Columbia Water & Light Department's Annual Transmission Planning Assessment

December 31, 2019

Revision History

Version	Date	Comments
1	12/31/2019	Created by Transmission Planner

Responsible Entity

City of Columbia Water and Light Department (CWLD) signed an agreement with MISO which details individual and joint Transmission Planner and Planning Coordinator responsibilities for performing the required studies for Planning Assessment in accordance with TPL-001-4.
The responsible CWLD entity for creating this Annual Assessment is the CWLD Transmission & Planning Engineer.

Review and Re-Certification Requirements

The assessment will be created and delivered to the Engineering Manager by the end of each calendar year. The assessment will be reviewed as appropriate by the CWLD Engineering and Operations working group for possible revision. The existing or revised document will be re-certified and distributed to appropriate staff members, reliability organizations, and other approved entities who submit requests for the CWLD's Annual Transmission Planning Assessment.

Planning Coordinator and Transmission Planner shall distribute its Planning Assessment results to adjacent Planning Coordinators and adjacent Transmission Planners within 90 calendar days of completing its Planning Assessment.

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Purpose

The purpose of this document is to provide evidence that CWLD has performed an annual assessment to satisfy the requirements of NERC standard TPL-001-4.

Planned Transmission Expansions to the CWLD System

1. None

NOTE: In previous years CWLD had a plan for Mill Creek transmission expansion project which included installation of new Mill Creek substation with 161 kV transmission line connections to Grindstone, Perche Creek and McBaine substations. The plan was recently cancelled.

Review of 2018 Assessment Conclusions and Current Corrective Actions

2018 Assessment of TPL-001-4

CWLD found valid contingencies for Categories P3, and P6 (Multiple Contingency) of the TPL-001-4 Standard in three of the four MMWG power flow models studied: 2019 Summer, 2019 Summer-Stress, 2023 Winter-Stress, and 2028 Summer seasons.

1. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer-Stress season.
2. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer, 2019 Summer-Stress, and 2028 Summer seasons.
3. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer, 2019 Summer-Stress, 2023 Winter-Stress, and 2028 Summer seasons.
4. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer-Stress, and 2028 Summer seasons.
5. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer-Stress, and 2028 Summer seasons.
6. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer, 2019 Summer-Stress, and 2028 Summer seasons.
7. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer-Stress, and 2028 Summer seasons.
8. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2028 Summer season.
9. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer, 2019 Summer-Stress, and 2028 Summer seasons.
10. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] 2028 Summer season.
11. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer-Stress season.
12. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer, 2019 Summer-Stress, and 2028 Summer seasons.
13. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer, 2019 Summer-Stress, and 2028 Summer seasons.
14. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer, 2019 Summer-Stress, and 2028 Summer seasons.

15. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer, 2019 Summer-Stress, and 2028 Summer seasons.
16. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer, 2019 Summer-Stress, and 2028 Summer seasons.
17. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2028 Summer season.
18. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2019 Summer, 2019 Summer-Stress, and 2028 Summer seasons.
19. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2028 Summer season.
20. Simultaneous outage of [redacted] resulted in thermal overload of [redacted] in 2028 Summer season.

These Multiple Contingency problems can be alleviated through controlled power generation changes, or opening of lines to re-distribute power flow, or utilizing short-term limits on the [redacted] transformer, or reducing loads.

In 2018 assessment, CWLD looked at extreme condition contingencies. This study looked at three separate instances of mutual tower lines with three transmission circuits, three separate instances of the loss of multiple buses in the same substation of the same voltage level, and one instance of the loss of three lines sharing the same right-of-way. There were extreme events category overloads and under-voltages contingencies detected in all seasons studied. Loads could be shed if needed in any extreme events category case.

2019 Assessment Methodology

2019 Steady State Analysis

For steady state analysis CWLD used the most recent fully developed cases of SERC LTWG DBU 2019 Series Final Base Case models, and performed simulations. For near term models CWLD selected nearest Summer peak (2020 Summer Peak) and following off-peak spring season (2021 Spring Light Load), and five year winter peak season (2024 Winter Peak). For long term model CWLD selected winter peak season (2029 Summer Peak). Long term summer peak was selected to evaluate a behavior of a season with highest overall load. List of seasons in this report:

