

**Western Area Power Administration  
Point-to-Point  
Transmission Request**

**2005-T4  
70466016  
70584027**

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Prepared By:



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## **Introduction**

This study is for Western Area Power Administrations three interconnection requests for transmission service. The requests are:

- 50 MW Network Load (2004-T4)
- 75 MW Point-to-Point (70466016)
- 75 MW Point-to-Point (70584027)

Exponential Engineering Company (EEC) was contracted to perform a study to assess the impacts of these additions on the western and eastern grids. The areas affected by these additions are the Western Electricity Coordinating Council (WECC) and the Mid-Continent Area Power Pool (MAPP).

The original study investigated a 2008 Heavy Summer Case with the addition of the Miracle Mile upgrade to be performed in 2009. The project is now scheduled for 2010 and therefore required restudy to investigate the impact on the transmission grid after the addition of the facilities detailed for alternative K in the “Eastern Wyoming Joint Queue Study TOT3 WECC Phase Two Study” performed by Basin Electric Power Cooperative. This report will detail the power flow results after the addition of these facilities.

## **Study Procedure**

### **Base Case**

#### **Base Case Alternative K**

To determine the system impact of the DC Tie and new 230kV transmission line a Western Electricity Coordinating Council (WECC) 2010 HS (Heavy Summer) Base Case was utilized for analysis. This Base Case was modified by Basin Electric Power Cooperative (BEPC) to include the Alternative K developed in the Eastern Wyoming Joint Queue Study (EWJQS) developed by BEPC. For this study, the original 2010HS Base Case was modified to include the following:

- 1) Miracle Mile Project – An existing 140 mile 115kV line is upgraded to 230kV from the Miracle Mile Substation to Ault Substation
- 2) 50 MVAR of switchable capacitors are added at Laramie, Archer, Stegall and Wray 115kV buses
- 3) The LRS-Story 345kV line is tapped adjacent to Archer Substation. A 345/230kV transformer is added at Archer Substation and a 10 mile 230kV line is added to connect Archer and Cheyenne Substations.
- 4) A 105 mile Stegall-Ault 230kV line is added.
- 5) A 126 mile Stegall-DJ 230kV line is added.

- 6) The Spring Canyon 230kV system is added.

This Base Case was then stressed to produce a TOT3 power flow of 1915MW. This level was determined by the EWJQS to be the operating limit of TOT3 with CPP at its lowest level. This case was used to determine any overloads inherent in the system with this loading level for comparison to the final Base Case with the additions.

### **Case – New Power Flow**

The final study phase added to the Base Case the new 200MW DC Tie and Sidney-Story 230kV line studied in the previous study to be the best alternative to deliver power to future load. The interconnection requests were for 150MW of point-to-point delivery and 50MW of network load. The original Base Case was modified to include the following:

- 1) 200MW of East-West DC Tie flow
- 2) A 76 mile Sidney-Story 230kV line was added.
- 3) Load in the area was increased by 150MW (point-to-point)
- 4) Network Generation was reduced by 50MW (network)

These additions created a power flow on the Sidney-Story 230kV line of 200MW and with the addition of this line to the TOT3 calculation increased the load on the corridor to 2117MW. This Base Case was used for contingency analysis to determine the impact of the additions on the WECC local system.

### **Criteria**

#### **System Intact**

Voltages are to remain within the required 0.95 to 1.05 per unit range. Transmission lines and transformers may not exceed 100% of their nominal rating.

#### **Single Contingency**

Voltages will remain between 0.90 and 1.10 per unit. Transmission lines and transformers may not exceed either 100% of their nominal rating or an established emergency rating.

#### **Stability**

Stability analysis was not performed for this study.

## Results

### Base Case Alternative K Power Flow

ACCC contingency studies were performed on the Base Case to determine overloading of facilities prior to the addition of the new interconnections. The TOT3 level developed for system intact was 1915MW. This level was set by dispatching Colorado and Wyoming generation to increase the TOT3 level to 1915MW with CPP at its minimum setting to eliminate 115kV overloads found in the EWJQS if the TOT3 level was increased further. The dispatch of generation is illustrated in Table 4, Table 5 and Table 6. The tables detail the increase of TOT3 for each sequential phase of additions described in the EWJQS.

