Eastern Wyoming Joint Queue Study
TOT3 WECC Phase Two Study

Basin Electric Power Cooperative
Point-To-Point Transmission Requests
#70306272, #70306271, #70306269

Western Area Power Administration
Point-To-Point Transmission Request
#70373324
#70314748

Total of 500 MW Yearly Firm Point-To-Point
Transmission Service Requests

Point of Receipt – Dave Johnston 230kV Bus
Point of Delivery – Ault 345kV bus

Final

Basin Electric Power Cooperative
July 17, 2006

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0. Executive Summary

This study is in response to a total of 500MW of point-to-point transmission service requests (TSR) from the Dave Johnston 230 KV Substation to the Ault 345 KV Substation across the TOT3 transmission path. The total consists of a 300MW TSR and a 200MW TSR.

TOT 3 (also known as Western Electricity Coordinating Council Path 36) defines the north to south transfer capability from Wyoming into Colorado. The geographic location is shown on the diagram provided in figure 3-1.

The established WECC rating is 1605MW. The OTC rating is calculated twice each year and the maximum rating is approximately 1580MW. The rating is a variable depending on LRS generation, Pawnee area generation, and DC tie output. Since TOT3 is an established WECC path, successful completion of the WECC path rating process is required to allow the TOT3 upgrades to proceed. Therefore, implementation of improvements identified by this study are contingent upon completion of the path rating process.

Western Area Power Administration's Miracle Mile Project is in the WECC Phase 2 process. This project will increase the TOT3 total transfer capability by 75 MW to 1680 MW with DC ties east-west. The project will be in service by 2009.

This study identifies transmission improvements necessary to increase the maximum established TOT3 rating by up to 575 MW to accommodate the 500 MW TSR plus the proposed 75 MW Miracle Mile Project increase. This condition corresponds to Sidney and Stegall DC ties operating east-west.

TOT7 powerflow is typically higher than its OTC rating in most of the proposed TOT3 limit cases. TOT7 is located south of TOT3. The powerflow plots for each case list the TOT7 powerflow. The TSR customers should consider submitting TOT7 requests if the ultimate point of delivery is Denver so the appropriate studies can be performed.

Several alternatives are considered. They are all built upon the Western Area Power Administration's (WAPA) Miracle Mile project. The alternatives incrementally add facilities until the required TOT3 limit is reached.

Alternative "K" provides the necessary increase in TOT3 capacity to meet the 500 MW TSR plus the Miracle Mile Phase 2 increase of 75 MW. A TOT3 limit of 2182 MW is achieved with DC ties east-west which is an increase of 577 MW from the established WECC limit. A one line diagram of Alternative K is provided in Figure 0-1. The new facilities are identified with dashed lines. Alternative K consists of the following facilities;

1. Miracle Mile Project - An existing 140 mile 115 KV line is being upgraded to 230 KV from Miracle Mile Substation to Ault Substation.

2. 50 MVAR of switchable capacitors are added at Laramie, Archer, Stegall, and Wray 115 KV buses.

3. The LRS-Story 345 KV line is tapped adjacent to Archer Substation. A 345/230 KV transformation is added at Archer Substation and a 10 mile 230 KV line is added to connect Archer to Cheyenne. The Cheyenne 230 KV bus is a component of the Miracle Mile Project

4. A 105 mile Stegall-Ault 230 KV line is added.

5. A 126 mile Stegall-DJ 230 KV line is added.

Also the alternative assumes the Gering-Mcgrew 115 KV and the Sidney-Peetz 115 lines load to 110% of 109MVA as an emergency rating. Otherwise the line ratings of these lines will have to be increased to 120 MVA. The Wyodak-DJ 230 KV line shown is an outlet for additional Wyodak area generation and not associated with the TOT3 upgrade.

The approximate cost estimate for this alternative is $93 million.

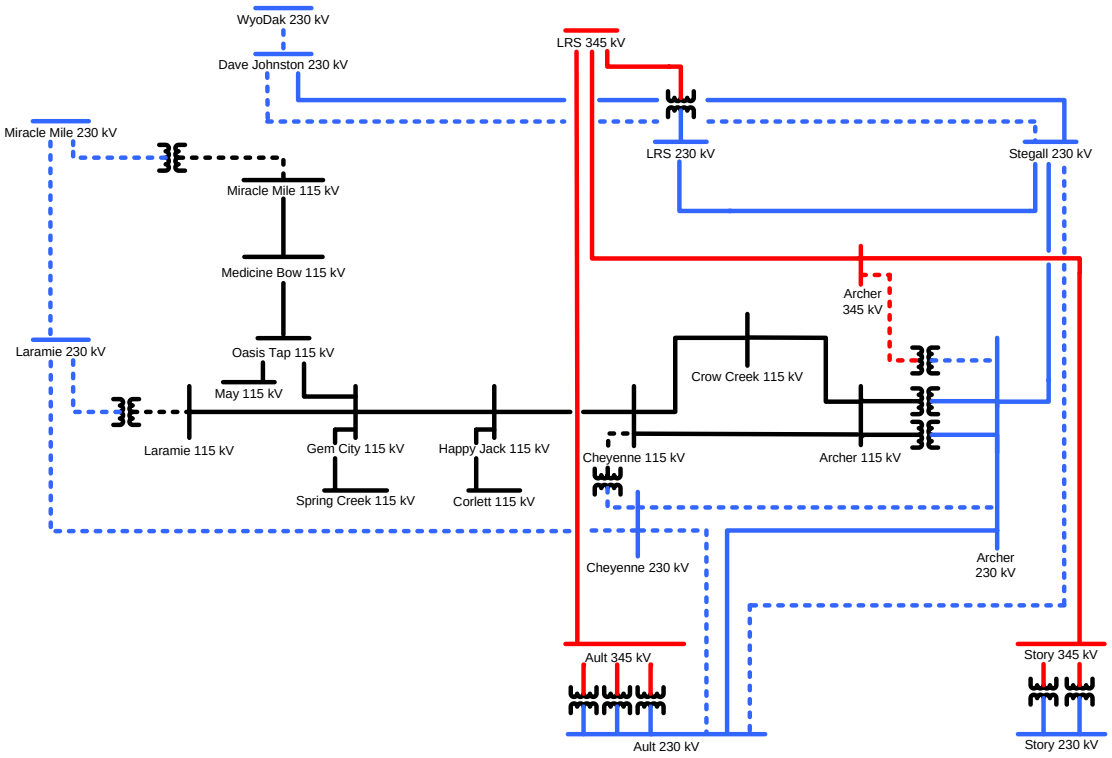


Figure 0-1

The Sidney 230/115 KV transformer overloads during the Sidney-N.Yuma 230 kV line outage in all DC east-west and DC=0 cases. Also its outage causes low voltage on the area 115 KV system. A 120% overload rating with additional capacitors or a second Sidney transformer may be necessary.

Other alternatives provided a lower increase in TOT3 TTC but have a much lower estimated cost. The Alternative C TOT3 TTC increase is 277 MW however the estimated cost is only $15.6 million (excluded the already budgeted Miracle Mile Project). This alternative is the most cost effective based on the data presented in Table 4-2. Therefore the TSR customer may want to select partial service based on the cost effectiveness of the various alternatives. The next highest increment is much less cost effective.

Alternative C consists of the following facilities;

1. Miracle Mile Project - An existing 140 mile 115 KV line is being upgraded to 230 KV from Miracle Mile Substation to Ault Substation.

2. 50 MVAR of switchable capacitors are added at Laramie, Archer, Stegall, and Wray 115 KV buses.

3. The LRS-Story 345 KV line is tapped adjacent to Archer Substation. A 345/230 KV transformation is added at Archer Substation and a 10 mile 230 KV line is added to connect Archer to Cheyenne. The Cheyenne 230 KV bus is a component of the Miracle Mile Project

A one line diagram of Alternative K is provided in Figure 0-2.

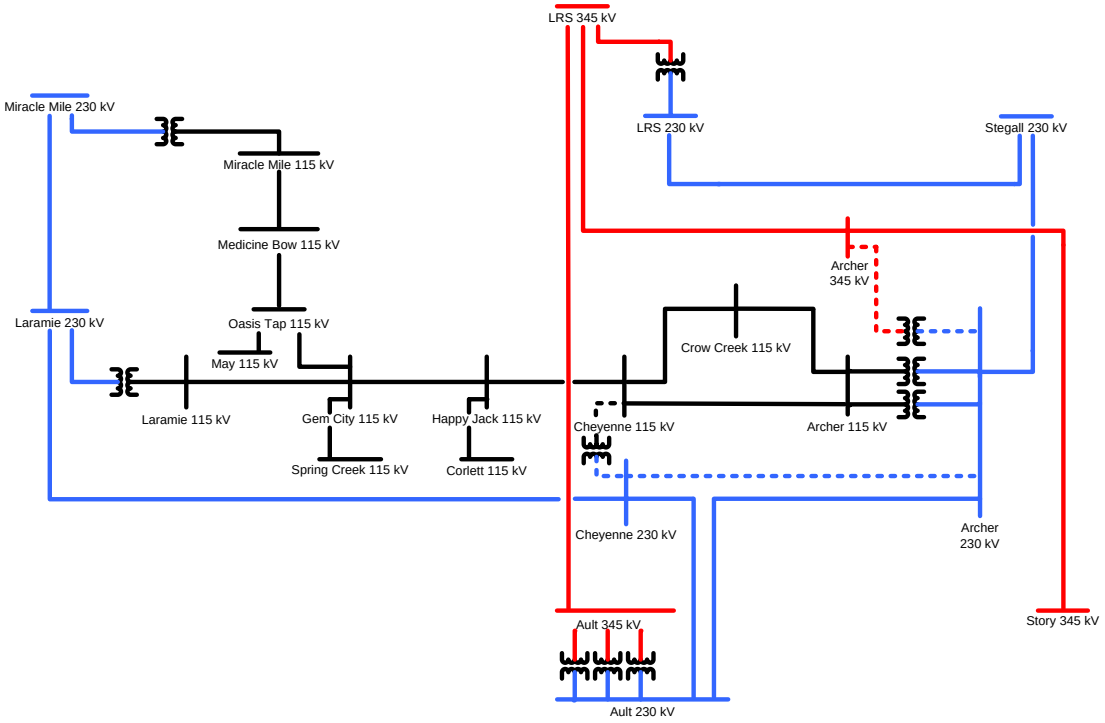


Figure 0-2

1. Introduction

This study is in response to a total of 500MW of point-to-point transmission service requests (TSR). The total consists of a 300MW TSR and a 200MW TSR. The 300MW TSR is actually three 100MW TSR's submitted to the MBPP transmission system OASIS and a single "up to" 300MW TSR submitted to the WAPA transmission system OASIS. The same customer made both requests. These requests are mutually exclusive and represent a single "up to" 300MW

point-to-point TSR from Dave Johnston to Ault. Also another customer made a 200MW Dave Johnston to Ault point-to-point TSR submitted to the WAPA transmission system OASIS.

The purpose of the system impact study is to evaluate the impacts of the TSR's. Contingency analysis is conducted to identify the thermal, voltage steady-state, and transient voltage impacts. The study is performed in accordance with WECC Planning Standards.

2. Description of Transmission Service Request

TRS # and Date	Capacity Requested	Point of Receipt	Point of Delivery	Start Date	End Date	Transmission Provider
70306269 2004-12-03 13:31:12 CS	100MW	Dave Johnston 230kV Bus	Ault 345kV bus	01/01/2009	01/01/2019	MBPP West
70306271 2004-12-03 13:30:35 CS	100MW	Dave Johnston 230kV Bus	Ault 345kV bus	01/01/2009	01/01/2019	MBPP West
70306272 2004-12-03 13:29:28 CS	100MW	Dave Johnston 230kV Bus	Ault 345kV bus	01/01/2009	01/01/2019	MBPP West
70373324 2005-03-22 17:13:14 CS	200MW	Dave Johnston 230kV Bus	Ault 345kV bus	05/01/2010	05/01/2011	WAPA RMR

Table 2-1 – Description of Transmission Service Requests

TRS #'s 70306269, 70306271, 70306272 are duplicated on the WAPA OASIS with a single "up to" 300 MW request #70314748. TSR #70373324 is a duplicate of TRS #2005-T3 on the WAPA-RMR OASIS.

3. Procedure

3.1 TOT3 Definition and Limits

TOT 3 (also known as Western Electricity Coordinating Council Path 36) defines the north to south transfer capability from Wyoming into Colorado. The geographic location is shown on the diagram provided in figure 3-1. The path consists of six transmission lines:

Laramie River Station (LRS)-Ault 345-kV Line	(Meter at LRS)
LRS-Story 345-kV Line	(Meter at LRS)
Archer-Ault 230-kV Line	(Meter at Archer)
Sidney-North Yuma 230-kV	(Meter at Sidney)
Sidney-Sterling 115-kV Line	(Meter at Sidney)
Cheyenne-Poudre 115-kV Line	(Meter at Cheyenne)

The established WECC rating is 1605MW. The OTC rating is calculated twice each year and the maximum rating is approximately 1580MW. The rating is a variable depending on LRS generation, Pawnee area generation, and DC tie output. The established WECC rating is determined with DC ties east-west, LRS at 1140 MW, and Pawnee area generation at 777 MW.

