vegetation unit needing to be pruned, removed or other type of treatment is noted during a pre-planning process for each circuit These units are recorded on circuit maps and assigned to contractor tree crews to perform the work Copies of the completed work plan maps and time sheets are kept on file at the offices of Forestry staff AEP Ohio is currently investigating the use of GIS based mapping as an electronic planning and data collection tool for all future work planning.

A third party auditor (ACRT) is currently used in conjunction with on-going AEP Ohio forestry staff inspections to assure work is completed to contract and guideline specifications These inspections are filed in each forester's office and also entered in the RWM (Right-of-Way Maintenance) database

Rule 11 Worst Performing Circuits – AEP Ohio annually submits to the PUCO a list of their 8% worst performing circuits. A number of these circuits have had tree-related outages and AEP Ohio Forestry works closely with the districts to develop comprehensive action plans to improve service reliability on these circuits

Required work may involve extensive end-to-end clearing or isolated Quality of Service clearing (protective zone, one or more laterals, etc.) to address the tree reliability of the circuit A specific forestry action plan is developed for each circuit in conjunction with the district's remedial plan to improve service reliability for each of these circuits

Unscheduled Work – AEP Ohio Forestry deals with a dynamic, living system. Variables such as tree species, weather patterns and soil conditions all affect initial tree growth and the re-growth rates of pruned trees Examples include isolated stands of fast growing trees or vines growing on AEP Ohio poles and hardware that may affect only a portion of the circuit's overall reliability.

Even the most aggressive line clearance program must still make allowances for responding to isolated tree-related outages, reliability issues and customer requests. AEP Ohio Forestry has traditionally dedicated a percentage of its total budget and crew strength for this type of work that is incremental to the work plan

New Construction Clearing – AEP Ohio Forestry clears easements in advance of new line construction activities This work is accomplished to establish an initial cleared width and height for the conductors Subsequent re-clearings on these lines are based on the extent of initial clearing

Storm Work – AEP Ohio foresters and contract tree crews respond to district requests to clear trees within AEP Ohio easements to restore electrical service during storm restoration efforts or to prevent an imminent outage or safety hazard

## Additional Program Basics

Customer Relations & Community Involvement

AEP Ohio values its customer relationships as much as our customers value their trees Great efforts are made to strike a balance between service reliability and the homeowner's landscaped vegetation AEP Ohio frequently utilizes telephone messages broadcast to all customers located on a circuit scheduled for vegetation work as a first notification of the work scheduled in the area The messages notify the customer/landowner that a forestry representative will be in contact in the near future Contract work planners utilize face-to-face communication and door cards to contact property owners before routine line clearance work is performed Contact with local community leaders is also made prior to work beginning in many areas to assure trees located on municipal properties are properly maintained.

AEP Ohio has invested time and resources into public education concerning proper tree care and sound environmental practices AEP Ohio's forestry group participates in many arboriculture organizations such as: National Arbor Day Foundation, Utility Arborist Association, International Society of Arboriculture, and other various state and local vegetation management organizations Many of the staff are certified arborists and/or licensed by the Ohio Department of Agriculture for herbicide and tree growth regulator application The AEP Ohio Forestry group has developed and distributes an all-purpose tree care book called 'The Right Tree.' AEP Ohio Forestry also conducts community forum presentations based on the 'The Right Tree' to local and regional groups.

While AEP Ohio Forestry has gone to great lengths to satisfy our customers there are times when a property owner lodges a complaint either directly to the companies or to the Commission. Forestry complaints can be grouped into two simplistic categories: a) a customer wants their tree(s) trimmed and it falls outside the scope of AEP Ohio's responsibility or AEP Ohio is unable to address the concern in a timeframe suitable to the customer; b) AEP Ohio has worked on the property and the end result is undesirable to the customer. Complaints are viewed as inputs as to potential program changes and AEP Ohio works diligently to amicably resolve any differing points of view

Aerial Saw Pruning

AEP Ohio contracts with Aerial Solutions, Inc. and Haverfield Aviation, Inc to remove lateral vegetation growth from our rights-of-way using aerial saws Suspended on a vertical boom beneath a helicopter, and powered by a separate motor, a series of rotary blades quickly, safely, and efficiently prune trees along the edge of the right-of-way Rights-of-way maintained with the aerial saw normally possess the following characteristics: steep, mountainous terrain; limited access, and prohibitive costs to trim by conventional means On readily accessible lines. traditional tree trimming crews use bucket trucks or skidder mounted saws or hand climb each tree individually In just a few hours the aerial saw can clear remote lines that would take ground crews weeks or months to complete.

The aerial saw eliminates the need for workers to enter private property to reach rights-of-way There is no need to make repeated trips across private property, eliminating the possibility of damaging lands by hauling heavy equipment across a customer's property The aerial saw also

eliminates the need for workers to climb countless trees in close proximity to energized conductors, which reduces the opportunity for personal injury accidents Slash, brush and other debris from aerial saw operations is left along the edge of the right-of-way leaving the center open for line access This debris would also be left on site were AEP Ohio Forestry to clear these lines using conventional means Any brush that falls into roadways, waterways, fences or pastures is moved to a wooded edge of the right-of-way or is chipped or mowed. Clearing lines with the aerial saw prevents countless numbers of outages. Pilot training, radio contact and ground observers have significantly reduced the number of limb contacts with the line Finally, brush growing on the floor of the right-of-way may be mowed or treated with a herbicide in advance of using the aerial saw to aid in increasing the pilot's visibility. The aerial saw is a powerful, cost effective tool enabling AEP Ohio Forestry to maintain more miles of line each year efficiently and improving overall system reliability

Tree Growth Regulators

AEP Ohio employs the use of Tree Growth Regulators (TGRs), on a limited basis to control crown growth and reduce the frequency and amount that trees must be trimmed TGRs control regrowth, allowing a tree to use its reserves to survive disease and insect attacks, and to withstand environmental assaults such as drought and pollution

A treated tree grows more slowly, and requires less trimming meaning less biomass is removed when they are pruned That results in a healthier, more natural-looking tree, and fewer visits from contract tree crews TGR products reduce tree growth for two to eight years, depending on species, rates of growth and other environmental conditions.

**Analysis/Assessment**

A monthly review is conducted to determine if each area is meeting planned right-of-way clearing goals This includes addressing the volume of work for worst performing circuits Any necessary adjustments are made at this time, which would move work forces onto circuits with tree-related concerns or change the number of crews to solve any problems Circuit reliability is continually monitored to address tree-related issues Work force productivity is also reviewed to provide the most cost effective management of these forces. Tree crew sizes or types may be altered and different equipment or right-of-way maintenance techniques employed to insure the work is completed in an efficient manner.