The contingencies used for the study are listed in Table 3. These contingencies were used for the prior study and are the typical contingencies run for TOT3 overload studies. Table 1: Base Case Overloads below illustrates the overloads found in the Base Case Alternative K power flow. The contingency (CONT) numbers are associated with the contingency table found in Table 3. The monitored buses and lines were those in the WAPA-RM and PSCO areas including the tie lines between the two areas.

CASE	MONITORED ELEMENT	CONT	BASE FLOW	MAX FLOW	RATE	PCT(%) OF RATING	AVAILABLE CAPACITY
ALT-K	73179 SIDNEY 115.00 73180 SIDNEY 230.00 1	5	131.95	205.23	167	122.89	-38.23
ALT-K	73150 PEETZ 115.00 73179 SIDNEY 115.00 1	5	74.82	115.16	109	103.45	-6.16
ALT-K	73150 PEETZ 115.00 73191 STERLING 115.00 1	5	72.74	110.94	109	102.96	-1.94
ALT-K	73012 AULT 345.00 73108 LAR.RIVR 345.00 1	2	674.88	998.46	956	101.4	-42.46
ALT-K	73011 AULT 230.00 70474 WINDSOR 230.00 1	21	444.16	500.33	495	100.47	-5.33

**Table 1: Base Case Overloads**

The contingency analysis did not produce any voltage violations for the study. The overloads illustrate the inability of TOT3 to move power from the Sidney area to the Story area and also the overloads that occur on the 345kV system and the TOT7A corridor.

### Case New Power Flow

ACCC contingency studies were performed on the Case – New Power Flow to determine the impact of the additional interconnections on the surrounding areas. The contingencies detailed above were analyzed monitoring the two areas and their associated tie lines.

Two ACCC studies were performed; one with CPP low which produced a TOT3 rating of 2117MW and one with CPP high (without redispatch) which produced a TOT3 rating of 2036MW. The CPP high study was run to determine what impact the increase generation would have on the overloads seen in the CPP low case. Table 2: Case New Power Flow Overloads illustrates the overloads found for both studies along with the overloads detailed in the ACCC analysis performed on the Base Case Alternative K.

CASE	MONITORED ELEMENT	CONT	BASE FLOW	MAX FLOW	RATE	PCT(% OF RATE)	AVAILABLE CAPACITY
ALT-K	73179 SIDNEY 115.00 73180 SIDNEY 230.00 1	5	131.95	205.05	167	122.79	-38.05
CPP LOW	73179 SIDNEY 115.00 73180 SIDNEY 230.00 1	5	135.06	174.65	167	104.58	-7.65
CPP HIGH	73179 SIDNEY 115.00 73180 SIDNEY 230.00 1	5	132.11	169.97	167	101.78	-2.97
ALT-K	73179 SIDNEY 115.00 73180 SIDNEY 230.00 1	16	131.95	205.23	167	122.89	-38.23
CPP LOW	73179 SIDNEY 115.00 73180 SIDNEY 230.00 1	16	135.06	175.11	167	104.86	-8.11
CPP HIGH	73179 SIDNEY 115.00 73180 SIDNEY 230.00 1	16	132.11	170.19	167	101.91	-3.19
ALT-K	73150 PEETZ 115.00 73179 SIDNEY 115.00 1	5	74.82	115.16	109	103.45	-6.16
ALT-K	73150 PEETZ 115.00 73191 STERLING 115.00 1	5	72.74	110.94	109	102.96	-1.94
ALT-K	73012 AULT 345.00 73108 LAR.RIVR 345.00 1	2	674.88	998.46	956	101.4	-42.46
CPP LOW	73012 AULT 345.00 73108 LAR.RIVR 345.00 1	2	681.05	1001.4	956	101.7	-45.4
CPP HIGH	73012 AULT 345.00 73108 LAR.RIVR 345.00 1	2	678.44	985.04	956	100.04	-29.04
ALT-K	73011 AULT 230.00 70474 WINDSOR 230.00 1	21	444.16	500.33	495	100.47	-5.33
CPP LOW	73011 AULT 230.00 70474 WINDSOR 230.00 1	21	450.66	500.05	495	100.5	-5.05
CPP LOW	73108 LAR.RIVR 345.00 77910 ARCHTAP3 345.00 1	1	569.33	987.26	956.1	100.25	-31.16
CPP HIGH	73009 ARCHER 230.00 77910 ARCHTAP3 345.00 1	1	318.41	588.96	560	105.17	-28.96