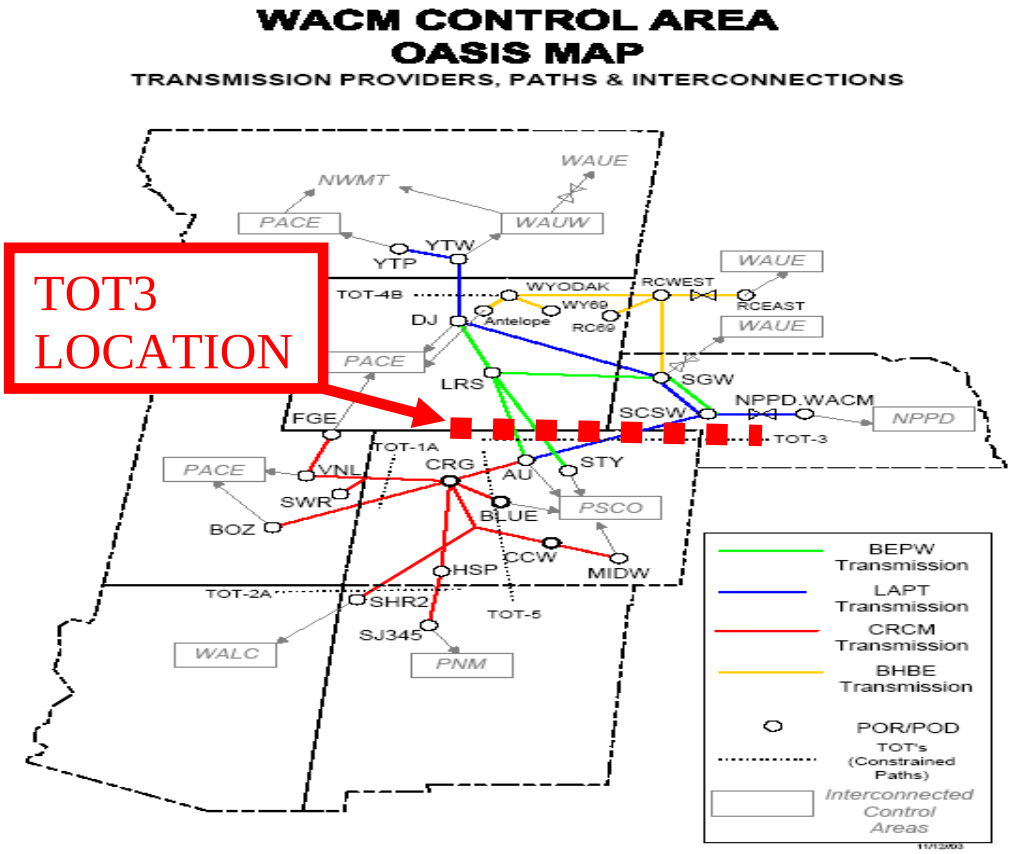


Figure 3-1

3.2 Criteria

3.2.1 System Normal (NERC/WSCC Category A):

All bus voltages should be within 0.95-1.05 per unit. All line and transformer loadings should be less than 100% of continuous rating (see Table A). Solution calculation should enable automatic transformer tap changing, switchable shunt device action, and area interchange control. Generation is changed manually to adjust TOT3 flow. Automatic phase shifter adjustments are locked during solution; however, they are adjusted manually to control TOT3 power flow.

3.2.2 Outage Conditions (NERC/WSCC Category B, C, and D):

All bus voltages should be within 0.90-1.10 per unit. All line and transformer loadings should be less than 100% of continuous rating or an established emergency rating. 110% ratings on overloaded 115 KV lines are considered.

3.2.3 Dynamic Stability:

All machines in the system will remain in synchronism as demonstrated by the relative rotor angles. All machine angles will be positively damped. The transient low voltage dip criteria is 0.70 p.u.

3.3 Base Case

The WECC base case is the 10hs1ap.sav. Case modifications will be documented in an “idv” file which will be included in the electronic documentation of this report. Three modified base cases will be created to check the impact of DC tie schedules. These cases will consist of the following combinations of LRS generation, Pawnee area generation, and DC tie schedules;

1)	LRS: 1140 MW	Pawnee: 777 MW	DC Ties: 300 E-W
2)	LRS: 1140 MW	Pawnee: 777 MW	DC Ties: 0 E-W
3)	LRS: 1140 MW	Pawnee: 777 MW	DC Ties: 300 W-E

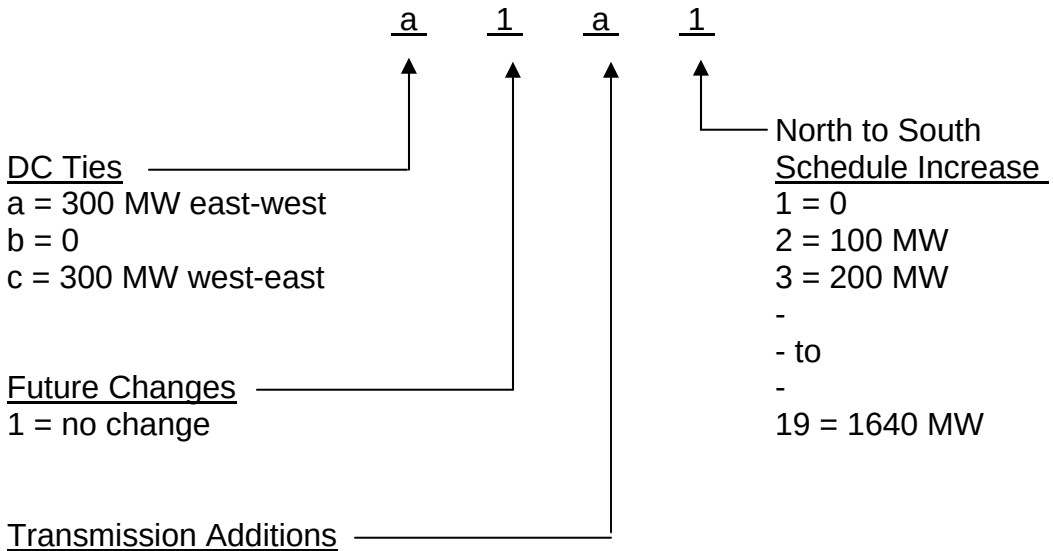
CPP generation will be set at 243MW for all cases as that is a probable condition for a heavy summer load scenario. A sensitivity with CPP at

66MW will be run as the WECC TOT3 established limit was studied at that MW. Pawnee generation total includes the output of the adjacent Manchief facility.

Base cases modifications include the addition of the Rapid City, Sidney, and Stegall DC tie detailed models; revised load estimates, new PSCO area representation, BHP detail, voltage control tune-ups, line rating changes, and other miscellaneous changes. All WAPA 115 KV lines with ratings of 80 MVA are assumed to be upgradable to 109 MVA. The LRS-Ault 345 KV line rating is upgradable to 1200 MVA with terminal equipment changes. The Stegall-Sidney 230 KV line has a thermal rating of 371 MVA.

3.4 Case Name Convention

The following case name convention is used;



Transmission Additions

a = No Change
b = Alternative B:
- Miracle Mile 230 KV Project
- Capacitors

c = Alternative C:
- LRS-Story 345 Tapped at Archer 230 KV
- Archer-Cheyenne 230 KV
- Plus Alternative B Facilities

d = Alternative D:
- Casper-Miracle Mile 230 KV
- Plus Alternative C Facilities

e = Alternative E:
-Wyodak-Casper 230 KV
- Plus Alternative D Facilities

f = Alternative F:
-Stegall-Story 230 KV
- Plus Alternative E Facilities

g = Alternative G:
-Stegall-Ault 230 KV
- Plus Alternative E Facilities
h = Alternative H:
-Stegall-Story 230 KV
- Plus Alternative C Facilities
i = Alternative I:
-Stegall-Ault 230 KV
- Plus Alternative C Facilities
j = Alternative J:
-Stegall-DJ 230 KV
- Plus Alternative H Facilities
k = Alternative K:
-Stegall-Ault 230 KV
- Plus Alternative H Facilities

The source of the schedule increases is generation north of TOT3 in Wyoming, Montana, Idaho, and Washington. It includes proposed generation including Dryfork and Wygen units #2 and #3. The generation is delivered in Colorado by reducing generation south of TOT3. The electronic documentation includes the electronic files used to model the schedules.

3.5 Description of Alternatives

The case name convention provided in section 3.4 lists alternatives “a” through “k”. This section provides a detailed description of each alternative.

Cost estimates are developed for each alternative. The unit costs are derived from the Colorado Long Range Transmission Plan, April 2004 Table 1. Appendix B provides the detailed cost estimates for each alternative. Cost estimates do not include WAPA’s Miracle Mile Project as it is already planned, budgeted, and common to each alternative. These costs are a rough estimate for planning purposes, not the engineering accurate estimate as provided with a facility study.

Alternative A - This is the “no change” alternative and is used to benchmark the modified base case performance. A simplified one line diagram is provided in Figure 3-2.

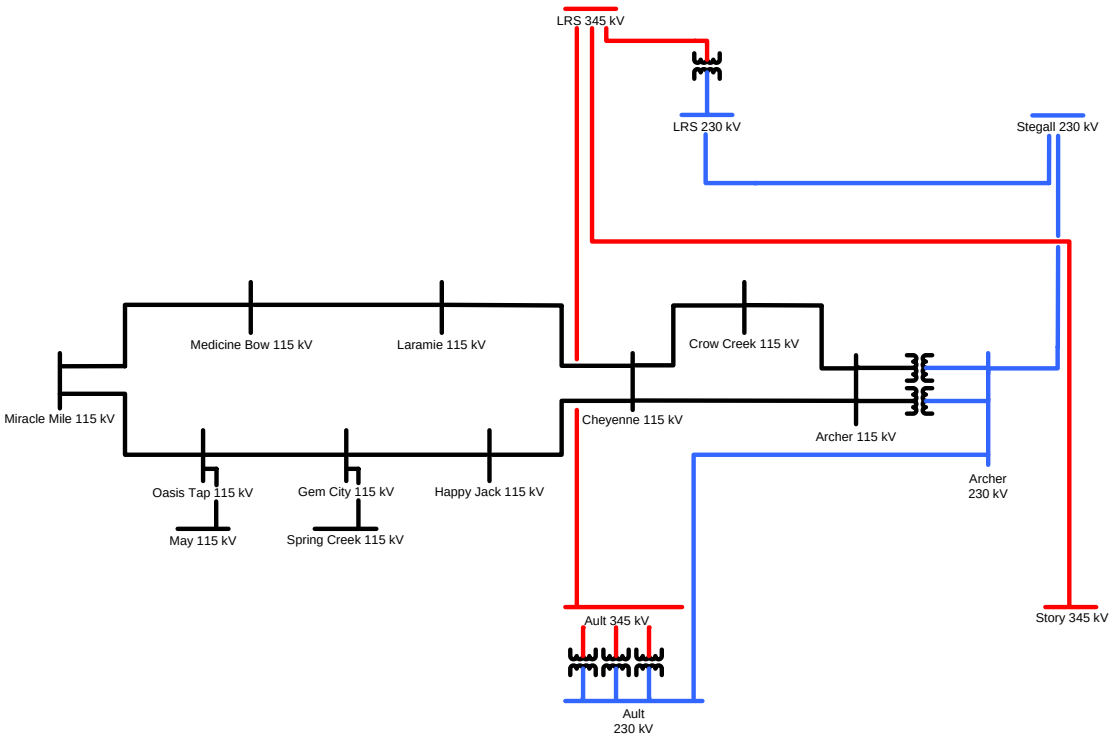


Figure 3-2 – Existing System

Alternative B - Consists of the Miracle Mile 230 KV project which is currently being developed by Western Area Power Administration. The project is in Phase 2 of the WECC path rating process. An existing 115 KV line is being upgraded to 230 KV from Miracle Mile Substation to Ault Substation. The new 230 KV line element between Cheyenne and Ault is a component of TOT3. Also 50 MVAR of switchable capacitors are added at Laramie, Archer, Stegall, and Wray 115 KV buses.