**Maintenance**

AEP Ohio has adopted clearing guidelines that provide ample clearances from conductors and appurtenances Costs for right-of-way clearing are effectively managed through our sole source contract with Asplundh Tree Expert Company, use of manual and mechanical clearing methods and various chemical applications Customers are notified of vegetation management to be done in their area. This communication enhances productivity and customer relations.

**Records/Reporting**

RWM is an internally developed invoicing and data collection program that AEP Ohio utilizes to collect information and data from the contractors timesheets Electronic invoicing is available for all contractors for payment through this system and information regarding circuit costs to clear, man-hours per work unit, and costs per work unit are collected Various reports are available in

RWM which help to monitor program effectiveness, contractor productivity and costs The reports are available by distribution circuit, area and district within the program

**Transmission: Right-of-Way Vegetation Control**

**Objective**
The primary objective of the AEP Vegetation Management Program is to safeguard public and worker safety, prevent outages and to minimize reliability events from vegetation located within and adjacent to the rights-of-way in a safe, environmentally friendly, and cost-effective manner. AEP's vegetation management program is compliant with NERC FAC-003-1, which governs vegetation maintenance on lines operating at 200 kV and higher.

**Inspection/Collection**
AEP foresters conduct aerial patrols, except where the Federal Aviation Administration (FAA) or other ordinance prohibits flight, covering substantial portions of the transmission system to identify areas where attention may be needed to prevent vegetation from interfering with circuit operation Where flights are prohibited, foot patrols are used to identify areas requiring maintenance

**Analysis/Assessment**
Circuit criticality, historical data, line voltage, location, vegetative inventory information and land use are among the items considered when developing the annual vegetation management plan

**Outcome/Incorporation**
The key measure of success is zero vegetation-related outages or operations on AEP's transmission system with a goal of achieving 25% less vegetation grow-in events over a 3-year period based upon 2005 statistics AEP has a database called Transmission Operating Reporting System (TORS) that is used to track the operating record for each transmission line A monthly TORS report is monitored to assess current vegetation reliability conditions or trends that may require mitigation measures.

**Maintenance Activities**
The AEP System Vegetation Management Program emphasizes tree removal to promote long-term vegetation control and to minimize future maintenance expenditures AEP vegetation maintenance activities may consist of manually or mechanically removing and/or trimming trees in and out of the rights-of-way, selective or broadcast applications of herbicides, either aerially or from the ground, and the application of tree growth regulators

**Maintenance Frequency**
Transmission Vegetation Management Program frequency is conditioned based and is not performed on a time based frequency schedule

**Records**
A systematic vegetation management work plan is annually entered into Forestry Operation's

Right of Way Maintenance (RWM) software system to allow tracking and reporting of each year's progress and expenses At the end of the calendar vegetation management cycle an annual completion report, including variances, is analyzed to provide guidance toward future plans.

**General Discussion**

The System Forestry group of AEP manages the vegetation along the transmission rights-of-way in Ohio. This is done through the implementation of a comprehensive, systematic integrated vegetation management (IVM) program designed to ensure that the vegetation along each transmission line is managed at the proper time, and in the most cost-effective and environmentally sound manner. AEP System Forestry is a centralized organization in both reporting and budgeting and primarily employs degreed foresters to oversee this program.

AEP's transmission system is managed on a prescriptive basis. Ongoing evaluation of the system, through comprehensive ground and aerial inspections by both Transmission Line and System Forestry personnel, provides the basic information used by System Forestry to develop its prescriptions. Additionally, line criticality, historical data, line voltage, location, vegetative inventory information and land use are among the items considered when developing management prescriptions. Factors considered by AEP when developing annual prescriptions include, but are not limited to:

- A priority and schedule of treatment by line/circuit;
- Type of treatment (mechanical, manual, herbicide) based on vegetative and environmental conditions;
- Cost of treatment

As succession occurs within the plant communities along the rights-of-way, these work prescriptions will change based on the sizes and types of vegetation present. Prescriptions, therefore, may include several activities such as tree trimming, tree removal, mechanical clearing and ground and aerial herbicide applications Subsequent prescriptions may address isolated locations requiring "yard tree" trimming, the removal of danger trees outside the maintained rights-of-way or control of fast growing brush, before the line is again maintained in its entirety AEP's System Forestry staff and its contractors continuously work to ensure the appropriate prescription is utilized to maximize effectiveness and efficiency

Certified utility line clearance contractors provide the labor force for the ground based clearing and herbicide applications FAA-licensed aerial contractors provide patrol, side trimming and herbicide application services. Contract work is designated and inspected by AEP foresters to ensure that the work is complete, performed in a timely manner, to AEP and industry standards, at reasonable cost, and with courtesy to property owners and to the public. Foresters travel throughout their assigned regions of the AEP companies to accomplish these tasks

AEP Vegetation Management Program Elements

- Inspections
- Annual Work Plan
- Unscheduled Work
- Storm Work

Inspections In general, 100% of the AEP transmission system is inspected each year by AEP Forestry The vast majority of these miles are inspected aerially, wherever the FAA or other similar law or ordinance does not prohibit overhead flight, and locations of concern are noted using inspection forms, which are forwarded to AEP foresters Forestry personnel investigate all observed and reported concerns and take appropriate actions to mitigate any threat to safety or reliability

Detailed climbing inspections and/or ground patrols are also performed periodically by line maintenance crews on the AEP transmission system Locations of concern identified during these "walking" inspections are also directed to AEP foresters for investigation and action AEP foresters check locations of concern and appropriate actions are taken

Annual Work Plan – Using inspection information and data from AEP asset managers, each line is prioritized based on its potential for tree-caused outages, criticality of the line, voltage, etc For lines requiring attention, AEP work plans may consist of manually or mechanically removing and/or trimming trees on and off the rights-of-way, selective or broadcast applications of herbicides, either aerially or from the ground, and the application of tree growth regulators. The range of required work may either involve management of the vegetation along the entire line or simply addressing individual locations of concern Site conditions, growth rates, length of time until the next anticipated maintenance, wind and conductor sag are all taken into consideration when determining which maintenance practices must be applied

Transmission work plans are normally developed in the fall of the preceding year, and input from asset managers and line maintenance personnel is solicited during development Finalized plans are normally presented to all interested parties for approval before being initiated

AEP's program is an integrated vegetation management program utilizing a variety of management techniques depending upon the condition of the vegetation and the management tool to be applied.