**Table 2: Case New Power Flow Overloads**

The addition of the interconnection improved or eliminated some overloads and increased others; these overloads will be discussed individually.

#### Sidney 115/230kV Transformer

The overload on the Sidney transformer in the Base Case was significant and surpassed the emergency rating. With the addition this overload is reduced to below the emergency rating of 120% in both the CPP Low and CPP High Cases.

#### Peetz-Sidney 115kV and Peetz-Sterling 115kV Lines

The overloads on the 115kV system out of Sidney were found in the Base Case. With the additions these overloads were eliminated due to the lower impedance path for the power flow through the Sidney-Story 230kV line.

#### Ault-LRS 345kV Line

The overload found on the Ault-LRS 345kV line occurs with the loss of the Archer Tap-LRS 345kV line. This overload occurs in the Base Case as well as with the additions. The loading does not increase more than 1% for any case and should not create problems with the additions. As stated in the EWJQS this line can be upgraded to 1200MW with terminal equipment changes (Section 3.3 of the EWJQS).

#### Ault-Windsor 230kV Line

The overload on the Ault-Windsor 230kV line does not increase more than 1% between the Base Case and Case New Power Flow. This overload does not exceed the 15-minute emergency rating of 110% of its 495MVA rating. This overload is eliminated when the CPP High case is run due to the additional generation available from the Story area to the Denver area.

#### LRS-Archer Tap 345kV Line

This line is loaded to 99.73% in the Base Case and is increased to 100.25% in the CPP Low case. This increase is less than 1% between the Base Case and Case New Power Flow. As with the Ault-LRS 345kV line the terminal equipment can be changed on this line to eliminate the overload.

#### Archer-Archer Tap 230/345kV Transformer

This transformer is loaded to 96.65% in the Base Case and is increased to 105.17% in the CPP High case and 99.81% in the CPP Low case. This transformer is rated at 560MVA in the cases but the required rating of the transformer has not yet been determined because it will be a new installation. Based on this information this overload can be eliminated from the analysis until the facility is to be built at which time an appropriate rating of the transformer will need to be determined.

## **Conclusions**

Based on the analysis performed in this restudy of the above interconnection requests there should be no upgrades required for the addition of the 200MW DC Tie and Sidney-Story 230kV transmission line. With the additions implemented from Alternative K of the Eastern Wyoming Joint Queue Study the remedial action required for these additions detailed in EEC's previous report can be eliminated. The interconnection additions will satisfy the requests submitted and will provide the required power flow that is required for their future load growth.