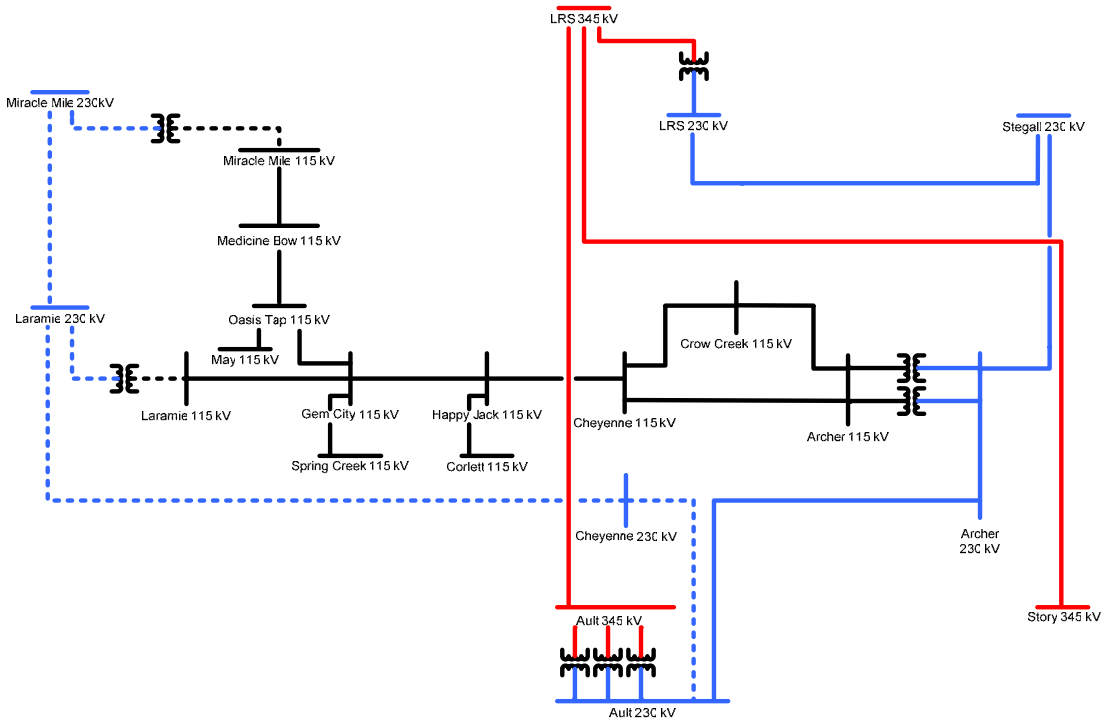


Figure 3-3 – Alternative B

Alternative C – Includes the Alternative B facilities plus the following. The LRS-Story 345 KV line is tapped adjacent to Archer Substation. A 345/230 KV transformation is added at Archer Substation and a 230 KV line is added to connect Archer to Cheyenne. This option will strengthen the Archer area during the LRS-Ault 345 KV outage.

Cost Estimate = $12,750,000

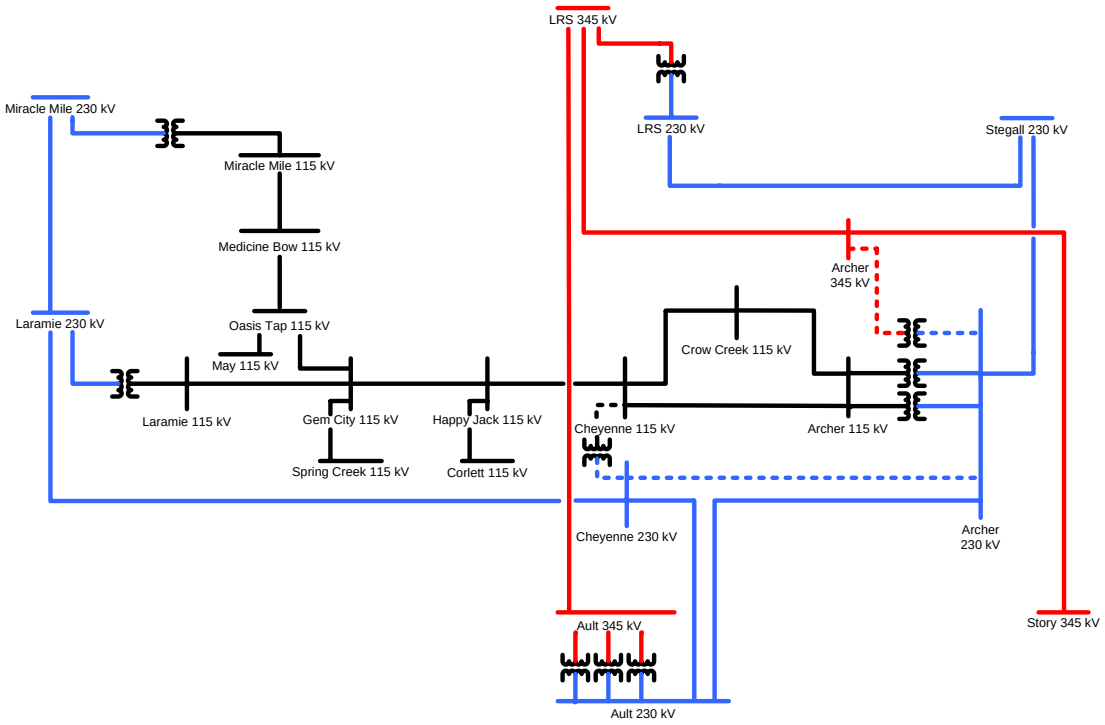


Figure 3-4 - Alternative C

Alternative D - Includes the Alternative C facilities plus the following. A 230 KV line is added to connect Casper Substation to Miracle Mile Substation. The Casper-Miracle Mile line may relieve 115kV loading.

Cost Estimate = $30,930,000

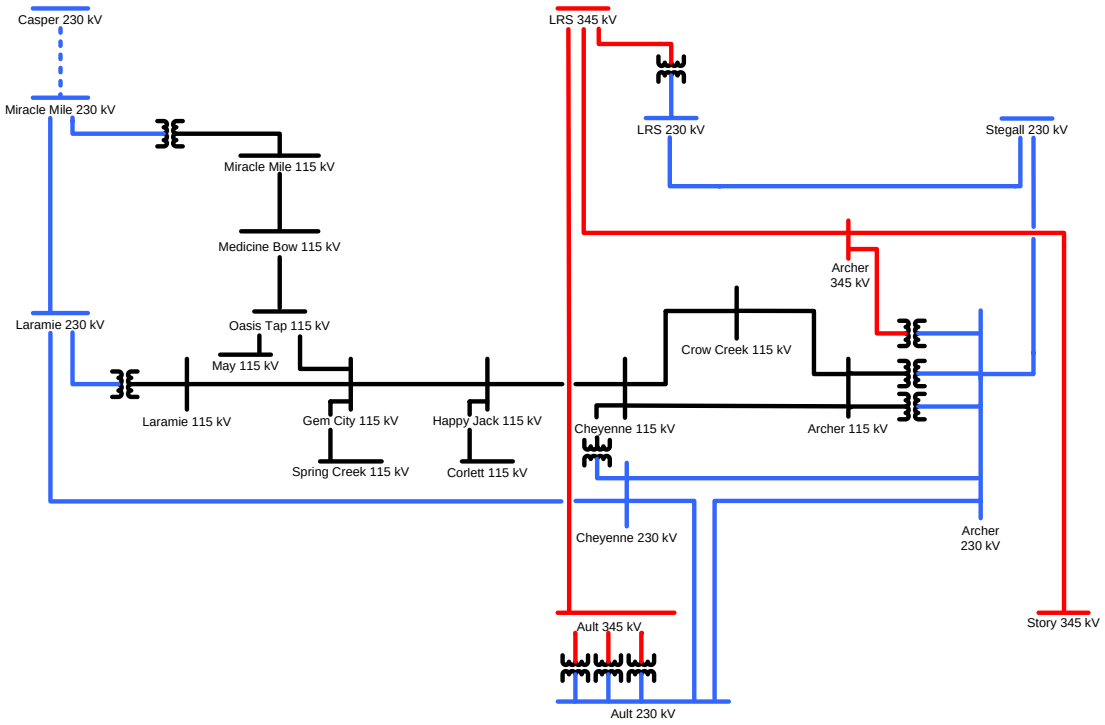


Figure 3-5 - Alternative D

Alternative E - Includes the Alternative D facilities plus the following. A 230 KV line is added to connect Casper Substation to Wyodak Substation. The Wyodak-Casper 230 KV line will provide an outlet to the Wyodak area and a connection to the Miracle Mile project. The purpose of this alternative is to check the impact on TOT3 of the proposed Wyodak outlet line.

Cost estimate is not provided as this alternative is just a check of the performance of the Wyodak-Casper 230Kv line.

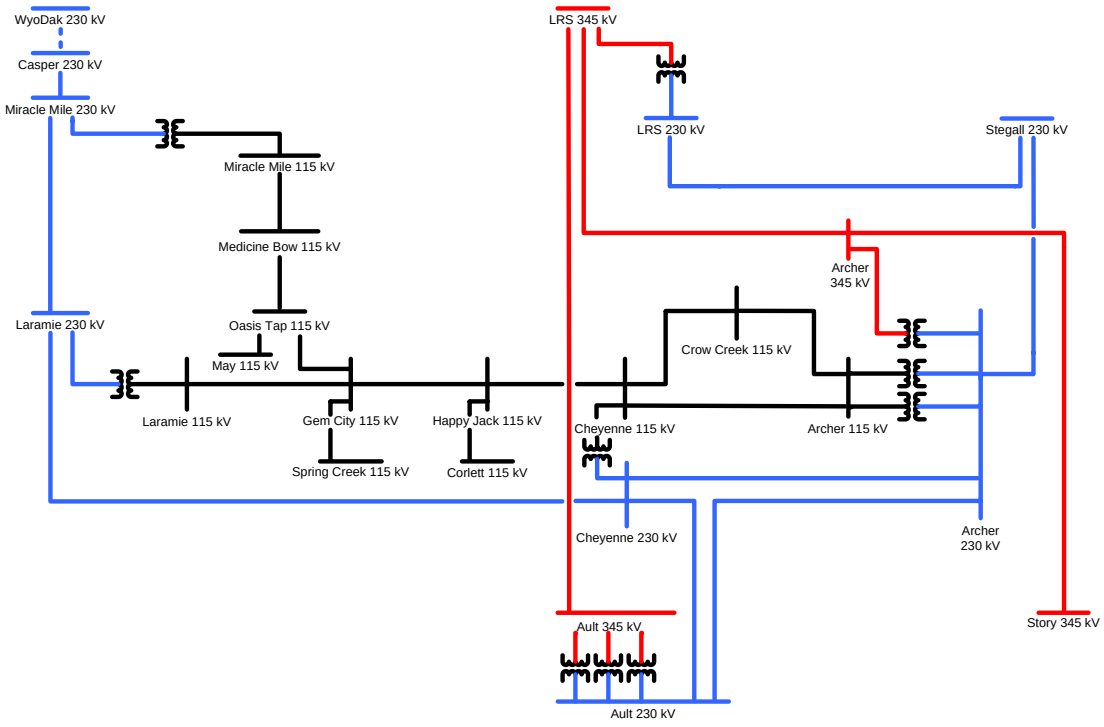


Figure 3-6 - Alternative E

Alternative F - Includes the Alternative E facilities plus the following. A 230 KV line is added to connect Stegall Substation to Story Substation. The Stegall-Story 230 KV line may relieve area 115 KV line loading. It is added to the TOT3 definition.

Cost Estimate = $71,430,000

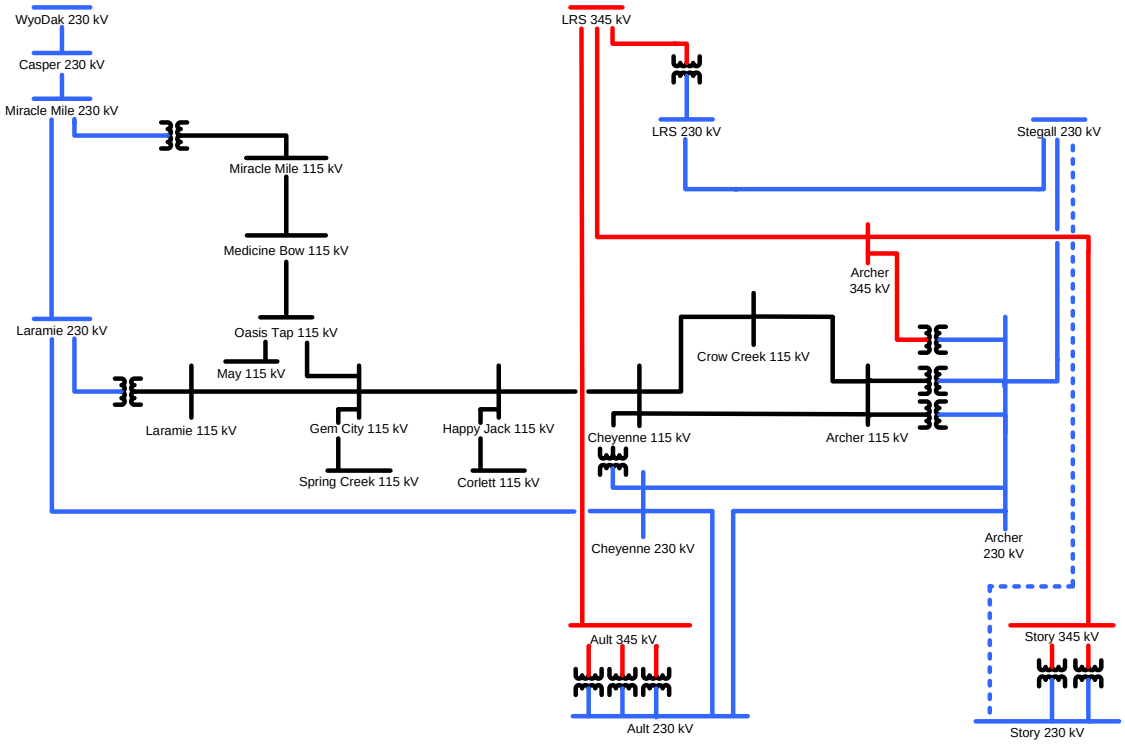


Figure 3-7 - Alternative F

Alternative G - Includes the Alternative E facilities plus the following. A 230 KV line is added to connect Stegall Substation to Ault Substation. The Stegall-Ault 230 KV line may relieve area 115 KV line loading. It is added to the TOT3 definition.