- 2020 Summer Peak (CWLD Load 365.5 MW, CWLD Generation 210.6 MW)
- 2021 Spring Light Load (CWLD Load 242.8 MW, CWLD Generation 123.1 MW)
- 2024 Winter Peak (CWLD Load 285.8 MW, CWLD Generation 130.1 MW)
- 2029 Summer Peak (CWLD Load 391.6 MW, CWLD Generation 225.0 MW)

CWLD also performed sensitivity test where CEC Generator 3 and Generator 4 outputs were set to zero MW, for the three near term planning horizon seasons:

- 2020 Summer Peak-Stress (CWLD Load 365.5 MW, CWLD Generation 140.6 MW)
- 2021 Spring Light Load-Stress (CWLD Load 242.8 MW, CWLD Generation 61.1 MW)
- 2024 Winter Peak-Stress (CWLD Load 285.8 MW, CWLD Generation 72.1 MW)

The selection of these cases in the Annual Transmission Planning Assessment satisfies the requirements of TPL standards to be conducted for near-term (years one through five) and longer-term (years six through ten) planning horizons. CWLD does not necessarily consider each included season to be a critical season for system conditions in the CWLD area. CWLD conducts an annual critical asset assessment and has found that none of its systems or facilities is critical to the reliability of the Bulk Electric System (BES). All cases include CWLD's existing and planned facilities, real and reactive loads, planned outages, firm transfers, and all other requirements under the TPL standards at demand levels respective to season. CWLD did not expect any contingencies to produce more severe system impacts.

CWLD used PSS/E version 33.0.1 to conduct its analysis on the cases. CWLD developed a contingency file, a monitoring element file, and a subsystem file that included all CWLD elements as well as any element up to three buses away from any CWLD bus. CWLD used PSS/E to perform single and multi-level (N-2) AC contingencies that covered every possible combination of contingency from Table 1 in the TPL-001-4 standard.

The following monitoring guidelines were used in the steady state analysis:

- High Voltage Concerns: Voltages over 1.07 p.u.

- Low Voltage Concerns: Voltages under 0.90 p.u.
- Transmission Lines: loaded over 100% of Rate A
- Transformers: loaded over 100% of MVA

2019 Stability Analysis

CWLD evaluated Dynamic System Modeling and Analysis study of CWLD system (stability analysis), prepared by Leidos in December 2014. The assessment was conducted utilizing the regional base case developed by Midcontinent Independent System Operator (MISO) as part of their annual expansion planning studies (MTEP). These cases represent 2019 summer light load and summer shoulder load system conditions. The base cases were further updated to accurately reflect a detailed CWLD system representation. The following disturbance performance monitoring guidelines were used in the Leidos dynamic simulations, based on the MISO Transmission Planning Business Practices Manual.

Post-Transient Facility Loading Limits:

- Transmission Lines: 110% of Emergency (Rate B) post contingency
- Transformers: 125% of Emergency (Rate B) post contingency

Voltage Deviations:

- Transient Voltage Deviation Limits (up to 20 seconds):
- High Voltage Concerns: Voltages over 1.20 p.u. (100 kV & above)
- Low Voltage Concerns: Voltages under 0.70 p.u. (100 kV & above)
- Post-Transient Voltage Deviation Limits (20 seconds to 30 minutes):
- High Voltage Concerns: Voltages over 1.10 p.u. (100 kV & above)
- Low Voltage Concerns: Voltages under 0.90 p.u. (100 kV & above)

The Dynamic Analysis also analyzed the CWLD system to account for any potential delay in the planned Mill Creek project. Separate light load and shoulder load cases were created by removing the Mill Creek Substation and all contingencies were simulated on these cases as well, and there were no TPL violations. This satisfies the sensitivity case portion of TPL requirements.

CWLD does not have any proposed generation additions in the long term planning horizon.

2019 Short Circuit analysis

CWLD performed a short circuit analysis in August 2019 and addressed the near-term transmission planning horizon. CWLD used SERC SCDWG 2018 Effort 2019_scdwg_final model. Short circuit studies were performed to evaluate the adequacy of the short time current or interrupting ratings of existing equipment, to determine the ratings of new equipment to be purchased, to provide short circuit source data to its members, or for CWLD's own protection coordination studies. The analysis was used to determine whether circuit breakers had interrupting capability for faults that they would be expected to interrupt using the system short circuit model with any planned generation and transmission facilities in service which could impact the study area. Short circuit simulations were run to determine the magnitude of single phase to ground and three phase faults at each bus in CWLD's system. These fault levels were compared to the existing power circuit breaker short circuit ratings to determine if any equipment ratings are exceeded. If equipment ratings were exceeded, then upgrades in equipment are recommended. Short circuit studies were performed using the PSSE software and SERC SCDWG models.