<b>CONTINGENCY LEGEND</b>	
<b>LABEL</b>	<b>EVENT</b>
1	DISCONNECT BRANCH FROM BUS 73108 [LAR.RIVR 345.00] TO BUS 73012 [AULT 345.00]
2	DISCONNECT BRANCH FROM BUS 73108 [LAR.RIVR 345.00] TO BUS 77910 [ARCHTAP3 345.00]
3	DISCONNECT BRANCH FROM BUS 73190 [STEGALL 230.00] TO BUS 73180 [SIDNEY 230.00]
4	DISCONNECT BRANCH FROM BUS 65420 [DAVEJOHN 230.00] TO BUS 73190 [STEGALL 230.00]
5	DISCONNECT BRANCH FROM BUS 73180 [SIDNEY 230.00] TO BUS 73579 [SPCANYON 230.00]
6	DISCONNECT BRANCH FROM BUS 73192 [STORY 230.00] TO BUS 70311 [PAWNEE 230.00]
7	DISCONNECT BRANCH FROM BUS 73179 [SIDNEY 115.00] TO BUS 73150 [PEETZ 115.00]
8	DISCONNECT BRANCH FROM BUS 73009 [ARCHER 230.00] TO BUS 73011 [AULT 230.00]
9	DISCONNECT BRANCH FROM BUS 73009 [ARCHER 230.00] TO BUS 73190 [STEGALL 230.00]
10	DISCONNECT BRANCH FROM BUS 73107 [LAR.RIVR 230.00] TO BUS 73190 [STEGALL 230.00]
11	DISCONNECT BRANCH FROM BUS 73107 [LAR.RIVR 230.00] TO BUS 65420 [DAVEJOHN 230.00]
12	DISCONNECT BRANCH FROM BUS 73108 [LAR.RIVR 345.00] TO BUS 73107 [LAR.RIVR 230.00]
13	DISCONNECT BRANCH FROM BUS 73179 [SIDNEY 115.00] TO BUS 73180 [SIDNEY 230.00]
14	DISCONNECT BRANCH FROM BUS 73193 [STORY 345.00] TO BUS 73192 [STORY 230.00] CIRCUIT 2
15	DISCONNECT BRANCH FROM BUS 73192 [STORY 230.00] TO BUS 73143 [N.YUMA 230.00]
16	DISCONNECT BRANCH FROM BUS 73579 [SPCANYON 230.00] TO BUS 73143 [N.YUMA 230.00]
17	REMOVE MACHINE 1 FROM BUS 73130 [MBPP-2 24.000]
18	REMOVE MACHINE G1 FROM BUS 70310 [PAWNEE 22.000]
19	DISCONNECT BRANCH FROM BUS 73443 [CHEYENNE 230.00] TO BUS 73011 [AULT 230.00]
20	DISCONNECT BRANCH FROM BUS 73190 [STEGALL 230.00] TO BUS 73011 [AULT 230.00]
21	DISCONNECT BRANCH FROM BUS 77910 [ARCHTAP3 345.00] TO BUS 73193 [STORY 345.00]

**Table 3: Contingency Legend**

<b>Static Generation</b>							
<b>Bus #</b>	<b>Name</b>	<b>Original</b>	<b>ALTB</b>	<b>ALTC</b>	<b>ALTK</b>	<b>New CPP LOW</b>	<b>New CPP HIGH</b>
70310	PAWNEE	540	540	540	540	540	540
70314	MANCHEF1	134	135	135	135	135	135
70315	MANCHEF2	135	135	135	135	135	135
70498	QF BCP1	27	OFF	OFF	OFF	OFF	30
70498	QF BCP2	34	OFF	OFF	OFF	OFF	36
70499	QFBCP1	22	OFF	OFF	OFF	OFF	24
70499	QFBCP2	23	OFF	OFF	OFF	OFF	25
70500	QF CPP1	22	OFF	OFF	OFF	OFF	24
70500	QF CPP2	22	OFF	OFF	OFF	OFF	24
70501	QF CPP2	25	OFF	OFF	OFF	OFF	27
70556	QF BCP3	68	68	68	68	68	70
73129	MBPP-1	605	605	605	605	605	605
73130	MBPP-2	605	605	605	605	605	605
73181	SIDNEYDC	200	200	200	200	400	400
73188	STEGALDC	100	100	100	100	100	100
	<b>TOTALS</b>	2562	2388	2388	2388	2588	2780

**Table 4: Static Generation Description**

<b>Phase Shifting Transformers</b>							
<b>Bus #</b>	<b>Name</b>	<b>Original</b>	<b>OTHERS</b>				
79060	SAN JUAN	-46	-30				
79061	SHIPROCK	-46	-30				

