# COMMON USE SYSTEM

# 2008
# LOCAL TRANSMISSION PLAN

## TRANSMISSION COORDINATION AND PLANNING COMMITTEE

## DECEMBER 18, 2008

# TABLE OF CONTENTS

# LIST OF TABLES

## 1. INTRODUCTION

In December of 2007, the Common Use System participants filed with FERC Attachment K to the Joint Open Access Transmission Tariff (JOATT) to meet the requirements outlined in FERC Order 890. In their Attachment K, the CUS participants created the Transmission Coordination and Planning Committee (TCPC) as the conduit to perform long-range planning studies with stakeholder input and involvement. This report will outline the 2008 study cycle and outline the finding of the planning study and serve as the 2008 Local Transmission Plan (LTP).

## 2. STUDY METHODOLOGY

The 2008 LTP study focused on the 2012 and 2017 study years. The WECC-approved base cases listed in the table below were used as starting points for the study.

**Table 1: WECC Base Cases**

| | | | |
|---|---|---|---|
| 2012 Heavy Summer | 12HS2A1P | 2017 Heavy Summer | 15HS1SA1P |
| 2012 Light Winter | 13HW1P | 2017 Light Winter | 17HW1A1P |

Each of the base cases were reviewed and updated to include projected system loads along with committed major system additions and resources to create benchmark cases. Each benchmark case was then subjected to various line and generation outages to determine if any reliability criteria were violated. If any reliability criteria were violated, a proposed solution was simulated to evaluate its effect on the violation.

Load and resource projections for 2012 and 2017 were obtained directly from the network customers, or were derived from the most recently provided load forecasts. The committed major system additions in the table below were modeled in all of the benchmark cases.

**Table 2: Committed Major System Additions**

| | |
|---|---|
| Hughes Transmission Project | Rapid City Voltage Support |
| Wyodak-DJ Area Transmission Project | Teckla Voltage Support |
| St. Onge 230/69 kV Substation | PacifiCorp Casper/DJ 230 kV Upgrades |
| Wygen3 Generating Unit | Dry Fork Generating Unit |

The benchmark cases were evaluated against system intact (N-0), single contingency (N-1) and prior outage/single contingency (N-1-1) scenarios.

Violations due to double transformer outages (N-1-1) were not commented on in this report due to their very small probability of occurring.

Rapid City generation was dispatched to determine any benefits to system reliability. The generation levels simulated are shown in the table below:

**Table 3: Rapid City Must-Run Levels**

| | |
|---|---|
| RCG1 | Ben French Steam @ 20 MW |
| RCG2 | RCG1 + Lange CT @ 20 MW |
| RCG3 | RCG1 + Lange CT @ 40 MW |
| RCG4 | RCG3 + RC CT #1 @ 20 MW |
| RCG5 | RCG4 + RC CT #2 @ 20 MW |
| RCG6 | RCG5 + RC CT #3 @ 20 MW |
| RCG7 | RCG6 + RC CT #4 @ 20 MW |

Uncertainty scenarios were developed to include any queued generation projects. The only uncertainty scenario identified was the 200 MW generator interconnection request at the Pumpkin Buttes 230 kV substation.

## 3. PERFORMANCE CRITERIA

Established NERC/WECC performance criteria were used as the basis to determine the suitability of the various addition options.

### 3.1. VOLTAGE

System intact and prior outage voltage was required to be between 0.95 per unit and 1.05 per unit at all buses after transformer taps and switched shunts had been allowed to adjust. Bus voltages were required to be between 0.90 per unit and 1.10 per unit following a forced outage (N-1) with transformer taps and manually switched shunts locked.

### 3.2. THERMAL

All transmission facilities within the study footprint were monitored for thermal overloads. Transmission lines were required to be at or less than 100% of their normal rating for system intact and prior outage conditions. Following a forced outage (N-1) the transmission lines were required to be at or less than 100% of their emergency rating. The CUS participants do not currently assign emergency ratings to their transmission lines.

All power transformers were monitored for thermal overloads. For system intact and prior outage conditions transformers were required to be at or less than 100% of continuous rating. Following a forced outage transformers were allowed to be loaded to 100% of their emergency rating.