2019 Results and Recommendations

For steady state analysis CWLD used SERC LTWG DBU 2019 Series Final Base Case models.

2019 TPL-001-4 Category P0 (No Contingency) Results

The CWLD transmission system did not demonstrate any exceptions to the planning criteria for any facility under normal system conditions for any of the cases in this study. No plans are necessary for inclusion in this report for any of the cases to meet the system performance standards of TPL-001-4 Category P0.

2019 TPL-001-4 Category P1 and P2 (Single Contingency) Results

The CWLD transmission system did not demonstrate any exceptions to the planning criteria for any facility under the loss of a single element as defined in TPL-001-4 Category P1 and P2 for any of the cases in this study. No plans are necessary for inclusion in this report for any of the cases to meet the system performance standards of TPL-001-4 Category P1 and P2.

2019 TPL-001-4 Category P3, (Multiple Contingency – Loss of generator plus system adjustments) Results

CWLD found overloads caused by Multiple Contingencies, Category P3, of the TPL-001-4 Standard in summer peak power flow models. A summary of the contingencies is as follows:

1) Thermal overload of [redacted] for simultaneous outage of
    a) Loss of [redacted] in season:
        i) 2020 Summer
        ii) 2020 Summer-Stress
        iii) 2029 Summer

Opening [redacted] line will eliminate both [redacted] overload.

No additional actions are necessary to meet the system performance standards of TPL-001-4 Category P3.

2019 TPL-001-4 Category P4, (Multiple Contingencies – Fault plus stuck bus-tie breaker) Results

CWLD found valid contingencies that create overloads for Multiple Contingencies Category P4 of the TPL-001-4 Standard in summer peak MMWG power flow models studied. A summary of the contingencies is as follows:

1) Thermal overload of [redacted] line for a stuck breaker at
    a) [redacted] in season:
        i) 2020 Summer

2) Thermal overload of [redacted] line for a stuck breaker at
   a) [redacted] bus in season:
      i) 2020 Summer
3) Thermal overload of [redacted] for simultaneous outage of
   a) [redacted] bus in season:
      i) 2020 Summer
      ii) 2020 Summer-Stress

Reducing [redacted], and if neded adjacent loads, will eliminate [redacted] and [redacted] line overload.

No additional actions are necessary to meet the system performance standards of TPL-001-4 Category P4.

2019 TPL-001-4 Category P6 (Multiple Contingencies – Two overlapping singles) Results

CWLD found valid contingencies that create overloads for Multiple Contingencies Category P6 of the TPL-001-4 Standard in all summer and winter MMWG power flow models studied. A summary of the contingencies is as follows:

1) Thermal overload of [redacted] transformer for simultaneous outage of
   a) [redacted] in season:
      i) 2020 Summer
      ii) 2020 Summer-Stress
      iii) 2029 Summer
   b) [redacted] in season:
      i) 2020 Summer
      ii) 2020 Summer-Stress
      iii) 2029 Summer
   c) [redacted] in season:
      i) 2020 Summer-Stress
   d) [redacted] in season:
      i) 2029 Summer
   e) [redacted] in season:
      i) 2020 Summer
      ii) 2020 Summer-Stress
      iii) 2024 Winter-Stress
      iv) 2029 Summer
   f) [redacted] in season:
      i) 2020 Summer-Stress

g) [redacted] in season:
   i) 2020 Summer-Stress
h) [redacted] in season:
   i) 2020 Summer
i) [redacted] in season:
   i) 2020 Summer
j) [redacted] in season:
   i) 2020 Summer-Stress

2) Thermal overload of [redacted] line for simultaneous outage of
   a) [redacted] in season:
      i) 2020 Summer
      ii) 2020 Summer-Stress
      iii) 2029 Summer

3) Thermal overload of [redacted] line for simultaneous outage of
   a) [redacted] in season:
      i) 2020 Summer
      ii) 2020 Summer-Stress
      iii) 2024 Winter-Stress
      iv) 2029 Summer
   b) [redacted] in season:
      i) 2029 Summer

4) Thermal overload of [redacted] line for simultaneous outage of
   a) [redacted] in season:
      i) 2020 Summer-Stress
      ii) 2029 Summer