**Table 5: Phase Shifting Transformers Description**

Variable Generators							
Bus #	Name	Original	ALTB	ALTC	ALTK	New CPP LOW	New CPP HIGH
60088	BRIDGER3	560	560	560	560	560	560
60089	BRIDGER4	560	560	560	560	560	560
60096	BRWNL1	100	100	100	100	100	100
60097	BRWNL2	100	100	100	100	100	100
60098	BRWNL3	100	100	100	100	100	100
60099	BRWNL4	80	80	80	80	80	80
60100	BRWNL5	142	142	142	142	142	142
60151	HELSCYN1	135	135	135	135	135	135
60152	HELSCYN2	135	135	135	135	135	135
60153	HELSCYN3	OFF	OFF	OFF	OFF	OFF	OFF
62048	COLSTRIP 3	823	823	823	823	823	823
62049	COLSTRIP 2	330	330	330	330	330	330
65191	BONANZA	490	490	490	490	490	490
65430	DAVEJON1	115	115	115	115	115	115
65435	DAVEJON2	115	115	115	115	115	115
65440	DAVEJON3	245	245	245	245	245	245
65445	DAVEJON4	355	355	355	355	355	355
70034	ARAP3	OFF	OFF	OFF	OFF	OFF	OFF
70035	ARAP4	110	110	110	110	110	110
70069	CABCRKA	27	27	27	27	27	27
70070	CABCRKB	OFF	OFF	OFF	OFF	OFF	OFF
70103	CHEROK1	77	110	110	60	60	60
70104	CHEROK2	114	114	114	100	100	100
70105	CHEROK3	66	160	160	60	60	60
70106	CHEROK4	182	380	380	380	330	330
70119	COMAN1	125.5	360	320	125	125	125
70120	COMAN2	300	360	360	300	300	300
70350	RAWHIDE	100	225	225	225	225	225
70351	RAWHIDEA	54	54	54	54	54	54
70406	ST.VR2	28	130	130	130	130	130
70407	ST.VR3	28	130	130	130	130	130
70408	ST.VR4	128	130	130	130	130	130
70409	ST.VRAIN	340	340	340	340	340	340
70446	VALMONT	185	185	185	185	185	185
70448	VALMONT6	52	52	52	52	52	52
70553	ARAP5-6	37	37	37	37	37	37
70553	ARAP5-6	37	37	37	37	37	37
70554	ARAP7	44	44	44	44	44	44
70557	VALMONT7	36	36	36	36	36	36
70557	VALMONT7	36	36	36	36	36	36
70565	BARRLAK1	62	62	62	62	62	62
70566	BARRLAK2	62	62	62	62	62	62

<b>Variable Generators</b>							
						<b>New</b>	<b>New</b>
<b>Bus #</b>	<b>Name</b>	<b>Original</b>	<b>ALTB</b>	<b>ALTC</b>	<b>ALTK</b>	<b>CPP LOW</b>	<b>CPP HIGH</b>
70567	RAWHIDED	54	54	54	54	54	54
70568	RAWHIDEB	54	54	54	54	54	54
70569	RAWHIDEC	54	54	54	54	54	54
70588	RMEC1	140	140	140	140	140	140
70589	RMEC2	141	141	141	141	141	141
70591	RMEC3	320	320	320	320	320	320
73226	YELLO1-1	72	72	72	72	72	72
73226	YELLO1-2	72	72	72	72	72	72
73227	YELLO3-4	72	72	72	72	72	72
73227	YELLO3-4	72	72	72	72	72	72
73302	BRLNGTN1	OFF	OFF	OFF	OFF	OFF	OFF
73303	BRLNGTN2	20	20	20	20	20	20
73434	NIXONCT2	30	30	30	30	30	30
73435	NIXONCT1	30	30	30	30	30	30
73532	LINCOLN1	77	77	77	77	77	77
73533	LINCOLN2	77	77	77	77	77	77
79015	CRAIG1	375	375	375	375	375	375
79016	CRAIG2	420	420	420	420	420	420
79017	CRAIG3	400	400	400	400	400	400
79040	HAYDEN1	98	98	98	98	98	98
79041	HAYDEN2	68	68	68	68	68	68
	Totals	9261.5	10212	10172	9753	9703	9703
	<b>TOT 3</b>		<b>1706.4</b>	<b>1707</b>	<b>1915</b>	<b>2117</b>	<b>2036</b>

**Table 6: Variable Generators Description**