Cost Estimate = $66,705,000

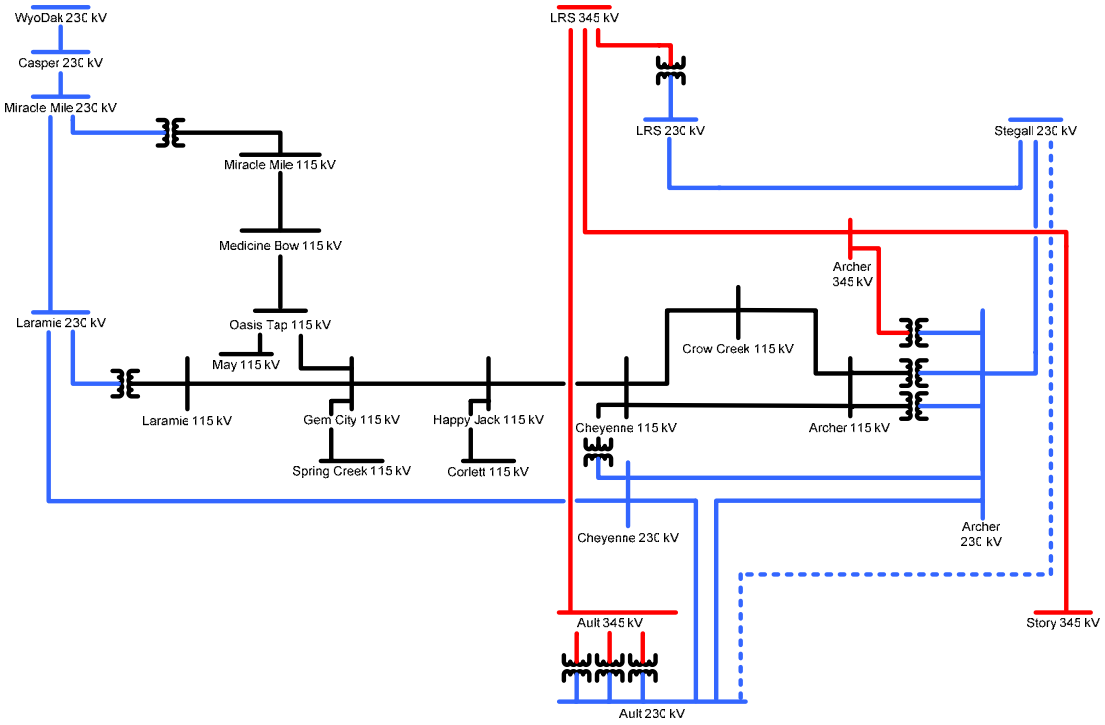


Figure 3-8 - Alternative G

Alternative H - Includes the Alternative C facilities plus the following. A 230 KV line is added to connect Stegall Substation to Story Substation. The Stegall-Story 230 KV line may relieve area 115 KV line loading. A Wyodak-Casper 230 KV line is added to provide an outlet line for new Wyodak area generation. This option lacks a Casper-Miracle Mile 230 KV line as it may aggravate Gem City 115 KV line overloads. The Stegall-Story 230 KV line is added to the TOT3 definition.

Cost Estimate = $53,250,000

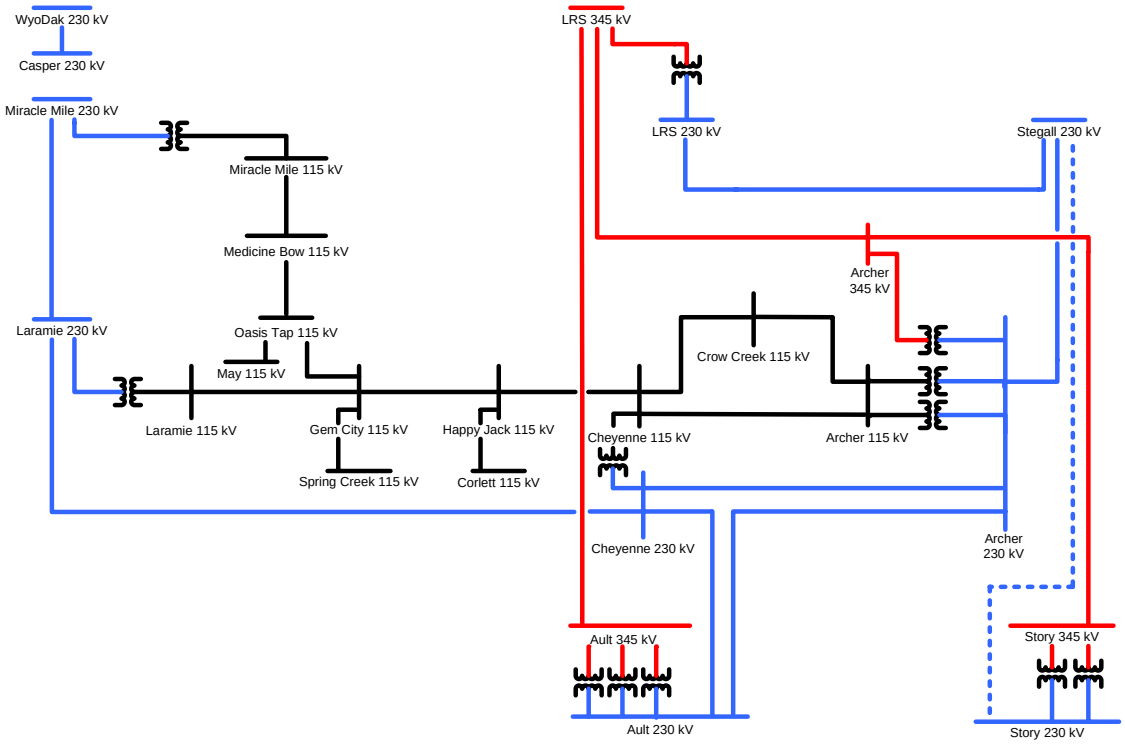


Figure 3-9 - Alternative H

Alternative I - Includes the Alternative H facilities except a Stegall-Ault 230 KV line is added instead of the Stegall-Story 230 KV line. The Stegall-Ault 230 KV Line is added to the TOT3 definition.

Cost Estimate = $48,525,000

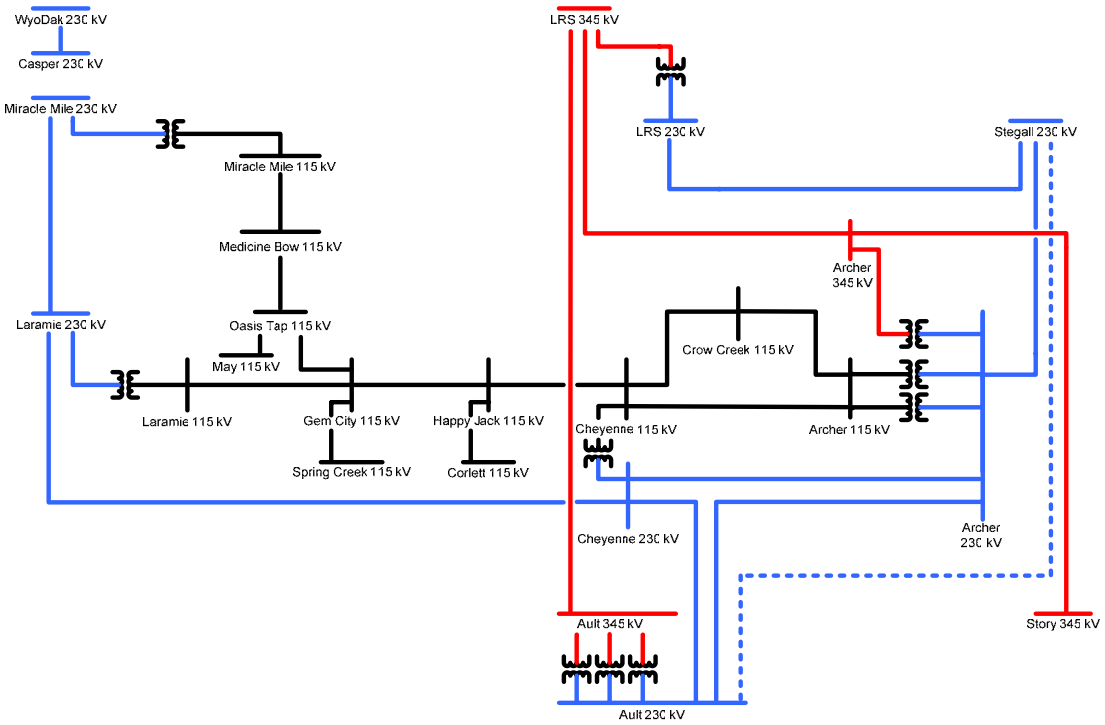


Figure 3-10 - Alternative I

Alternative J – Includes the Alternative C facilities plus the following. A 230 KV line is added to connect Stegall Substation to Story Substation. The Stegall-Story 230 KV line may relieve area 115 KV line loading. A Wyodak-Dave Johnston-Stegall 230 KV line is added to provide an outlet line for new Wyodak area generation. The Stegall-Story 230 KV line is added to the TOT3 definition.

Cost Estimate = $95,640,000

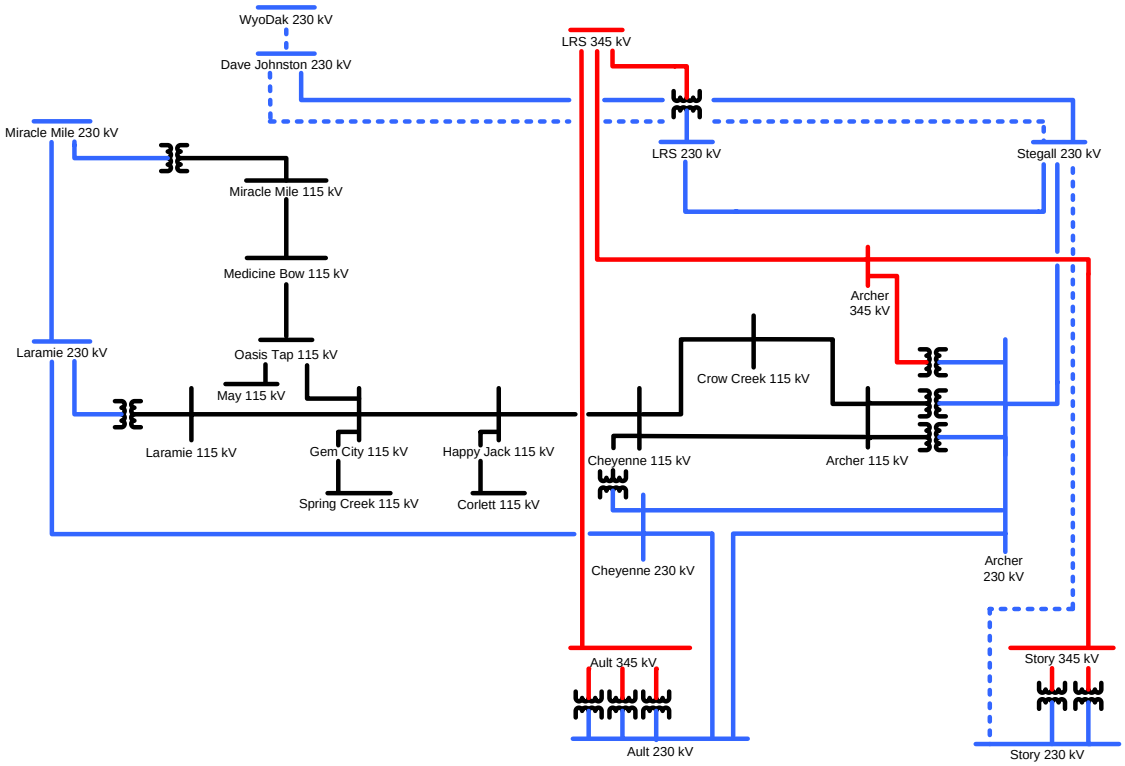


Figure 3-11 - Alternative J

Alternative K – Includes the Alternative C facilities plus the following. A 230 KV line is added to connect Stegall Substation to Ault Substation. The Stegall-Ault 230 KV line may relieve Archer-Stegall 230 KV line and area 115 KV line loading. A Wyodak-Dave Johnston-Stegall 230 KV line is added to provide an outlet line for new Wyodak area generation and relieve loading on the DJ-LRS 230 KV line. The Stegall-Ault 230 KV line is added to the TOT3 definition.