5) Thermal overload of [redacted] for simultaneous outage of
   a) [redacted] in season:
      i) 2020 Summer-Stress
      ii) 2029 Summer
   b) [redacted] in season:
      i) 2020 Summer-Stress
   c) [redacted] in season:
      i) 2020 Summer-Stress
      ii) 2024 Winter -Stress
      iii) 2029 Summer
   d) [redacted] in season:
      i) 2020 Summer-Stress
   e) [redacted] in season:

i) 2029 Summer

f) [redacted] in season:

i) 2029 Summer

g) [redacted] in season:

i) 2029 Summer

6) Thermal overload of [redacted] line for simultaneous outage of

a) [redacted] in season:

i) 2029 Summer

Contingency 1, Thermal overload of [redacted]. In July 2016 CWLD and AECI developed [redacted] that provides various remedial options for overload of [redacted] transformer, which can be used for mitigation of [redacted]. Remedial actions include either increasing CWLD generation to decrease area interchange import to CWLD, or utilizing short-term limits on the [redacted] transformer, or opening appropriate lines, or reducing CWLD loads.

Contingency 2, Thermal overload of [redacted], can be mitigated by reducing [redacted] load.

Contingency 3, Thermal overload of [redacted], can be mitigated by reducing [redacted] loads.

Contingency 4, Thermal overload of [redacted], can be mitigated by reducing [redacted] loads.

Contingency 5, Thermal overload of [redacted], can be mitigated by reducing [redacted] loads.

Contingency 6, Thermal overload of [redacted], can be mitigated by reducing [redacted] loads.

In general, overload problems can all be alleviated through controlled power generation, or interruption of electric service at one or more substations along the affected path, or reducing loads. Operating guides for these conditions will be issued as necessary to aide operators in the handling of such events.

There were P6 category under-voltages contingencies detected in 2020 Summer, 2020 Summer-Stress, and 2029 Summer seasons. For contingencies that would decrease voltages, operators would adjust tap positions on transformers in order to adjust for under-voltages. If tap adjustment is not sufficient, P6 category loads could be shed.

2019 TPL-001-4 Extreme Events Results

CWLD looked at extreme condition contingencies which include three separate instances of mutual tower lines with three transmission circuits, three separate instances of the loss of multiple buses in the same substation of the same voltage level, and one instance of the loss of three lines sharing the same right-of-way. The following is a direct printout of the contingency file used for studying extreme events:

```
COM %%%%%%%%%%%%%%%%%%%%%% Loss of lines on a common right-of-way %%%%%%%%%%%%%%%%%%%%%%
CONTINGENCY CATD_01
[redacted]
  END
COM %%%%%%%%%%%%%%%%%%%%% Loss of 3 or more lines mutual tower run %%%%%%%%%%%%%%%%%%%%%
CONTINGENCY CATD_02
[redacted]
  END
CONTINGENCY CATD_03
[redacted]
  END
CONTINGENCY CATD_04
[redacted]
  END
COM %%%%%%%%%%%%%%%%%%%% Loss of a substation at one voltage level %%%%%%%%%%%%%%%%%%%%%
CONTINGENCY CATD_05
[redacted]
  END
CONTINGENCY CATD_06
[redacted]
  END
CONTINGENCY CATD_07
[redacted]
```

There were extreme events category overloads contingencies identified in all seasons studied. Loads could be shed if needed in any extreme events category case.

2019 Stability Analysis Results

CWLD evaluated Dynamic System Modeling and Analysis of CWLD system assessment prepared by Leidos in December 2014. CWLD system did not change since last evaluation was performed. In that study Leidos evaluated cases with or without CLWD Mill Creek Project upgrade. The dynamic stability assessment results demonstrate no criteria violations, and from dynamic stability perspective CWLD satisfies the requirements of the NERC TPL Reliability Standards.

2019 Short Circuit Analysis Results

CWLD performed a Short Circuit Analysis in August 2019 and addressed the near-term transmission planning horizon. CWLD did not find any instance of circuit breakers not having sufficient interrupting capability for faults that they would be expected to interrupt using the system short circuit model with any planned generation and transmission facilities in service which could impact the study area.

2019 Coordination with Adjacent Transmission Planners

CWLD coordinates and shares contingencies affecting adjacent facilities with Transmission Planners from AECI, Ameren, and MISO.

MISO performs Planning Coordinator coordination with Planning Coordinators from adjacent areas.

2019 Spare Equipment with Long Lead Time

Due to relatively small size of its major transmission equipment, CWLD does not have a need for spare major transmission equipment with lead time of one year or more, and further study is not required.

End of document