Unscheduled Work – Forestry deals with a dynamic, living system Variables such as tree species, weather patterns and soil conditions all affect tree growth and the regrowth rates of trimmed trees.

Even the most comprehensive line clearance program must make allowances for responding to isolated vegetation-related threats and customer requests AEP Forestry has traditionally dedicated a portion of its total budget and crew strength to this type of work that is incremental to the work plan. Such work may include isolated stands of fast growing trees, vines growing on AEP poles and hardware, fire or insect damaged stands adjacent to the rights-of-way, or trees located in slips or slide areas

Storm Work – AEP foresters and contract tree crews respond as required to trim, remove and clear trees within AEP easements to restore electrical service during storms or to prevent an imminent outage or safety hazard

## Additional Program Basics

Customer Relations & Community Involvement

Forestry personnel utilize face-to-face communication and door cards to contact resident property owners before routine line clearance work is done. AEP has invested time and resources into public education concerning proper tree care and sound environmental practices. AEP System Forestry participates in many organizations such as the National Arbor Day Foundation, the Utility Arborist Association, the International Society of Arboriculture, the U.S. Environmental Protection Agency's *Pesticide Environmental Stewardship Program*, and various state and local vegetation management organizations. AEP Corporate Communications in cooperation with Transmission Management has produced a brochure, Transmission Right of Way Clearing and Maintenance, *A Balanced Approach to Vegetation Management*, which is given to landowners and other community groups, outlining general policies for AEP's Transmission vegetation management program.

While AEP Forestry goes to great lengths to satisfy our customers there are times when a homeowner lodges a complaint either directly to AEP or to a state commission. Forestry complaints can be grouped into two categories: a) a customer wants their tree pruned and it falls outside the scope of AEP responsibility or AEP is unable to prune it in a timeframe suitable to the customer; and, b) AEP has pruned a tree and the result is unacceptable to the customer. Complaints are viewed as advice on potential program changes, and AEP works diligently to amicably resolve any differing points of view.

Tree Growth Regulators

Caring for trees under power lines requires regular pruning. Each new pruning places a tree under stress because it removes leaves and branches, which manufacture and store nutrients. This forces the tree to tap its reserves to grow new wood. Tree Growth Regulators (TGRs) control crown growth and reduce the frequency and amount that trees must be trimmed. TGRs control regrowth, allowing a tree to use its reserves to survive disease and insect attacks, and to withstand environmental assaults like drought and pollution.

A treated tree grows more slowly and requires less pruning, meaning fewer branches may be removed when it is re-pruned. That means a healthier, more natural-looking tree, and fewer visits from line clearance crews. TGR products reduce tree growth for two to eight years, depending on species, application rates and other environmental conditions.

## Summary

AEP System Forestry continually seeks technological innovations and process improvements to maintain our vegetation management program as one of the best in the industry. AEP System Forestry personnel participate in and/or lead vegetation management organizations such as: the Edison Electric Institute's Vegetation Management Task Force, the International Society of Arboriculture, the Utility Arborist Association, the U.S. EPA's Pesticide Environmental Stewardship Program, numerous state or regional vegetation management associations and numerous state and local urban and community forestry councils.

**Attachment G**

## Substation: Station Inspections

### Program Details

The station inspection program is critical to the reliable and safe operation of both transmission and distribution substations. It provides the necessary information and data concerning the operation and condition of each piece of electrical equipment in the substation in order to properly plan and schedule maintenance. Substation inspections provide a means to keep control systems and relay protection serviceable. They ensure transformer radiators are free of debris and shunt capacitors are ready for service. Substation enclosures such as fences and buildings are also checked as part of the station inspection to make sure these are secure and to ensure the safety of the public.

### Objective

The objectives of this maintenance program are to:

- prevent unplanned outages or failures and/or safety hazards by identifying and correcting problems during scheduled inspections; and
- reduce customer outages and associated call-outs for station problems by detecting problems and correcting them in a timely manner.

### Inspection/Collection

Station metering equipment monitors current flows, bus voltages and power loadings on high voltage equipment. Circuit breakers, load tap changers, voltage regulators and other switchgear utilize counters to register the number of operations that have occurred, and are used to analyze automatic operations. Each month during routine substation inspections, these values are recorded and later loaded into AEP's maintenance software, which drives maintenance on that equipment.

A visual inspection identifies any external problems on transformers, circuit breakers, capacitors, other electrical equipment including protection and control devices and station batteries. The support insulators and bushings are inspected for damage. Fences, buildings, foundations and driveways are visually checked. All safety equipment is checked. Identified problems are noted on the inspection report and any serious condition is immediately reported to maintenance personnel.

### Analysis/Assessment

The results of the station inspection program can be monitored by querying AEP's facility database each month. This information is recorded and evaluated to determine if the equipment is operating properly and within specifications.

### Outcome/Incorporation

Typically the outcome of the station inspection program is the data necessary to develop the various equipment maintenance programs.

**Maintenance Activities**
The station servicer who finds a problem during station inspection has two options for correcting the problem on a piece of equipment or portion of the station structure:

- if the problem is minor in nature, the servicer can document and complete the required repair to correct the problem, and/or
- the servicer prepares a report on more complex problems, in sufficient detail for the maintenance personnel to proceed with repairs

The replacement of burned out control panel and equipment lights is accomplished during the inspection. Also, station batteries are inspected for corroded terminals and any abnormal cells. Terminals are cleaned and any abnormalities are reported into the tablet computers. Battery ground lights are checked which could indicate a possible ground in the DC system, and the overall battery voltage and battery charger voltage and current are taken and recorded, with the battery charger output voltage adjusted as necessary during the inspection

Control house heaters, air conditioning units or heat pumps are checked to ensure these devices are operating properly Station grounds are inspected with special attention to the fence and gates to ensure the station is secure. Any problems with the fence or gate are repaired If permanent repairs cannot be completed at this time it is noted in the tablet computers and temporary repairs are made During the inspection personnel inspect the yards, structures and equipment for broken insulators, bird nests and other yard debris

Typically many of the minor items discovered as part of the Station Inspection Program can be and are remedied during the inspection The level of resources required and the severity of the findings determine the scheduling and response if the situation cannot be dealt with during the time of the inspection.

**Inspection Frequency**
Stations are scheduled for inspection on a monthly basis unless extenuating circumstances such as storm recovery efforts preclude the monthly inspection. Additionally, preventative diagnostic thermal imaging scans are scheduled to be performed yearly on stations where voltage ratings equal or exceed 230 kV and every other year on stations where voltage ratings are less than 230 kV.