Cost Estimate = $90,915,000

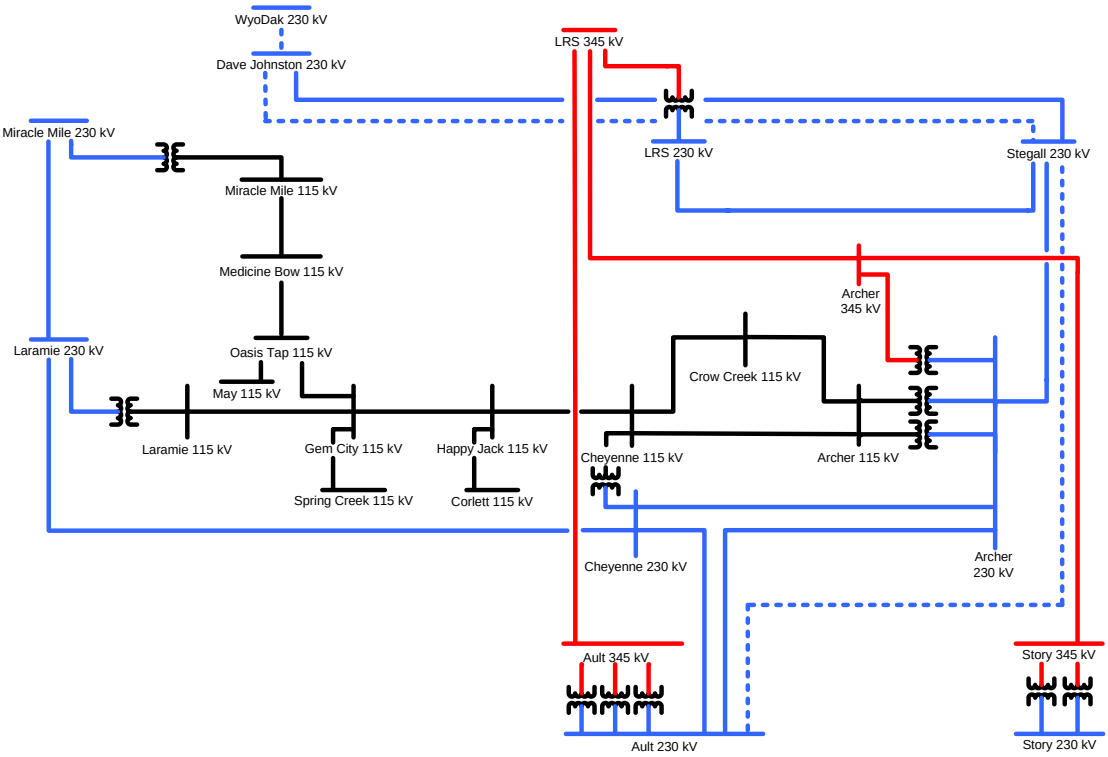


Figure 3-12 - Alternative K

3.6 Steady State

The study area is defined as all facilities located in the Eastern Wyoming, Western Nebraska, Eastern Colorado, and Foothills zones. The steady state outage list contains all facilities operated at 230kV and 345kV located within the study area. The monitored bus and branch list contains all buses and branches in the study area. Some Foothills area facilities are related to TOT7. Criteria violations involving these facilities are noted but not considered TOT3 limitations.

The TOT3 limit is benchmarked for each case. Incrementally scheduling generation from Wyoming to the Foothills and Denver areas controls TOT3 flow. For each case TOT3 flow is incrementally increased. At some increment of TOT3 increase a valid criteria violation is encountered and defines the TOT3 limit for that case. The exact TOT3 limit is determined by interpolating the results of two points lying near the limit. The process is repeated for each DC tie schedule permutation as described in section 3.3.

3.7 Transient Stability

TOT3 area transient stability response is dependant on LRS response to area disturbances. A LRS three phase fault with loss of either the Ault 345kV line or Story 345kV line are typically the worst case disturbances. Cases representing maximum TOT3 limits are tested. If transient stability violations are encountered, TOT3 is incrementally reduced until a limit is found. The defined TOT3 limit is the lower of the steady state or transient stability case capacity.

4. Results

Detailed powerflow results are provided in Appendix A and a summary table is provided in Table 4-1.

Alternative	DC = East-West			DC = 0		DC = West-East	
	TOT3	Change from base case	Change from 1605 MW	TOT3	Change from base case	TOT3	Change from base case
A – Base Case	1537	N/A	- 68	1400	N/A	1186	N/A
B – Miracle Mile Project	1649	+ 112	+44	1544	+ 144	1272	+ 86
C	1819	+ 282	+ 214	1774	+ 375	1218	+ 32
C With 110% 115KV Line Overload	1882	+ 345	+ 277	1802	+ 402	1408	+ 221
C with Gering-Mcgrew 115 KV at 125 MVA rating						1493	+307
D	1860	+ 323	+ 255	1676	+ 276	1244	+ 58
D With 110% 115KV Line Overload	1884	+ 347	+ 279	1758	+ 358	1465	+ 278
E	1850	+ 313	+ 245	1645	+ 245	1270	+ 84
E With 110% 115KV Line Overload	1885	+ 348	+ 280	1710	+ 310	1477	+ 291
F	1906	+ 368	+ 301	1690	+ 290	1447	+ 261
F With 110% 115KV Line Overload	1993	+ 456	+ 388	1761	+ 361	1536	+ 349
G	1927	+ 390	+ 322	1701	+ 301	1457	+ 270
G With 110% 115KV Line Overload	2019	+ 482	+ 414	1774	+ 374	1540	+ 354
H	1991	+453	+ 386	1717	+ 317	1428	+ 242
H With 110% 115KV Line Overload	N\A	N\A		1818	+ 418	1533	+347
I	2033	+ 496	+ 428	1711	+ 312	1423	+ 236
I With 110% 115KV Line Overload	2102	+ 565	+ 497	1822	+ 422	1536	+ 349
J	2002	+ 464	+ 397	1954	+ 554	1429	+ 242
J With 110% 115KV Line Overload	N\A	N\A		N\A	N\A	1646	+ 459
K	2070	+533	+465	2022	+622	1350	+164
K With 110% 115KV Line Overload	2182	+645	+577	N\A	N\A	1568	+382
K with Gering-Mcgrew 115 KV at 125 MVA rating						1751	+565

Table 4-1: Summary of Results – CPP at 243MW

The Base Case TOT3 limit with DC ties east-west is 1537 MW. This is less than the established limit of 1605 MW and less then the typical OTC summer limits of approximately 1580 MW. The Base Case limit is due to Laramie 115 KV low voltage during the LRS-Ault 345 KV outage. Out year load increases are impacting Laramie 115 KV voltage and decreasing the TOT3 limit from existing values. In order to increase the TOT3 limit by 575 MW from the established limit of 1605 MW with DC ties east-west a new TOT3 limit of 2180 MW is required.

Summary results are provided in sections 4.1 through 4.3. The limits are based on steady state results unless otherwise specifically noted. Each limit is based on an interpolation of two cases near the limit. Therefore the exact TOT3 limit is determined for each condition.

Many TOT3 limits are determined by 115 KV line minor overloads. These lines have a low “flowability” compared to the parallel 230 or 345 KV lines. If a 110% emergency overload is allowed on these facilities a significant TOT3 increase may be possible. Results are provided for 100% continuous rating and also for the 110% 115 KV line rating. If emergency ratings are not possible then the results apply to a line rating upgrade such as increasing clearance or a reconductor.

TOT7 powerflow is typically higher than the OTC rating in most of the TOT3 limit cases. For example, the Alternative I case (A1I16) with TOT3 at 2100 MW the associated TOT7 flow is 1100MW. The powerflow plots for each case list the TOT7 powerflow. The TSR customer should consider TOT7 requests if the ultimate point of delivery is Denver so the appropriate studies can be performed.

The Sidney 230/115 KV transformer overloads during the Sidney-N.Yuma 230 kV line outage in all DC east-west and DC=0 cases. Also its outage causes low voltage on the area 115 KV system. A 120% overload rating may be necessary with additional capacitors.

Each alternative provides a certain incremental increase in TOT3 TTC and has an estimated construction cost. Table 4-2 provides data showing the TTC increase, cost estimate, and a dollar per MW increase number. The purpose of this table is to provide a measure of cost effectiveness of each alternative.

ECONOMIC COMPARISION

Alternative	TOT3	Change from 1605 MW	Cost Estimate In $1000's	Change $1000/MW
C With 110% 115KV Line Overload	1882	277	$15,600	56
D With 110% 115KV Line Overload	1884	279	$33,780	121
E With 110% 115KV Line Overload	1885	280	n/a	n/a
F With 110% 115KV Line Overload	1993	388	$74,280	191
G With 110% 115KV Line Overload	2019	414	$69,555	168
H With 110% 115KV Line Overload	1991	386	$56,100	145
I With 110% 115KV Line Overload	2102	497	$51,375	103
J With 110% 115KV Line Overload	2002	397	$98,490	248
K With 110% 115KV Line Overload	2182	577	$93,765	163

Table 4-2: Economic Comparison

Table 4-2 provides a simple economic comparison of the alternatives. It shows the TOT3 increase along with a cost estimate. Cost effectiveness is determined by dividing the dollars by MW increase. A lower ratio is more cost effective than a higher ratio.

Alternative B data is not provided as it only contains the Miracle Mile Project which is already planned and budgeted. Alternative E is a sensitivity of the impact of the Wyodak outlet line which is needed to support additional Wyodak area generation and not a TOT3 facility. Therefore the costs are labeled "n/a".

Alternative C is the most cost effective with a $1000/MW figure of 56. It provides an increase of 277MW of which 75MW is assigned to the Miracle Mile Project.

Therefore, 202MW are left to meet the transmission requests associated with this study. This is only a portion of the "up to 300MW" request.

In order to grant the total "up to 300MW" request and the 75MW is assigned to the Miracle Mile Project, Alternative I is the lowest cost option. It has a TOT3 increase of 497, a cost of $51.3 million, and a $1000/MW value of 103.

The 575MW increase required for the combined TSR's and the Miracle Mile Project can only be obtained with Alternative K which provides a 577MW increase, a cost of $93.7 million, and a $1000/MW value of 163.

The results of the CPP at 66 MW sensitivity are provided in Table 4-3.

Sensitivity of CPP at 66 MW

Alternative	DC = East-West		
	TOT3	Change from base case	Change from 1605 MW
A – Base Case	1576	N/A	- 29
B – Miracle Mile Project.	1710	+ 134	+ 105
C	1705	+ 129	+ 100
C With 110% 115KV Line Overload	1865	+ 289	+ 260
C with Sidney-Peetz 115 KV at 125 MVA rating	1952	+ 376	+ 347
K	1915	+339	+ 310
K With 110% 115KV Line Overload	2083	+507	+ 478

Table 4-3: Summary of Results – CPP at 66MW

The CPP generation effects the powerflow on the 115 KV system between Sidney and Beaver Creek. In the base case and Alternatives B and C, CPP at 66 MW provides a slightly higher TOT3 limit compared to CPP at 243 MW. In alternative K the TOT3 limit is lower.

4.1 DC Ties East to West

Alternative A – Existing System

The TOT3 limit is 1537 MW based on Laramie 115 KV voltage during the LRS-Ault 345 KV outage.

Case Name	Forced Outage	Limiting Facility	Voltage	TOT3	Interpolated TOT3 Limit
A1A6	LRS-Ault 345	Laramie 115	0.889	1577	**1537**
A1A5	LRS-Ault 345	Laramie 115	0.907	1512	

Alternative B – Miracle Mile Project

The TOT3 limit is 1649 based on overload of the Archer-Stegall 230 KV line during the LRS-Ault 345 KV outage.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1B7	LRS-Ault 345	Archer-Stegall 230	101.4% of 478 MVA	1672	**1649**	**112**
A1B6	LRS-Ault 345	Archer-Stegall 230	97.3% of 478 MVA	1606		

Alternative C – Add Archer Tap of LRS-Story 345 KV line

The Archer Tap is effective in mitigating the LRS-Ault 345 KV outage issues. The limitation moves to the east side of TOT3. The Sidney-North Yuma 230 KV outage causes the Sidney-Peetz 115 KV line to overload.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1C12	Sidney-N.Yuma 230	Sidney-Peetz 115	102.6% of 109 MVA	1864	**1819**	**282**
A1C11	Sidney-N.Yuma 230	Sidney-Peetz 115	100.3% of 109 MVA	1824		

Allowing a slight emergency overload rating on the Sidney-Peetz 115 KV line allows a significant increase in TOT3 capacity. Option #1 results show if Sidney-Peetz is allowed to overload to 104% of 109MVA (114 MVA) then the Archer-Ault 230 KV line overload becomes the limiter with TOT3 at 1882 MW.

Option #1 – Allow Sidney-Peetz 115 KV line to load to 104% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1C13	LRS-Ault 345	Archer-Ault 230	102.6% of 462 MVA	1930	**1882**	**345**
A1C12	LRS-Ault 345	Archer-Ault 230	99% of 462 MVA	1864		

Alternative D = C + Casper–Miracle Mile 230 KV

The Casper-Miracle Mile 230 KV addition results in a TOT3 limit of 1860 MW versus 1819 MW for Alternative C. This is due to additional flow on the Miracle Mile 230 KV line allowing the Sidney-Peetz 115 KV overload to occur at a higher TOT3 flow.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1D13	Sidney-N.Yuma 230	Sidney-Peetz 115	105.8% of 109 MVA	1950	**1860**	**323**
A1D12	Sidney-N.Yuma 230	Sidney-Peetz 115	101.4% of 109 MVA	1882		

Allowing a slight emergency overload rating on the Sidney-Peetz 115 KV line allows a 24 MW increase in TOT3 capacity. Option #1 results show if Sidney-Peetz is allowed to overload to 102% of 109MVA (111 MVA) then the Archer-Ault 230 KV line overload becomes the limiter with TOT3 at 1884 MW. However, compared to Option #1 in Alternative C this provides little TOT3 increase (1884 MW versus 1882 MW).