### 3.3. DYNAMIC

All buses were monitored for first swing voltage performance and all generators were monitored for angular stability. All first-swing bus voltage dips were required to remain above 0.7 per unit. All generators were required to stay in synchronism with rotor angles positively damped.

### 3.4. PRIOR OUTAGES

The table below lists the prior outages that were studied.

**Table 4: Prior Outages**

| | |
|---|---|
| 1. SYSTEM INTACT | 16. TECKLA-PUMP. BTS 230 |
| 2. WYODAK-CARR DRW 230 | 17. BARBER CK-PUMP. BTS 230 |
| 3. WYODAK-DONKEY CRK 230 | 18. CARR DRW-BARBER CRK 230 |
| 4. WYODAK-HUGHES 230 | 19. PUMP. BTS-DAVE JOHNS 230 |
| 5. WYODAK-OSAGE 230 | 20. ST.ONGE-LOOKOUT 230 |
| 6. CARR DRW-BUFFALO 230 | 21. ST.ONGE-LANGE 230 |
| 7. HUGHES-LOOKOUT 230 | 22. S. RAPID-LANGE 230 |
| 8. HUGHES-DRY FORK 230 | 23. WESTHILL-S. RAPID 230 |
| 9. DRY FORK-CARR DRAW 230 | 24. OSAGE-WESTHILL 230 |
| 10. DRY FORK-ARVADA 230 | 25. OSAGE-YELLOW CRK 230 |
| 11. TONGUE RVR-ARVADA 230 | 26. LOOKOUT-YELLOW CRK 230 |
| 12. TONGUE RVR-SHERIDAN 230 | 27. WESTHILL-STEGALL 230 |
| 13. DONKEY CRK-PUMP. BTS 230 | 28. WYODAK UNIT |
| 14. DONKEY CRK-RENO 230 | 29. DRY FORK UNIT |
| 15. TECKLA-RENO 230 | |

## 4. LOAD FORECASTS

The load forecasts for the 2012 and 2017 study periods on the CUS.

**Table 5: Modeled Loads**

| 2012 Load Forecast | 2017 Load Forecast |
|---|---|
| **Heavy Summer** | **Heavy Summer** |
| CUS Total Load = 1100 MW | CUS Total Load = 1365 MW |
| RC Area Load = 210 MW | RC Area Load = 265 MW |
| CBM Load* = 280 MW | CBM Load* = 376 MW |
| **Light Winter** | **Light Winter** |
| CUS Total Load = 848 MW | CUS Total Load = 1104 MW |
| RC Area Load = 97 MW | RC Area Load = 147 MW |
| CBM Load* = 250 MW | CBM Load* = 356 MW |

* CBM load modeled as 80% motors in transient simulations

## 5. STUDY OBJECTIVES

The objective of this study was to evaluate the transmission systems ability to meet the load growth and transmission usage needs of existing and future customers, while taking into account planned major transmission projects. This study will also address system modifications or additions needed to mitigate any performance criteria violations which are encountered.

The final result of this study will identify system upgrades and additions which may be included in system capital expansion plans.

# 6. STUDY RESULTS

## 6.1. 2012 RESULTS

### HEAVY SUMMER

The 2012 heavy summer simulations did not show any criteria violations for power flow simulations which could not be mitigated with the dispatching of Rapid City area generation. The prior outages which require Rapid City generation are:

- Wyodak-Osage 230 kV
- Lookout-St. Onge 230 kV
- Westhill-South Rapid 230 kV
- Hughes-Lookout 230 kV
- Lange-St. Onge 230 kV
- Osage-Yellow Creek 230 kV

The 2012 heavy summer dynamic simulations resulted in no performance criteria violations.

The uncertainty scenario resulted in similar system performance to the benchmark simulations in that no performance criteria violations were identified and there were no changes in the Rapid City generation requirements.

### LIGHT WINTER

The 2012 light winter simulations did not show any criteria violations for power flow simulations which could not be mitigated with the dispatching of Rapid City area generation. The prior outages which require Rapid City generation are:

- Wyodak-Osage 230 kV
- Lookout-St. Onge 230 kV
- Westhill-South Rapid 230 kV
- Hughes-Lookout 230 kV
- Lange-St. Onge 230 kV
- Osage-Yellow Creek 230 kV

The 2012 light winter dynamic simulations resulted in no performance criteria violations.