**Records**
The station maintenance history is documented using maintenance software. Field maintenance personnel typically identify equipment and stations with recurring problems and submit those problems into a replacement database This database is the primary source for information regarding which systems or pieces of equipment should be considered for replacement

Station problems are also identified by reviewing AEP's reliability indices and customer outages. This analysis may uncover problems occurring with specific pieces of equipment or locations Likewise, this data will be entered into the replacement database for solution development

During the monthly station inspections the most common items that are discovered are relay targets and counter operations on circuit breakers and transformer load tap changers Both of

these items are very important in the overall plan for scheduling future maintenance on these pieces of equipment These readings are entered into tablet computers, which are later downloaded into AEP's Integrated Station Information System, along with load readings on all transformers and circuit breakers

## Substation: Circuit Breakers and Reclosers

### Program Details

Reliable operation of circuit breakers and reclosers requires that all components of these devices be in serviceable condition These devices have a large number of mechanical parts that require special attention The maintenance program for circuit breakers and reclosers includes procedures that provide for monitoring, testing and planned maintenance to assure the integrity of these components and the overall performance of the circuit breaker

### Objective

The objectives of this maintenance program are to:

- prevent misoperations or failures by identifying and correcting problems during scheduled inspections; and
- reduce safety hazards, customer outages and associated call-outs for circuit breaker problems by replacing limited lifetime components in a timely manner

Traditional time-based maintenance is gradually being replaced with condition-based maintenance. This change often extends the necessary maintenance interval and improves service reliability, while providing operating life extension as an end result

### Inspection/Collection

Circuit breakers and reclosers have counters that register the number of open/close operations that have occurred Each month during routine substation inspections, these counter values are recorded and later loaded into AEP's maintenance software, which drives maintenance on the operating mechanisms A visual inspection identifies any external problems or problems with low levels of $SF_6$ gas or oil The bushings are also inspected Any problems are noted on the inspection report and any serious condition is immediately reported to maintenance personnel

### Analysis/Assessment

The status or progress of the circuit breaker and recloser maintenance program can be monitored by querying the facility database each month to see how many maintenance jobs have been completed and identify which facilities currently require maintenance This information can be trended from month to month to show how the maintenance is following relative to schedule If necessary, management can make changes required to achieve the plan

### Outcome/Incorporation

Typically the outcome of the inspection and analysis is the maintenance plan Occasionally the analysis indicates that equipment should be replaced. The AEP companies' capital plans include funding for replacing equipment that has become unreliable or obsolete This may have been

caused by but not limited to deteriorating components, lack of available parts from vendors, and equipment problems causing repeated customer outages

**Maintenance Activities**

Preventive maintenance on circuit breakers and reclosers is evolving from traditional time-based maintenance to Condition Based Maintenance (CBM), which includes time and operations intervals Some of the principles of Reliability-Centered Maintenance (RCM) are also being applied RCM focuses on the reliability of components and is triggered by conditions that exist such as:

- the total number of operations that have occurred since the last maintenance, which indicates the amount of duty (or use) the operating mechanism has incurred;
- the fault duty (the number of circuit breaker operations where fault current is involved);
- the length of time since the operating mechanism was last maintained; or
- the length of time since the interrupting modules or tanks were last maintained

CBM also includes intervals and operations counts that are specific to the manufacturer and type of unit. The intervals are determined by considering the manufacturer's original recommendations, past operating experience and industry guidelines Computer program algorithms, which take into account the items listed above, have been developed to aid in identifying when circuit breaker maintenance is needed. Maintenance engineers review the data and prioritize the circuit breakers requiring maintenance, and then field personnel schedule the work

Two types of maintenance are typically performed:

- external inspection and maintenance, which includes; insulating liquid tests, electrical tests, cleaning, lubricating and testing mechanisms, and checking operation of heaters
- internal inspection and maintenance, which includes; insulating liquid tests, electrical tests, internal inspection of contacts, interrupters and tanks, checking adjustments and replacing gaskets, servicing compressor, checking compressor pump up times and precharge pressures where applicable, replacing deteriorated gaskets, checking operation of heaters, inspecting and cleaning control valves, performing timing tests, and checking accuracy of gauges and settings of pressure switches

Other maintenance that is performed on circuit breakers includes the following:

- Predictive diagnostics that are also performed on circuit breakers and reclosers to determine maintenance requirements For example, infrared scanning of substations will identify hot spots that may exist on the bushings or connectors, or in control cabinets These are reported and corrected as soon as practical to minimize equipment failures and customer outages
- Circuit breakers are operated (opened and closed) periodically to "exercise" them, which keeps the operating mechanisms and mechanical linkages lubricated and free to operate when called upon. This also provides an opportunity to find problems before they cause a misoperation or outage.

**Inspection/Maintenance Frequency**
Circuit Breakers and Reclosers are scheduled for inspection on a monthly basis as part of the station inspection unless extenuating circumstances such as storm recovery efforts preclude the monthly inspection. The maintenance schedule depends upon factors such as the type of circuit breaker or recloser, its voltage class, the time since its last complete inspection, and its operating history. This results in a complete disassembly and inspection with typical frequencies ranging from 2 to 8 years

**Records**
Equipment maintenance history is documented in the maintenance software program. Field maintenance personnel typically identify equipment with recurring problems and enter this information into a replacement database This database is the primary source for information regarding which pieces of equipment should be replaced

Equipment problems may also be identified by reviewing AEP's equipment outage information and customer outages. Investigating these will uncover problems that may be occurring with specific pieces of equipment Likewise, this equipment data will be entered into the replacement database

Typical remediation for bushings that exhibit elevated power factor readings would be an accelerated testing schedule or a scheduled replacement. Gas leaks are addressed based on the severity and the location of the gas leak If the gas leak is severe, a complete overhaul of the circuit breaker may be required which would be scheduled as soon as practical Deteriorated oil is typically cleaned and reclaimed by filtering at the time of the circuit breaker/recloser internal inspection, or replaced with new oil if the level of deterioration warrants Deteriorated or worn internal components are typically replaced or repaired during the circuit breaker/recloser internal inspection, however, judgment is used on continued serviceability and the circuit breaker may be placed on an accelerated inspection schedule Compressor system problems and mechanism problems are addressed when found as these conditions can affect the timing and operation of the circuit breaker or recloser. Any moisture intrusion is typically corrected at the time of the internal inspection

## Substation: Transformers

**Program Details**
Reliable operation of transformers requires that all components of these devices be in serviceable condition. These devices have a number of mechanical and electrical parts that require special attention The maintenance program for transformers includes procedures that provide for monitoring, testing and planned maintenance to assure the integrity of these components and the overall performance of the transformers.