Option #1 – Allow Sidney-Peetz 115 KV line to load to 102% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1D13	LRS-Ault 345	Archer-Ault 230	103.6% of 462 MVA	1950	**1884**	**347**
A1D12	LRS-Ault 345	Archer-Ault 230	99.9% of 462 MVA	1882		

Alternative E = D + Casper–Wyodak 230

This alternative adds a Casper-Wyodak 230 KV line to Alternative D which completes a 230 KV path from Wyodak through the Miracle Mile Project across TOT3. Compared to Alternative D the TOT3 limit actually decreases slightly due to the overload of the Gem City-Happy Jack 115 KV line. The flow bias created by the Miracle Mile to Wyodak 230 KV connection is causing a limit when the Laramie-Cheyenne 230 KV section is opened.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1E12	Laramie-Cheyenne 230	Gem City-H.Jack 115	103.8% of 120 MVA	1887	**1850**	**313**
A1E11	Laramie-Cheyenne 230	Gem City-H.Jack 115	99.6% of 120 MVA	1846		

Allowing a slight emergency overload rating on the Gem City-Happy Jack 115 KV line allows a 21 MW increase in TOT3 capacity.

Option #1 – Allow Gem City-Happy Jack 115 KV line to load to 102% of 120 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1E13	Sidney-N.Yuma 230	Sidney-Peetz 115	105.4% of 109 MVA	1956	**1871**	**334**
A1E12	Sidney-N.Yuma 230	Sidney-Peetz 115	101% of 109 MVA	1887		

Allowing a slight emergency overload rating on the Gem City-Happy Jack 115 KV line and Sidney-Peetz 115 KV line results in TOT3 capacity of 1885 MW which is similar to the Alternative C rating of 1882 MW.

Option #2 – Allow Gem City-Happy Jack 115 KV line to load to 104% of 120 MVA and the Sidney-Peetz 115 KV line to load to 101% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1E13	LRS-Ault 345	Archer-Ault 230	103.9% of 462 MVA	1956	**1885**	**348**
A1E12	LRS-Ault 345	Archer-Ault 230	100.1% of 462 MVA	1887		

Alternative F = E + Stegall-Story 230

A new Stegall-Story 230 KV line parallels the existing Archer-Stegall and Sidney-Peetz lines whose overloads typically cause TOT3 limits. The new facilities increase the TOT3 limit to 1906 MW.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1F13	Laramie-Cheyenne 230	Gem City-H.Jack 115	106.5% of 120 MVA	1979	**1906**	**368**
A1F12	Laramie-Cheyenne 230	Gem City-H.Jack 115	100.2% of 120 MVA	1908		

Allowing an emergency overload rating on the Gem City-Happy Jack 115 KV line of 109% of 120 MVA (131 MVA) results in TOT3 capacity of 1993 MW.

Option #1 – Allow Gem City-Happy Jack 115 KV line to load to 109% of 120 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1F14	LRS-Ault 345	Archer-Ault 230	100.1% of 462 MVA	1995	**1993**	**456**
A1F13	LRS-Ault 345	Archer-Ault 230	99.2% of 462 MVA	1979		

Alternative G = E + Stegall-Ault 230

A new Stegall-Ault 230 KV line parallels the existing Archer-Stegall and Sidney-Peetz lines whose overloads typically cause TOT3 limits. The new increase increases the TOT3 limit to 1927 MW.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1G13	Laramie-Cheyenne 230	Gem City-H.Jack 115	105.2% of 120 MVA	1986	**1927**	**390**
A1G12	Laramie-Cheyenne 230	Gem City-H.Jack 115	98.9% of 120 MVA	1915		

Allowing an emergency overload rating on the Gem City-Happy Jack 115 KV line of 110% of 120 MVA (132 MVA) results in TOT3 capacity of 2019 MW.

Option #1 – Allow Gem City-Happy Jack 115 KV line to load to 110% of 120 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit Based on 110% overload	TOT3 Increase
A1G15	Laramie-Cheyenne 230	Gem City-H.Jack 115	116.0% of 120 MVA	2074	**2019**	**482**
A1G14	Laramie-Cheyenne 230	Gem City-H.Jack 115	108.1% of 120 MVA	2002		

Alternative H = C + Stegall-Story 230

This alternative adds the Stegall-Story 230 KV line to Alternative C. It is similar to Alternative F, but without the Miracle Mile-Casper 230 KV line. Alternative F included a Miracle Mile-Casper 230 KV line and was limited by Gem City-Happy Jack 115 KV line overloads. It is possible the Miracle Mile-Casper 230 KV line increased flow-ability on the Gem City-Happy Jack 115 KV line. Therefore, this alternative adds the Stegall-Story 230 without the addition of the Miracle Mile-Casper 230 KV line.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1H15	LRS-Ault 345	Archer-Stegall 230	103.6% of 478 MVA	2045	**1991**	**453**
A1H16	LRS-Ault 345	Archer-Stegall 230	98.9% of 478 MVA	1974		

Alternative I = C + Stegall-Ault 230

This alternative adds the Stegall-Ault 230 KV line to Alternative C. It is the same as Alternative H but a Stegall-Ault 230 KV line is added instead of a Stegall-Story 230 KV line.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1I15	Dave Johnston–LRS 230	Dave Johnston-Stegall 230	102% of 319 MVA	2052	**2033**	**496**
A1I14	Dave Johnston–LRS 230	Dave Johnston-Stegall 230	94.5% of 319 MVA	1981		

Option #1 – Allow Dave Johnston–Stegall 230 KV line to load to 105% of 319 MVA. This is not a problem as the 319 MVA rating is based on a wavetrap, the conductor rating is 478 MVA. Then the next limits are:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1I16	Dave Johnston–LRS 230	Alcova–Miracle M. 115	103.5% of 109 MVA	2114	**2078**	**541**
A1I15	Dave Johnston–LRS 230	Alcova–Miracle M. 115	97.5% of 109 MVA	2052		

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1I16	Dave Johnston–LRS 230	Lingle-White Rock 115	103.3% of 109 MVA	2114	**2079**	**542**
A1I15	Dave Johnston–LRS 230	Lingle-White Rock 115	97.7% of 109 MVA	2052		

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1I16	Sidney-N.Yuma 230	Sidney-Peetz 115	102.9% of 109 MVA	2114	**2082**	**545**
A1I15	Sidney-N.Yuma 230	Sidney-Peetz 115	97.3% of 109 MVA	2052		

Option #2 – Allow Dave Johnston–Stegall 230 KV line to load to 107% of 319 MVA. Allow the Alcova-Miracle Mile 115, the Lingle-White Rock 115, and the Sidney-Peetz 115 lines load to 102%. These loadings are within their emergency rating of 110% of 109 MVA (120 MVA). Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1I16	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	101.2% of 442 MVA	2114	**2102**	**565**
A1I15	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	95% of 442 MVA	2052		

Alternative J = C + WyoDak-Dave Johnston-Stegall-Story 230

This alternative adds the Wyodak-DJ-Stegall-Ault 230 KV line to Alternative C. It is similar to Alternative I but adds a new DJ-Stegall 230 KV line which helps parallel 115 KV and 230 KV line overloads and allows a higher TOT3 limit. The limiter is overload of the Archer-Ault 230 kV line during the LRS-Ault 345 KV outage.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1J14	LRS-Ault 345	Archer-Ault 230	100.3% of 462 MVA	2007	**2002**	**464**
A1J13	LRS-Ault 345	Archer-Ault 230	99.4% of 462 MVA	1991		

Alternative K = C + WyoDak-Dave Johnston-Stegall-Ault 230

Alternative K is derived from Alternative J but the proposed line is terminated at Ault instead of Stegall. This improves the TOT3 limit by paralleling the Archer-Ault 230 KV which is the limiter in Alternative J.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
A1K15	Sidney-N.Yuma 230	Sidney-Peetz 115	101.7% of 109 MVA	2089	**2070**	**533**
A1K16	Sidney-N.Yuma 230	Sidney-Peetz 115	107.6% of 109 MVA	2153		

Option #1 – Allow Sidney-Peetz 115 KV line to load to 110% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	TOT3 Limit	TOT3 Increase
A1K19	Sidney-N.Yuma 230	Sidney-Peetz 115	109% of 109 MVA	2182	**2182**	**645**

The next higher increment of TOT3 transfer fails to solve. Therefore case A1K19 is considered at TOT3 limit case for this condition.

4.2 DC Ties = 0 MW

Alternative A – Existing System

The TOT3 limit is 1400 MW based on Laramie 115 KV voltage during the LRS-Ault 345 KV outage.

Case Name	Forced Outage	Limiting Facility	Voltage	TOT3	Interpolated TOT3 Limit
B1A6	LRS-Ault 345	Laramie 115	0.889	1435	**1400**
B1A5	LRS-Ault 345	Laramie 115	0.909	1371	

Alternative B – Miracle Mile Project

This limit is based on the transient stability performance. The 3 phase fault at the LRS 345 KV bus and loss of the LRS-Ault 345 KV line causes a voltage dip violation at the Sentinel 115 KV bus.

Case Name	Fault	Limiting Buss	Voltage Dip	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1B8	3 PH Fault at LRS; Loss of LRS-Ault 345	Sentinel 115	0.6796	1585	**1544**	**144**
B1B7		Sentinel 115	0.7064	1531		

Alternative C – Add Archer Tap of LRS-Story 345 KV line

The Archer Tap alternative mitigates the transient stability limitation of Alternative B.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1C14	Dave Johnston–LRS 230	Dave Johnston-Stegall 230	104.6% of 319 MVA	1796	**1774**	**375**
B1C13	Dave Johnston–LRS 230	Dave Johnston-Stegall 230	101.4% of 319 MVA	1781		

Option #1 – Allow Dave Johnston–Stegall 230 KV line to load to 105% of 319 MVA. This is not a problem as the 319 MVA rating is based on a wavetrap, the conductor rating is 478 MVA. Then the next limits are:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1C14	Dave Johnston–LRS 230	Alcova–Miracle M. 115	100.9% of 109 MVA	1796	**1792**	**392**
B1C13	Dave Johnston–LRS 230	Alcova–Miracle M. 115	97.4% of 109 MVA	1781		

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1C14	Dave Johnston–LRS 230	Lingle-White Rock 115	100% of 109 MVA	1796	**1796**	**396**

Option #2 – Allow Dave Johnston–Stegall 230 KV line to load to 106% of 319 MVA. Allow the Alcova-Miracle Mile 115 KV and Lingle-White Rock 115 KV lines to load to 102% and 101% respectively. These are within their emergency rating of 110% of 109 MVA (120 MVA). Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1C17	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	104% of 442 MVA	1825	**1802**	**402**
B1C14	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	98.9% of 442 MVA	1796		

Alternative D = C + Casper–Miracle Mile 230

The Casper-Miracle Mile 230 KV line addition increases the flow bias through the Miracle Mile project and causes the Gem City-Happy Jack 115 KV line to overload at a lower TOT3.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1D11	Laramie-Cheyenne 230	Gem City-H.Jack 115	103.8% of 120 MVA	1697	**1676**	**276**
B1D10	Laramie-Cheyenne 230	Gem City-H.Jack 115	98.8% of 120 MVA	1669		

Allowing an emergency overload rating on the Gem City-Happy Jack 115 KV line of 110% of 120 MVA (132 MVA) results in TOT3 capacity of 1758 MW.