The uncertainty scenario resulted in similar system performance to the benchmark simulations in that no performance criteria violations were identified and there was not a change in the Rapid City generation requirements.

## 6.2. 2017 RESULTS

### HEAVY SUMMER

The 2017 heavy summer power flow simulations revealed numerous criteria violations which could not be mitigated with the dispatching of Rapid City area generation. Most of these violations were characterized as voltage collapse scenarios in the Black Hills and Rapid City area due to N-1-1 outages in the eastern portion of CUS. These violations are primarily due to the expected load growth in the Rapid City area. The prior outages that resulted in the voltage collapse vulnerability are:

- Wyodak - Hughes 230 kV
- Wyodak - Osage 230 kV
- Osage - Westhill 230 kV
- Osage - Yellow Creek 230 kV
- Hughes - Lookout 230 kV
- Lookout - St. Onge 230 kV
- Lange - St. Onge 230 kV
- Lange - Rapid City 230 kV
- Westhill- South Rapid 230 kV
- Westhill - Stegall 230 kV

The 2017 HS power flow analysis also revealed:

- The 230\69 kV transformers in the Rapid City area overloaded during the outage of another Rapid City area transformer. This is primarily due to the increased load in the Rapid City area.
- The outage of the Osage 69\230 kV transformer resulted in low voltages on the Osage area 69 kV system. This is primarily due to the retirement of the Osage generating units.
- During prior outages, an outage on the Hughes-Lookout–St. Onge 230 kV lines could result in low voltages on the Sundance Hill – Bell Creek 69 kV system. This is primarily due to the expected new load growth on the area 69 kV system.

The 2017 heavy summer dynamic simulations also revealed low voltage dip violations and potential voltage collapse during the N-1-1 disturbance simulations on the eastern portion of the CUS. This coincides with the power flow results and is contributed to the expected load growth in the Rapid City area.

To remedy the observed loading and voltage violations a new Teckla – Osage – Lange – Ben French 230 kV line, and a new Ben French 230\69 kV transformer were included in the system model. These system upgrades provide an additional 230 kV source and 230\69 kV transformation in the Black Hills and Rapid City area. Operational schemes for the Rapid City DC tie and the CUS gas combustion turbine generation units may also be required to maintain system reliability. These operational requirements will be based on the CUS load levels and 230 kV outages. Study criteria can be met with these system upgrades and the implementation of operational requirements on the CUS facilities.

The uncertainty scenario resulted in similar system performance to the benchmark simulations. With the outlined system upgrades to the Rapid City area no additional performance criteria violations were identified.

### LIGHT WINTER

The 2017 light winter power flow simulations did not result in any additional criteria violations. These simulations included the addition of the new Teckla – Osage – Lange – Ben French 230 kV line, and the new Ben French 230\69 kV transformer.

The 2012 light winter dynamic simulations also resulted in no additional performance criteria violations.

The uncertainty scenario resulted in similar system performance to the benchmark simulations in that no performance criteria violations were identified and there was not a change in the Rapid City generation requirements.

Operational schemes for the Rapid City DC tie and the CUS gas combustion turbine generation units may be required to maintain system reliability. These operational requirements will be based on the CUS load levels and 230 kV outages. Study criteria can be met with the outlined system upgrades and the implementation of operational requirements on the CUS facilities.

## 7. CONCLUSIONS

The committed major system transmission and resource additions meet the anticipated customer need in the 2012 study year.

The 2017 study year revealed the need for transmission enhancements on the CUS. This is based on the current load growth projections for the system. The peak load power flow study revealed that an additional 230 kV line is required into the Rapid City and Black Hills area. During the outage of two of the 230 kV lines in this area, the existing system can not support the projected loads. The peak load study also revealed overloads on the existing Rapid City area 230\69 kV transformers, and low voltages on the Osage and Belle Creek area 69 kV system. A potential solution to remedy these loading and voltage concerns is a new Teckla-Osage-Lange-Ben French 230 kV transmission line, a new Ben French 230\69 kV transformer, and additional voltage support devices in the Osage and Belle Creek areas. Assessment of the required system enhancements will continue through additional load serving studies and the TCPC study process. This will ensure the CUS will adequately meet the transmission system requirements for CUS customers.