**Objective**
The objectives of this maintenance program are to:

- prevent unplanned outages or failures by identifying and correcting problems during scheduled inspections;

- reduce safety hazards, customer outages and associated call-outs for transformer problems by replacing limited lifetime components in a timely manner; and
- utilize best practices and technology to achieve optimum loading of all transformers

Traditional time-based maintenance is gradually being replaced with condition-based maintenance This change often extends the necessary maintenance interval, while improving service reliability and operating life extension

**Inspection/Collection**
Transformers have temperature indicators located on the transformer tank to measure insulating fluid and winding temperatures In addition, transformers are equipped with ammeters and wattmeters to measure loadings. Transformers with Load Tap Changers (LTC's) also have counters that register the number of tap changing operations that have occurred Each month during routine substation inspections, these values are recorded and later loaded into the AEP maintenance software program, which drives maintenance on the equipment A visual inspection identifies any external problems or problems such as low levels of insulating fluid. The bushings are also inspected. Any problems are noted on the inspection report and any serious condition is immediately reported to maintenance personnel.

**Analysis/Assessment**
The transformer maintenance program can be monitored by querying the facility database each month to see how many maintenance jobs have been completed and which units are coming due for maintenance This information can be trended from month to month to show how maintenance is following relative to the schedule If necessary, management can make changes required to achieve the plan

**Outcome/Incorporation**
Typically the outcome of the inspection and analysis is the maintenance plan. Occasionally the analysis indicates that the equipment should be replaced The AEP companies' capital plans include funding to replace equipment that has become unreliable or obsolete. This equipment may have deteriorating components, parts may not be available from vendors, or other maintenance problems may be causing repeated customer outages

**Maintenance Activities**
Preventive maintenance on transformers is evolving from traditional time-based maintenance to Condition Based Maintenance (CBM), which includes time and operations intervals. Some of the principles of Reliability Centered Maintenance (RCM) are also being applied RCM focuses on the reliability of components and is triggered by conditions that are detected through:

- fluid and gas tests;
- external measurements and monitoring;
- the total number of LTC tap changing operations that have occurred since the last maintenance, which indicates the duty cycle of the tap changing mechanism;
- the loading that has occurred; and
- the elapsed time since the minor maintenance cycle was last performed, or
- the elapsed time since the major maintenance cycle was last performed.

CBM also includes intervals and operations counts that are specific to the manufacturer and type of unit The intervals are determined by considering the manufacturer's original recommendations, past operating experience and industry guidelines Computer program algorithms, which take into account the items listed above, have been developed to aid in identifying when transformer maintenance is needed. Maintenance engineers review the data and prioritize the transformers requiring maintenance, and then field personnel schedule and perform the work

Two types of maintenance are performed:

- Transformer Minor Maintenance, involves external inspection and maintenance, which includes electrical tests, lubrication of fans, cleaning of radiators used to cool the insulating fluid and internal maintenance of the LTC mechanism, where present.
- Transformer Major Maintenance, involving internal inspection and maintenance, begins with a pre-assessment The maintenance includes filtering and vacuum processing the insulating fluid, replacing the gasket seals, performing electrical tests, and addressing any items which were found during the pre-assessment inspection and internal maintenance of the LTC mechanism, where present

Other maintenance that is performed on transformers includes:

- Predictive diagnostics are performed on transformers to determine maintenance requirements For example, infrared scanning of substations will identify hot spots that may exist on the bushings or connectors, or in control cabinets These are reported and corrected as soon as practical to minimize equipment failures, safety problems and customer outages
- Transformer accessories are operated periodically to "exercise" them, which keeps the mechanisms free to operate when called upon, and the electrical contacts are wiped clean of oxidation film. This also provides an opportunity to find problems before they cause a misoperation or outage

**Inspection/Maintenance Frequency**

Transformers are scheduled for inspection on a monthly basis as part of the station inspection unless extenuating circumstances such as storm recovery efforts preclude the monthly inspection The maintenance schedule depends upon factors such as the type of transformer, its voltage class, its. MVA rating, the time since its last complete inspection, and its operating history Oil samples are extracted for gas analysis on a schedule ranging from 6 months to 48 months depending upon the specific type of gas analysis performed Sampling is scheduled more frequently for transformers exhibiting gassing characteristics out of nominal bounds. Minor transformer maintenance frequency is condition based and performed approximately every four years or more or less frequently depending upon diagnostic conditions. Major transformer maintenance frequency is conditioned based and not time based.

**Records**

The equipment maintenance history is documented in the maintenance software Field maintenance personnel typically identify equipment with recurring problems and enter the data into a replacement database. This database is the primary source for information regarding which pieces of equipment should be replaced

Equipment problems are also identified by reviewing AEP's reliability indices and customer outages Reviewing this data may uncover problems occurring with specific pieces of equipment Likewise, this equipment data will be entered into the replacement database.

Typical remediation for bushings that exhibited elevated power factor readings would be an accelerated testing schedule or a scheduled replacement Surge arresters found deteriorated based on test results are addressed by an accelerated testing schedule or a scheduled replacement Typically, most minor oil leaks and minor gas system leaks are addressed as much as practical on site during preventive maintenance; however, leaks that cannot be easily repaired would be scheduled for repair based on the severity of the condition and the level of resources required. Load Tap Changer contacts exhibiting excessive wear are generally replaced during the LTC inspection process and LTC filtration units are maintained as conditions warrant. Debris in transformer cooling systems (radiators) are typically removed when found However, transformers with coolers instead of radiators require high-pressure washing which must be scheduled. Defective gauges found are either recalibrated or scheduled for replacement in the normal course of business.

## Substation: Voltage Regulators

### Program Details

Reliable operation of voltage regulators requires that all components of these devices be in serviceable condition These devices have a number of mechanical and electrical parts that require special attention The maintenance program for voltage regulators includes procedures that provide for testing and planned maintenance to assure the integrity of these components and the overall performance of the voltage regulators

### Objective

The objectives of this maintenance program are to:

- prevent unplanned outages or failures by identifying and correcting problems during scheduled inspections; and
- reduce safety hazards, customer outages and associated call-outs for voltage regulator problems by replacing limited lifetime components in a timely manner

Traditional time-based maintenance has been replaced with Condition-Based Maintenance (CBM) This change often extends the necessary maintenance interval, while providing operating life extension as an end result

### Inspection/Collection

Voltage regulators have counters that register the number of tap changing operations that have occurred Each month during routine substation inspections, these values are recorded and later loaded into the AEP maintenance software program, which drives maintenance on the equipment. A visual inspection identifies any external problems or problems with low levels of insulating fluid The bushings are also inspected Any problems are noted on the inspection report and any serious condition is immediately reported to maintenance personnel

**Analysis/Assessment**
The voltage regulator maintenance program, which is tied to the transformer minor maintenance program can be monitored by querying the facility database each month to see if any maintenance jobs were required This information can be trended from month to month to review regulator performance relative to the expectations If necessary, changes can be made as required to achieve the desired performance.