Option #1 – Allow Gem City-Happy Jack 115 KV line to load to 110% of 120 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit 110% overload	TOT3 Increase
B1D13	Laramie-Cheyenne 230	Gem City-H.Jack 115	114% of 120 MVA	1802	**1758**	**358**
B1D12	Laramie-Cheyenne 230	Gem City-H.Jack 115	108% of 120 MVA	1736		

Alternative E = D + Casper–Wyodak 230

The Casper-Wyodak 230 KV line addition increases the flow bias through the Miracle Mile project and causes the Gem City-Happy Jack 115 KV line to overload at a lower TOT3.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1E10	Laramie-Cheyenne 230	Gem City-H.Jack 115	103.5% of 120 MVA	1674	**1645**	**245**
B1E9	Laramie-Cheyenne 230	Gem City-H.Jack 115	99.5% of 120 MVA	1641		

Option #1 – Allow Gem City-Happy Jack 115 KV line to load to 110% of 120 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit 110% overload	TOT3 Increase
B1E12	Laramie-Cheyenne 230	Gem City-H.Jack 115	113.5% of 120 MVA	1742	**1710**	**310**
B1E11	Laramie-Cheyenne 230	Gem City-H.Jack 115	109.1% of 120 MVA	1702		

Alternative F = E + Stegall-Story 230

The limit is based on Gem City-Happy Jack 115 KV line overload during the Laramie-Cheyenne 230 KV outage.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1F10	Laramie-Cheyenne 230	Gem City-H.Jack 115	100.2% of 120 MVA	1691	**1690**	**290**
B1F11	Laramie-Cheyenne 230	Gem City-H.Jack 115	105.4% of 120 MVA	1720		

Option #1 – Allow Gem City-Happy Jack 115 KV line to load to 110% of 120 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit 110% overload	TOT3 Increase
B1F12	Laramie-Cheyenne 230	Gem City-H.Jack 115	110.1% of 120 MVA	1762	**1761**	**361**
B1F11	Laramie-Cheyenne 230	Gem City-H.Jack 115	105.4% of 120 MVA	1720		

Alternative G = E + Stegall-Ault 230

The limit is based on Gem City-Happy Jack 115 KV line overload during the Laramie-Cheyenne 230 KV outage.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1G11	Laramie-Cheyenne 230	Gem City-H.Jack 115	104.5% of 120 MVA	1726	**1701**	**301**
B1G10	Laramie-Cheyenne 230	Gem City-H.Jack 115	99.2% of 120 MVA	1696		

Option #1 – Allow Gem City-Happy Jack 115 KV line to load to 110% of 120 MVA (or 132 MVA). Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit 110% overload	TOT3 Increase
B1G13	Laramie-Cheyenne 230	Gem City-H.Jack 115	115.2% of 120 MVA	1835	**1774**	**374**
B1G12	Laramie-Cheyenne 230	Gem City-H.Jack 115	109.3% of 120 MVA	1766		

Alternative H = C + Stegall-Story 230

This alternative is similar to Alternative F. Alternative F included a Miracle Mile-Casper 230 KV line and was limited by Gem City-Happy Jack 115 KV line overloads. It is possible the Miracle Mile-Casper 230 KV line increased flow-ability on the Gem City-Happy Jack 115 KV line. Therefore, this alternative adds the Stegall-Story 230 without the addition of the Miracle Mile-Casper 230 KV line.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1H12	Dave Johnston–LRS 230	Dave Johnston-Stegall 230	102.7% of 319 MVA	1741	**1717**	**317**
B1H11	Dave Johnston–LRS 230	Dave Johnston-Stegall 230	98.2% of 319 MVA	1701		

Option #1 – Allow Dave Johnston–Stegall 230 KV line to load to 110% of 319 MVA. This is not a problem as the 319 MVA rating is based on a wavetrap, the conductor rating is 478 MVA. Then the next limits are:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1H13	Dave Johnston–LRS 230	Lingle-White Rock 115	102.6% of 109 MVA	1809	**1774**	**374**
B1H12	Dave Johnston–LRS 230	Lingle-White Rock 115	97.6% of 109 MVA	1741		

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1H14	Dave Johnston–LRS 230	Alcova–Miracle M. 115	101% of 109 MVA	1823	**1817**	**418**
B1H13	Dave Johnston–LRS 230	Alcova–Miracle M. 115	98.5% of 109 MVA	1809		

Option #2 – Allow Dave Johnston–Stegall 230 KV line to load to 110% of 319 MVA. Allow the Lingle-White Rock 115 KV, and Alcova-Miracle Mile 115 KV lines load to 104% and 100% respectively. These loadings are within their emergency rating of 110% of 109 MVA (120 MVA). Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1H14	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	101.2% of 442 MVA	1823	**1818**	**418**
B1H13	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	98% of 442 MVA	1809		

Alternative I = C + Stegall-Ault 230

This alternative is the same as H but a Stegall-Ault 230 KV line is added instead of a Stegall-Story 230 KV line.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1I12	Dave Johnston–LRS 230	Dave Johnston-Stegall 230	104% of 319 MVA	1746	**1711**	**312**
B1I11	Dave Johnston–LRS 230	Dave Johnston-Stegall 230	99.5% of 319 MVA	1707		

Option #1 – Allow Dave Johnston–Stegall 230 KV line to load to 106% of 319 MVA. This is not a problem as the 319 MVA rating is based on a wavetrap, the conductor rating is 478 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1I13	Dave Johnston–LRS 230	Lingle-White Rock 115	103.7% of 109 MVA	1813	**1766**	**366**
B1I12	Dave Johnston–LRS 230	Lingle-White Rock 115	98.4% of 109 MVA	1746		

Option #2 – Allow Dave Johnston–Stegall 230 KV line to load to 111% of 319 MVA. Allow the Lingle-White Rock 115 KV line to load to 105%. This loading is within its emergency rating of 110% of 109 MVA (120 MVA). Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1I14	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	101.1% of 442 MVA	1827	**1822**	**422**
B1I13	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	97.9% of 442 MVA	1813		

Alternative J = C + WyoDak-Dave Johnston-Stegall-Story 230

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
B1J15	LRS-Ault 345	Archer-Ault 230	99% of 462 MVA	1935	**1954**	**554**
B1J14	LRS-Ault 345	Archer-Ault 230	95.2% of 462 MVA	1863		

Alternative K = C + WyoDak-Dave Johnston-Stegall-Ault 230

Case Name	Forced Outage	Low Bus voltage	Voltage	TOT3	TOT3 Increase
B1K18	LRS-Ault 345	Mcgrew 115	0.905 pu	2022	**622**

The next higher increment of TOT3 transfer fails to solve. Therefore case B1K18 is considered at TOT3 limit case for this condition.

4.3 DC Ties West to East

Alternative A – Existing System

Case Name	Forced Outage	Limiting Facility	Voltage	TOT3	Interpolated TOT3 Limit
C1A5	LRS-Ault 345	Laramie 115	0.889	1217	**1186**
C1A4	LRS-Ault 345	Laramie 115	0.904	1175	

Alternative B – Miracle Mile Project

Case Name	Forced Outage	Limiting Facility	Voltage	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1B6	N. Yuma-Story 230	Vernon LM 115	0.895	1313	**1272**	**86**
C1B5	N. Yuma-Story 230	Vernon LM 115	0.903	1247		

Alternative C – Add Archer Tap of LRS-Story 345 KV line

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1C6	Sidney-Stegall 230	Gering-McGrew 115	103.9% of 109 MVA	1293	**1218**	**32**
C1C5	Sidney-Stegall 230	Gering-McGrew 115	100.4% of 109 MVA	1226		

Option #1 – Allow Gering-McGrew 115 KV line to load to 110% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit 110% Overload	TOT3 Increase
C1C8	Sidney-Stegall 230	Gering-McGrew 115	110.2% of 109 MVA	1412	**1408**	**221**
C1C7	Sidney-Stegall 230	Gering-McGrew 115	107.8% of 109 MVA	1359		

Increasing the rating of the Gering-Mcgrew 115 KV line to 115% of 109 MVA (125 MVA) would allow a TOT3 limit of 1493 MW, a **307 MW** increase

Alternative D = C + Casper–Miracle Mile 230

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1D6	Sidney-Stegall 230	Gering-McGrew 115	102.3% of 109 MVA	1307	**1244**	**58**
C1D5	Sidney-Stegall 230	Gering-McGrew 115	99.8% of 109 MVA	1239		

Option #1 – Allow Gering-McGrew 115 KV line to load to 109% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1D9	Laramie-Cheyenne 230	Gem City-H.Jack 115	104.2% of 120 MVA	1482	**1446**	**260**
C1D8	Laramie-Cheyenne 230	Gem City-H.Jack 115	98.1% of 120 MVA	1430		

Option #2 – Allow Gering-McGrew 115 KV line to load to 110% of 109 MVA and the Gem City-Happy Jack 115 KV line to load to 102% of 120 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit 110% Overload	TOT3 Increase
C1D9	Sidney-Stegall 230	Gering-McGrew 115	110.8% of 109 MVA	1482	**1465**	**278**
C1D8	Sidney-Stegall 230	Gering-McGrew 115	108.4% of 109 MVA	1430		

Alternative E = D + Casper–Wyodak 230

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1E6	Sidney-Stegall 230	Gering-McGrew 115	102% of 109 MVA	1311	**1270**	**84**
C1E5	Sidney-Stegall 230	Gering-McGrew 115	98.6% of 109 MVA	1241		

Option #1 – Allow Gering-McGrew 115 KV line to load to 107% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1E8	Laramie-Cheyenne 230	Gem City-H.Jack 115	102.6% of 120 MVA	1434	**1409**	**223**
C1E7	Laramie-Cheyenne 230	Gem City-H.Jack 115	96.8% of 120 MVA	1379		

Option #2 – Allow Gering-McGrew 115 KV line to load to 110% of 109 MVA and the Gem City-Happy Jack 115 KV line to load to 107% of 120 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit 110% Overload	TOT3 Increase
C1E9	Sidney-Stegall 230	Gering-McGrew 115	110.4% of 109 MVA	1486	**1477**	**291**
C1E8	Sidney-Stegall 230	Gering-McGrew 115	108% of 109 MVA	1434		

Alternative F = E + Stegall-Story 230

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1F9	Laramie-Cheyenne 230	Gem City-H.Jack 115	105.7% of 120 MVA	1501	**1447**	**261**
C1F8	Laramie-Cheyenne 230	Gem City-H.Jack 115	100.1% of 120 MVA	1448		

Option #1 – Allow Gem City-Happy Jack 115 KV line to load to 109% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1F10	Dave Johnston-LRS 230	Dave Johnston-Stegall 230	100.8% of 319 MVA	1534	**1526**	**340**
C1F9	Dave Johnston–LRS 230	Dave Johnston-Stegall 230	97.6% of 319 MVA	1501		

Option #2 – Allow Gem City-Happy Jack 115 KV line to load to 109% of 120 MVA and the Dave Johnston-Stegall 230 KV line to load to 100% of 319 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1F10	Sidney-Stegall 230	Gering-McGrew 115	100.5% of 109 MVA	1534	**1526**	**340**
C1F9	Sidney-Stegall 230	Gering-McGrew 115	98.5% of 109 MVA	1501		

Option #3 – Allow Gem City-Happy Jack 115 KV line to load to 110% of 120 MVA, Dave Johnston-Stegall 230 KV line to load to 101% of 319 MVA, and the Gering-McGrew 115 KV line to load to 100% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit 110% Overload	TOT3 Increase
C1F10	Laramie-Cheyenne 230	Gem City-H.Jack 115	109.8% of 120 MVA	1534	**1536**	**349**
C1F9	Laramie-Cheyenne 230	Gem City-H.Jack 115	105.7% of 120 MVA	1501		

Alternative G = E + Stegall-Ault 230

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1G9	Laramie-Cheyenne 230	Gem City-H.Jack 115	105% of 120 MVA	1504	**1457**	**270**
C1G8	Laramie-Cheyenne 230	Gem City-H.Jack 115	99.4% of 120 MVA	1451		

Option #1 – Allow Gem City-Happy Jack 115 KV line to load to 101% of 120 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1G9	Sidney-Stegall 230	Gering-McGrew 115	101.6% of 109 MVA	1504	**1464**	**277**
C1G8	Sidney-Stegall 230	Gering-McGrew 115	99.5% of 109 MVA	1451		

Option #2 – Allow Gem City-Happy Jack 115 KV line to load to 107% of 120 MVA and the Gering-McGrew 115 KV line to load to 103% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1G10	Dave Johnston - LRS 230	Dave Johnston - Stegall 230	101.8% of 319 MVA	1536	**1517**	**331**
C1G9	Dave Johnston – LRS 230	Dave Johnston - Stegall 230	98.7% of 319 MVA	1504		

Option #3 – Allow Gem City-Happy Jack 115 KV line to load to 110% of 120 MVA, Gering-McGrew 115 KV line to load to 104% of 109 MVA, and the Dave Johnston-Stegall 230 KV line to load to 102% of 319 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit 110% Overload	TOT3 Increase
C1G11	Laramie-Cheyenne 230	Gem City-H.Jack 115	115.2% of 120 MVA	1565	**1540**	**354**
C1G10	Laramie-Cheyenne 230	Gem City-H.Jack 115	109.2% of 120 MVA	1536		

Alternative H = C + Stegall-Story 230

This alternative is similar to Alternative F. Alternative F included a Miracle Mile-Casper 230 KV line and was limited by Gem City-Happy Jack 115 KV line overloads. It is possible the Miracle Mile-Casper 230 KV line increased flow-ability on the Gem City-Happy Jack 115 KV line. Therefore, this alternative adds the Stegall-Story 230 without the addition of the Miracle Mile-Casper 230 KV line.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1H8	Dave Johnston– LRS 230	Dave Johnston-Stegall 230	100.2% of 319 MVA	1430	**1428**	**242**
C1H7	Dave Johnston– LRS 230	Dave Johnston-Stegall 230	93.9% of 319 MVA	1376		

Option #1 – Allow Dave Johnston–Stegall 230 KV line to load to 107% of 319 MVA. This is not a problem as the 319 MVA rating is based on a wavetrap, the conductor rating is 478 MVA. Then the next limits are:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1H9	Dave Johnston–LRS 230	Lingle-White Rock 115	101.2% of 109 MVA	1482	**1471**	**285**
C1H8	Dave Johnston–LRS 230	Lingle-White Rock 115	95.6% of 109 MVA	1430		

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1H9	Sidney-Stegall 230	Gering-McGrew 115	100.2% of 109 MVA	1482	**1477**	**291**
C1H8	Sidney-Stegall 230	Gering-McGrew 115	98.1% of 109 MVA	1430		

Option #2 – Allow Dave Johnston–Stegall 230 KV line to load to 115% of 319 MVA. Allow the Lingle-White Rock 115 KV and Gering-McGrew 115 KV lines load to 108% and 103% respectively. These loadings are within their emergency rating of 110% of 109 MVA (120 MVA). Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1H11	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	101.3% of 442 MVA	1540	**1533**	**347**
C1H10	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	96.3% of 442 MVA	1514		

Alternative I = C + Stegall-Ault 230

This alternative is the same as H but a Stegall-Ault 230 KV line is added instead of a Stegall-Story 230 KV line.