**Outcome/Incorporation**
Typically the outcome of the inspection and analysis is a CBM maintenance plan as required Occasionally the analysis indicates that the equipment should be replaced The AEP companies' capital plans include funding to replace equipment that has become unreliable or obsolete This equipment may have deteriorating components, parts may not be available from vendors, or other maintenance problems causing repeated customer outages

**Maintenance Activities**
Preventive maintenance on voltage regulators has evolved from traditional time-based maintenance to Condition Based Maintenance (CBM), which includes time and operations intervals Some of the principles of Reliability-Centered Maintenance (RCM) are also being applied. RCM focuses on the reliability of components and is triggered by conditions that are detected through:

- fluid and gas tests;
- external measurements;
- the total number of tap changing operations that have occurred since the last maintenance, which indicates the duty cycle of the operating mechanism;
- the loading that has occurred; and
- the elapsed time since the minor maintenance cycle was last performed.

CBM also includes intervals and operations counts that are specific to the manufacturer and type of unit. The intervals are determined by considering the manufacturer's original recommendations, past operating experience and industry guidelines Computer program algorithms, which take into account the items listed above, are being developed to aid in identifying when voltage regulator maintenance is needed Maintenance engineers review the data and prioritize the equipment requiring maintenance, and then field personnel schedule and perform the work. A voltage regulator which is in deteriorated condition will be removed for a pre-assessment evaluation to determine if more extensive major maintenance will be cost effective The preassessment evaluation includes insulating fluid samples, a detailed visual inspection, review of the accessories and their condition and inspection of the control wiring.

Two types of maintenance are performed:

- Voltage regulators are typically installed for regulation of the main transformer voltage in the substation Their maintenance is included in the work schedule for the Transformer minor maintenance program, an external inspection and maintenance, which includes electrical tests
- Voltage regulators found to require Major Maintenance by the preassessment inspection are replaced The deteriorated voltage regulator is removed and placed into the AEP

repair shops for complete reconditioning, an internal inspection and maintenance or scrapping. The reconditioning includes replacing the insulating fluid, replacing the gasket seals, electrical tests, and attending to any items that were found during the preassessment inspection and internal maintenance of the tap switch.

Other maintenance that is performed on regulators includes:

- Predictive diagnostics are performed on voltage regulators to determine maintenance requirements. For example, infrared scanning of substations will identify hot spots that may exist on the bushings or connectors, or in control cabinets. These are reported and corrected as soon as practical to minimize equipment failures and customer outages.
- Voltage regulators are operated periodically through neutral to "exercise" them, which keeps the mechanisms free to operate when called upon, and the electrical contacts wiped clean of oxidation film. This also provides an opportunity to find problems before they cause a misoperation or outage.

**Inspection/Maintenance Frequency**

Station voltage regulators are scheduled for inspection on a monthly basis unless extenuating circumstances such as storm recovery efforts preclude the monthly inspection. The maintenance frequency is not time dependant but is based upon condition based maintenance.

**Records**

The equipment maintenance history is documented in the maintenance software. Field maintenance personnel typically identify equipment with recurring problems and enter the data into a replacement database. This database is the primary source for information regarding which pieces of equipment should be replaced.

Equipment problems are also identified by reviewing AEP's reliability indices and customer outages. Reviewing this data may uncover problems occurring with specific pieces of equipment. Likewise, this equipment data will be entered into the replacement database.

Typically AEP has used Load Tap Changers (LTC) units, as opposed to separate voltage regulators, to regulate distribution station bus and system voltages. Since LTC's are an integral part of a transformer, maintenance of these units is addressed as part of the transformer maintenance. In some cases AEP has installed separate voltage regulators either in series with the transformer or on a distribution feeder in order to regulate bus and system voltage. Maintenance on voltage regulators that are connected in series with transformers is planned and scheduled as part of the transformer maintenance. Based on the previous experience and information for monthly station inspections, no feeder or bus regulator maintenance was planned or performed for regulators in Ohio. Data gathered as part of the monthly station inspection programs was continually monitored and evaluated. If necessary, regulator maintenance will be performed as equipment conditions warrant.

## Substation: Capacitor Banks

**Program Details**

Reliable operation of capacitor banks requires that all components of these devices and their associated switchgear is in serviceable condition These devices have relatively few mechanical parts that require special attention. The maintenance program for capacitor banks includes procedures that provide for testing and planned maintenance to assure the integrity of these components and the overall performance of the capacitor bank.

**Objective**

The objectives of this maintenance program are to:

- prevent unplanned outages or failures by identifying and correcting problems during scheduled inspections; and
- reduce safety hazards, customer outages and associated call-outs for capacitor bank problems by replacing limited lifetime components in a timely manner

Traditional time-based maintenance has been replaced with Condition-Based Maintenance (CBM). This change often extends the necessary maintenance interval, while providing operating life extension as an end result.

**Inspection/Collection**

Switchgear for capacitor banks have counters that register the number of switch operations that have occurred Each month during routine substation inspections, these values are recorded and later loaded into AEP's maintenance software, which drives maintenance on that equipment During the monthly station inspections, station capacitor banks are visually checked for blown fuses, deformed or ruptured capacitor units The support insulators and switchgear bushings are also inspected Any problems are noted on the inspection report and any serious condition is immediately reported to maintenance personnel

**Analysis/Assessment**

The capacitor bank maintenance program can be monitored by querying the facility database each month to see how many maintenance jobs have been completed This information can be trended from month to month to show how maintenance is following relative to the schedule. If necessary, management can make changes required to achieve the plan

**Outcome/Incorporation**

Typically the outcome of the inspection and analysis is the maintenance plan Occasionally the analysis indicates that the equipment should be replaced The AEP companies' capital plans include funding to replace equipment that has become unreliable or obsolete This equipment may have deteriorating components, parts may not be available from vendors, or other maintenance problems causing customer inconvenience

**Maintenance Activities**

Preventive maintenance on capacitor banks has evolved from traditional time-based maintenance to CBM, which is driven by inspections and testing Some of the principles of Reliability-Centered Maintenance (RCM) are being applied RCM focuses on the reliability of components and is triggered by conditions that exist such as:

- visual and infrared inspections; and
- an unbalance condition in the entire bank

CBM also includes intervals and operations counts that are specific to the manufacturer and type of unit. The intervals are determined by considering the manufacturer's original recommendations, past operating experience and industry guidelines. Maintenance engineers review the information monitored above and prioritize the units requiring maintenance, and then field personnel schedule and perform the work.

Shunt capacitor banks in stations have very few moving parts that require maintenance Capacitor cans are self-contained units and vacuum switches, used to switch capacitor banks, are typically sealed units requiring minimal maintenance.

Three types of maintenance are performed:

- Capacitor bank switchgear maintenance is coordinated with the circuit breaker external maintenance program specific to that type of switch, an external inspection and maintenance, which includes electrical tests,
- Capacitor banks receive a visual and mechanical inspection, which includes tightening hardware and connections, inspecting for leaks, lubricating any moving parts, inspecting and replacing fluid labels, inspecting and cleaning the fuse holders, and
- Capacitor bank controls are inspected and recalibrated

Other maintenance that is performed on capacitor banks includes the following

- Predictive diagnostics that are also performed on capacitor banks to determine maintenance requirements For example, infrared scanning of substations will identify hot spots that may exist on the bushings or connectors, or in control cabinets These are reported and corrected as soon as practical to minimize equipment failures and customer outages

**Inspection/Maintenance Frequency**

Station capacitor banks are scheduled for inspection on a monthly basis unless extenuating circumstances such as storm recovery efforts preclude the monthly inspection The maintenance frequency is not time dependant but is based upon condition based maintenance

**Records**

The equipment maintenance history is documented in the maintenance software Field maintenance personnel typically identify equipment with recurring problems and enter the data into a replacement database This database is the primary source for information regarding which pieces of equipment should be replaced

Equipment problems are also identified by reviewing AEP's reliability indices and customer outages. Analyzing this data may uncover problems that may be occurring with specific pieces of equipment Likewise, this equipment data will be entered into the replacement database

Since capacitor banks are comprised of sealed units, with essentially no moving parts, minimal maintenance is required Any maintenance that is required is normally scheduled to coincide with station breaker maintenance Prior to each peak load season (winter and/or summer) station capacitor banks are checked, typically during a monthly station inspection, to make sure that the unit is operating properly and will be available when called upon to support system voltages Should a component failure, such as a capacitor can, fuse or vacuum bottle, be identified as part of the monthly station inspections the failed unit is simply replaced with a new unit Typically these repairs are made shortly after the condition is identified

**Substation: Protection and Control**

**Objective**

Protection System elements continually monitor the power system and protect lines and station equipment from damage by isolating those facilities from system disturbances These sophisticated Protection Systems are designed to minimize the number of customer outages, safety issues and pieces of equipment affected. Maintenance is an ongoing program by which Protection System function is proven, and restored, if needed, with the goal of preventing misoperation or failures of station equipment; minimizing customer outages; minimizing maintenance call-outs and maximizing the life of station equipment. This program is structured to comply with requirements of NERC Reliability Standards: PRC-005-1, PRC-008-0, PRC-011-0 and PRC-017-0

**Inspection/Collection**

Protection System elements are calibrated on a regular schedule for operating accuracy as well as a functional test of the tripping circuits. The newest generation of microprocessor relays has self-checking features which trigger an alarm when a failure is detected

**Analysis/Assessment**

The Protection System maintenance program is designed to be monitored by querying the facility database each month to see how many tests have been completed This information can be trended from month to month to show how progress is being made relative to the schedule If necessary, management can make the changes required to achieve the plan

**Outcome/Incorporation**

Typically the outcome of the testing is the maintenance plan Occasionally the testing indicates that equipment should be replaced Equipment replacement may be due to the fact the manufacturer no longer supports that specific piece of equipment, lack of replacement units or components, or misoperations

**Maintenance Activities**

Preventive maintenance on Protection System elements has been primarily dictated by criticality of the facilities that they protect and the historical performance of the relay The microprocessor - based relay, with self-diagnostic capabilities, has begun to replace the older electromechanical relays Although the new relays increase the time between maintenance visits, the time it takes to perform the testing has also increased due to the technical complexity of the relay. To offset this, automatic relay testing via laptop computers is being implemented to reduce the testing time

As maintenance is required, field personnel schedule outages to perform the work. Two types of Protection System maintenance are performed:

- Calibration: Adjustment of the operating threshold or measurement accuracy to meet specifications or applicable accuracy requirements. Electromechanical relays are checked to be free from foreign particles and connections checked for continuity.
- Functional Trip Testing: Application of signals to elements or components removed from service, to observe functional performance or output behavior of the DC circuitry including any incorporated communications-assisted functions This test involves manually closing the tripping contacts for each schematic component to verify correct operation.

**Inspection/Maintenance Frequency**

Maintenance intervals vary depending upon the maintenance activity to be performed, such as the maintenance activities described above, the type/style of equipment comprising the Protection System and the associated power equipment's own maintenance schedule.

**Records**

Equipment maintenance history is documented in the maintenance software Field maintenance personnel typically identify equipment with recurring problems and enter the data into a replacement database This database is the primary source for information regarding which pieces of equipment should be replaced

Reviewing reliability indices and customer outages may also identify equipment problems. Investigation will uncover problems that may be occurring with specific pieces of equipment

**Attachment H**

**Distribution: Network Systems**

**Program Details**
AEP Ohio operates network electrical systems in downtown Columbus and Canton, Ohio These systems have been designed for single and double contingency events to provide a premium style service to these downtown areas

Network inspections are performed annually for vaults and associated equipment to include transformers and network protectors Network manholes, which typically do not have equipment installations other than underground cables, are inspected once every four years The development of these guidelines was based on equipment manufacturer recommendations, local environmental conditions and historical data

Operating data is collected and physical condition noted during the inspections. In addition, oil filled equipment is checked for leaks

A number of inspection reports are used and maintained locally for network facilities These include a manhole inspection report, a vault inspection report and a transformer and protector inspection report.

**Analysis/Assessment**
Local supervision reviews the inspection results to determine corrective action priorities as needed Data analysis includes a comparison with historical trends All equipment irregularities are analyzed for any adverse maintenance causes

Following review of the inspection reports, work is then planned to perform maintenance on the inspected items if warranted Work is prioritized based upon the nature of the condition found during inspection

Based upon annual inspection results, the capital budget process is refined to include network improvements The network systems engineering group combines field inspection results with engineering analysis to identify the effectiveness of each program component. There are periodic reviews of inspection frequencies and inspection tasks

**Maintenance**
Maintenance needs identified by the Network Systems inspection program have both a corrective and a preventive component Inoperative equipment is scheduled for repair or replacement Through visual inspections and testing, equipment can be scheduled for maintenance to assure continued reliable operation is maintained

**Records/Reporting**
The locations, types, identifiers and nameplate information of network facilities are stored in AEP Ohio's UG Network Systems Equipment and Enclosure (NEED) database AEP Ohio's mapping system (DGIS) also provides information about Network facilities NEED is used to

trigger scheduling of the inspections Records of inspection and program findings are kept manually. Periodic program status reports are reviewed by supervision to assure the program is on schedule Copies of the inspection sheets are filed locally for analysis/reporting purposes

**Attachment I**

## Transmission: Line Inspections

### Objective
The intent of line inspections is to check the present condition of a line and determine if any of its components exhibit a near-term potential to fail and cause an outage or a safety problem

### Inspection/Collection
Line patrols are to be performed a minimum of once a year for each line Inspection methods vary and can be performed from the air, ground, or by climbing a structure All structures or a few targeted structures in a line may be inspected at a given time utilizing one or more inspection methods One method of inspection may lead to another to confirm or further define the severity of a detected problem In general, aerial patrols are performed a minimum of once a year for each line Foot patrols or climbing inspections are scheduled as needed Forced line outages usually require an aerial, foot patrol/climbing or combination of all inspections to identify the cause of the outage so the line can be properly repaired and returned to service It is not unusual for inspections of this nature to detect non-outage-related problems that need attention

### Analysis/Assessment
The data collected during the inspection process is used to develop line maintenance and repair plans. AEP has a prioritization process that categorizes detected problems The most serious items detected that can lead to line outages and/or safety concerns, such as broken poles or cross-arms, are scheduled for prompt corrective action Less serious problems, such as loose bolts or broken ground wires, that have little or no chance of causing outages or safety issues are catalogued, prioritized and scheduled for replacement or repair in a timely manner.

### Outcome/Incorporation
The immediate result of a good inspection program is that distinct problems or potential problems are detected before they cause outages or safety problems A good response program must be in place to allow prompt replacement or repair of serious equipment problems and a systematic maintenance or replacement program must exist to handle less critical matters

### Maintenance Activities
AEP has a solid maintenance program in place that uses inspection data along with analytical processes to develop comprehensive line and right-of-way maintenance programs.

### Inspection Frequency
Line patrols are to be performed a minimum of once a year for each line

### Records
Inspection data is inventoried for future reference Records are being stored on paper or electronically. AEP has a computerized record keeping system that enables AEP to track and predict when it is appropriate to perform maintenance on line components

**Attachment J**

## Transmission: Line Maintenance

### Objective
The intent of line maintenance is to avoid line outages and/or safety concerns whenever practical and to minimize the duration of outages when they occur

### Inspection/Collection
Line inspections provide information that is used to develop maintenance or replacement plans.

### Analysis/Assessment
Data collected as part of the line inspection program is analyzed and categorized to establish a work plan. The most serious items detected that can lead to line outages and/or safety hazards, such as broken poles or cross-arms, are scheduled for prompt corrective action

Less serious problems, such as loose bolts or broken ground wires, which have little or no chance of causing outages or safety issues are catalogued, prioritized and scheduled for replacement or repair in a timely manner. Typically, these problems are corrected as general line maintenance is performed but, in some cases, may become part of a capital line rebuild or rehabilitation program

### Outcome/Incorporation
The number of line outages traceable to failed components measures the success of a line maintenance program When a component failure occurs, every reasonable effort is made to determine what caused the failure If the failure is traced to a non-critical problem previously reported during an inspection, similar reported problems at other locations on the line would be reviewed to determine if additional maintenance is required. Causes of outages are noted in AEP's Transmission Outage Reporting System (TORS). Trends in failures of certain line components can be monitored and, if significant, corresponding action will be taken In cases where problems are significant in quantity/magnitude, line rebuilds or facility replacements may be appropriate These projects and/or repairs are included as part of AEP's capital plan

### Maintenance Activities
After analysis of inspection data has been performed, repair or replacement of problem parts or components is scheduled The following items are typical of those requiring repair or replacement: structures, poles, cross-arms, insulators, guy wires, conductors and ground wires. Items simply needing adjustments include loose bolts or conductor clamps.

### Maintenance Frequency
Transmission line maintenance frequency is conditioned based and is not performed on a time based frequency schedule

### Records
AEP's TORS database is used to track all outages and their causes In addition, AEP has developed an Integrated Transmission Information System (ITIS) database that will contain

information relative to component replacements on a line A comparison of TORS data indicating outages caused by component failure with maintenance history data in HIS can be made. A higher than normal outage rate due to a certain component failure can be noted. If this occurs, line locations where the item was used can be determined and a detailed line inspection scheduled The purpose of this inspection would be to determine if the item in question should be replaced

# Ohio Distribution Line Clearance Guidelines

6-Nov

| | R/W width | TRIMS * | | | REMOVALS ** | BRUSH CUT | HERBICIDE TREATMENT | Tree Growth Regulators |
|---|---|---|---|---|---|---|---|---|
| | | side trim | under trim | overhang | | | | |
| **multi phase facilities** | 30 feet minimum*** | In maintained locations such as yards etc. 10 feet minimum from primary conductors | Minimum 10 foot clearance from primary conductor | All overhanging limbs cut back | Aggressively sought | All woody species are cut and/or mowed. All pole bases cleared for a 5 foot radius of vegetation and area treated with a herbicide. | Aggressively sought and used extensively. All stumps treated. No brush height or application restrictions, may be used as a reclearing tool. Re-growth is treated. | Used Moderately |
| **All other primary facilities** | 30 feet or to the existing tree line | Minimum 10 foot clearance from primary conductor | Minimum 10 foot clearance from primary conductor | Overhang removed to a height above the primary for a clear hinge or swing point providing 10 feet of hinge or swing clearance above the conductor | Highly desired | All woody species are cut and/or mowed. All pole bases cleared for a 5 foot radius of vegetation and area treated with a herbicide. | Aggressively sought and used extensively. All stumps treated. No brush height or application restrictions, may be used as a reclearing tool. Re-growth is treated. | Limited Use |

* trim distances are a function of regrowth rate, position to conductors, species, "protection zone" etc..

** removals must also meet species, position to conductors, vigor and completion time & expense considerations

*** variable with construction type. we suggest a wider r/w width for crossarm construction