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1I8	Dave Johnston–LRS 230	Dave Johnston-Stegall 230	101.3% of 319 MVA	1434	**1423**	**236**
C1I7	Dave Johnston–LRS 230	Dave Johnston-Stegall 230	95% of 319 MVA	1379		

Option #1 – Allow Dave Johnston–Stegall 230 KV line to load to 106% of 319 MVA. This is not a problem as the 319 MVA rating is based on a wavetrap, the conductor rating is 478 MVA. Then the next limits are:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1I8	Sidney-Stegall 230	Gering-McGrew 115	101.1% of 109 MVA	1434	**1405**	**219**
C1I7	Sidney-Stegall 230	Gering-McGrew 115	99% of 109 MVA	1379		

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1I9	Dave Johnston–LRS 230	Lingle-White Rock 115	102.2% of 109 MVA	1486	**1466**	**280**
C1I8	Dave Johnston–LRS 230	Lingle-White Rock 115	96.4% of 109 MVA	1434		

Option #2 – Allow Dave Johnston–Stegall 230 KV line to load to 116% of 319 MVA. Allow the Gering-McGrew 115 KV, and the Lingle-White Rock 115 KV lines to load to 106% and 109% respectively. These loadings are within its emergency rating of 110% of 109 MVA (120 MVA). Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1I11	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	101.4% of 442 MVA	1543	**1536**	**349**
C1I10	Dave Johnston-Stegall 230	Dave Johnston-LRS 230	96.3% of 442 MVA	1516		

Alternative J = C + WyoDak-Dave Johnston-Stegall-Story 230

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1J8	Sidney-Stegall 230	Gering-McGrew 115	101.3% of 109 MVA	1465	**1429**	**242**
C1J7	Sidney-Stegall 230	Gering-McGrew 115	99.3% of 109 MVA	1409		

Option #1 – Allow Gering-McGrew 115 KV line to load to 110% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit 110% Overload	TOT3 Increase
C1J13	Sidney-Stegall 230	Gering-McGrew 115	112.3% of 109 MVA	1693	**1646**	**459**
C1J12	Sidney-Stegall 230	Gering-McGrew 115	108.9% of 109 MVA	1623		

Alternative K = C + WyoDak-Dave Johnston-Stegall-Ault 230

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit	TOT3 Increase
C1K7	Sidney-Stegall 230	Gering-McGrew 115	102.5% of 109 MVA	1414	**1350**	**164**
C1K8	Sidney-Stegall 230	Gering-McGrew 115	104.7% of 109 MVA	1470		

Option #1 – Allow Gering-McGrew 115 KV line to load to 110% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Overload	TOT3	Interpolated TOT3 Limit 110% Overload	TOT3 Increase
C1K12	Sidney-Stegall 230	Gering-McGrew 115	113% of 109 MVA	1627	**1568**	**382**
C1K11	Sidney-Stegall 230	Gering-McGrew 115	110.9% of 109 MVA	1586		

Option #2 – Allow Gering-McGrew 115 KV line to load to 120% of 109 MVA. Then the next limit is:

Case Name	Forced Outage	Limiting Facility	Voltage	TOT3	Interpolated TOT3 Limit 120% Overload	TOT3 Increase
C1K14	LRS-Ault	McGrew 115	0.93 p.u.	1712	**1751**	**565**
C1K15	LRS-Ault	McGrew 115	0.878 p.u.	1781		

APPENDIX A

POWERFLOW AND STABILITY RESULTS

See “Appendix A-BEPC-2006-TOT3 Study.pdf”

APPENDIX B

COST ESTIMATES

ALTERNATIVE C

Substation	Item	Unit Cost	Number	Total Costs
Archer Tap	230KV Bay	$900,000	2	$1,800,000
	345KV Bay	$1,300,000	3	$3,900,000
	345/230KV Transformer	$3,000,000	1	$3,000,000
Cheyenne	230KV Bay	$900,000	1	$900,000
Substation Subtotal				$9,600,000
Line		Cost per Mile	Miles	Total Costs
Archer-Cheyenne 230 KV		$315,000	10	$3,150,000
Line Subtotal				$3,150,000
2nd Sidney 230/115KV	230/115KV Transformer	$1,200,000	1	$1,200,000
	230KV Bay	$900,000	1	$900,000
	115KV Bay	$750,000	1	$750,000
Substation Subtotal				$2,850,000

TOTAL COST **$15,600,000**

ALTERNATIVE D

Substation	Item	Unit Cost	Number	Total Costs
Archer Tap	230KV Bay	$900,000	2	$1,800,000
	345KV Bay	$1,300,000	3	$3,900,000
	345/230KV Transformer	$3,000,000	1	$3,000,000
Cheyenne	230KV Bay	$900,000	1	$900,000
Substation Subtotal				$9,600,000
Line		Cost per Mile	Miles	Total Costs
Archer-Cheyenne 230 KV		$315,000	10	$3,150,000
Line Subtotal				$3,150,000

Substation	Item	Unit Cost	Number	Total Costs
Casper	230KV Bay	$900,000	1	$900,000
Miracle Mile	230KV Bay	$900,000	1	$900,000
Substation Subtotal				$1,800,000
Line		Cost per Mile	Miles	Total Costs
Casper-Miracle Mile 230 KV		$315,000	52	$16,380,000
Line Subtotal				$16,380,000
2nd Sidney 230/115KV	230/115KV Transformer	$1,200,000	1	$1,200,000
	230KV Bay	$900,000	1	$900,000
	115KV Bay	$750,000	1	$750,000
Substation Subtotal				$2,850,000

TOTAL COST **$33,780,000**

ALTERNATIVE F

Substation	Item	Unit Cost	Number	Total Costs
Archer Tap	230KV Bay	$900,000	2	$1,800,000
	345KV Bay	$1,300,000	3	$3,900,000
	345/230KV Transformer	$3,000,000	1	$3,000,000
Cheyenne	230KV Bay	$900,000	1	$900,000
Substation Subtotal				$9,600,000

Line	Cost per Mile	Miles	Total Costs
Archer-Cheyenne 230 KV	$315,000	10	$3,150,000
Line Subtotal			$3,150,000

Substation	Item	Unit Cost	Number	Total Costs
Casper	230KV Bay	$900,000	1	$900,000
Miracle Mile	230KV Bay	$900,000	1	$900,000
Substation Subtotal				$1,800,000

Line	Cost per Mile	Miles	Total Costs
Casper-Miracle Mile 230 KV	$315,000	52	$16,380,000
Line Subtotal			$16,380,000

Substation	Item	Unit Cost	Number	Total Costs
Stegall	230KV Bay	$900,000	1	$900,000
Story	230KV Bay	$900,000	2	$1,800,000
Substation Subtotal				$2,700,000

Line	Cost per Mile	Miles	Total Costs
Stegall-Story 230 KV	$315,000	120	$37,800,000
Line Subtotal			$37,800,000

2nd Sidney 230/115KV	230/115KV Transformer	$1,200,000	1	$1,200,000
	230KV Bay	$900,000	1	$900,000
	115KV Bay	$750,000	1	$750,000
Substation Subtotal				$2,850,000

TOTAL COST **$74,280,000**

ALTERNATIVE G

Substation	Item	Unit Cost	Number	Total Costs
Archer Tap	230KV Bay	$900,000	2	$1,800,000
	345KV Bay	$1,300,000	3	$3,900,000
	345/230KV Transformer	$3,000,000	1	$3,000,000
Cheyenne	230KV Bay	$900,000	1	$900,000
Substation Subtotal				$9,600,000
Line		Cost per Mile	Miles	Total Costs
Archer-Cheyenne 230 KV		$315,000	10	$3,150,000
Line Subtotal				$3,150,000

Substation	Item	Unit Cost	Number	Total Costs
Casper	230KV Bay	$900,000	1	$900,000
Miracle Mile	230KV Bay	$900,000	1	$900,000
Substation Subtotal				$1,800,000
Line		Cost per Mile	Miles	Total Costs
Casper-Miracle Mile 230 KV		$315,000	52	$16,380,000
Line Subtotal				$16,380,000

Substation	Item	Unit Cost	Number	Total Costs
Stegall	230KV Bay	$900,000	1	$900,000
Ault	230KV Bay	$900,000	2	$1,800,000
Substation Subtotal				$2,700,000
Line		Cost per Mile	Miles	Total Costs
Stegall-Ault 230 KV		$315,000	105	$33,075,000
Line Subtotal				$33,075,000
2nd Sidney 230/115KV	230/115KV Transformer	$1,200,000	1	$1,200,000
	230KV Bay	$900,000	1	$900,000
	115KV Bay	$750,000	1	$750,000
Substation Subtotal				$2,850,000

TOTAL COST **$69,555,000**

ALTERNATIVE H

Substation	Item	Unit Cost	Number	Total Costs
Archer Tap	230KV Bay	$900,000	2	$1,800,000
	345KV Bay	$1,300,000	3	$3,900,000
	345/230KV Transformer	$3,000,000	1	$3,000,000
Cheyenne	230KV Bay	$900,000	1	$900,000
Substation Subtotal				$9,600,000

Line	Cost per Mile	Miles	Total Costs
Archer-Cheyenne 230 KV	$315,000	10	$3,150,000
Line Subtotal			$3,150,000

Substation	Item	Unit Cost	Number	Total Costs
Stegall	230KV Bay	$900,000	1	$900,000
Story	230KV Bay	$900,000	2	$1,800,000
Substation Subtotal				$2,700,000

Line	Cost per Mile	Miles	Total Costs
Stegall-Story 230 KV	$315,000	120	$37,800,000
Line Subtotal			$37,800,000

2nd Sidney 230/115KV	230/115KV Transformer	$1,200,000	1	$1,200,000
	230KV Bay	$900,000	1	$900,000
	115KV Bay	$750,000	1	$750,000
Substation Subtotal				$2,850,000

TOTAL COST **$56,100,000**

ALTERNATIVE I

Substation	Item	Unit Cost	Number	Total Costs
Archer Tap	230KV Bay	$900,000	2	$1,800,000
	345KV Bay	$1,300,000	3	$3,900,000
	345/230KV Transformer	$3,000,000	1	$3,000,000
Cheyenne	230KV Bay	$900,000	1	$900,000
Substation Subtotal				$9,600,000
Line		Cost per Mile	Miles	Total Costs
Archer-Cheyenne 230 KV		$315,000	10	$3,150,000
Line Subtotal				$3,150,000

Substation	Item	Unit Cost	Number	Total Costs
Stegall	230KV Bay	$900,000	1	$900,000
Ault	230KV Bay	$900,000	2	$1,800,000
Substation Subtotal				$2,700,000
Line		Cost per Mile	Miles	Total Costs
Stegall-Ault 230 KV		$315,000	105	$33,075,000
Line Subtotal				$33,075,000
2nd Sidney 230/115KV	230/115KV Transformer	$1,200,000	1	$1,200,000
	230KV Bay	$900,000	1	$900,000
	115KV Bay	$750,000	1	$750,000
Substation Subtotal				$2,850,000

TOTAL COST **$51,375,000**

ALTERNATIVE J

Substation	Item	Unit Cost	Number	Total Costs
Archer Tap	230KV Bay	$900,000	2	$1,800,000
	345KV Bay	$1,300,000	3	$3,900,000
	345/230KV Transformer	$3,000,000	1	$3,000,000
Cheyenne	230KV Bay	$900,000	1	$900,000
Substation Subtotal				$9,600,000
Line		Cost per Mile	Miles	Total Costs
Archer-Cheyenne 230 KV		$315,000	10	$3,150,000
Line Subtotal				$3,150,000

Substation	Item	Unit Cost	Number	Total Costs
Stegall	230KV Bay	$900,000	1	$900,000
Story	230KV Bay	$900,000	2	$1,800,000
Substation Subtotal				$2,700,000
Line		Cost per Mile	Miles	Total Costs
Stegall-Story 230 KV		$315,000	120	$37,800,000
Line Subtotal				$37,800,000

Substation	Item	Unit Cost	Number	Total Costs
Stegall	230KV Bay	$900,000	1	$900,000
Dave Johnston	230KV Bay	$900,000	2	$1,800,000
Substation Subtotal				$2,700,000
Line		Cost per Mile	Miles	Total Costs
Stegall-Dave Johnston 230 KV		$315,000	126	$39,690,000
Line Subtotal				$39,690,000
2nd Sidney 230/115KV	230/115KV Transformer	$1,200,000	1	$1,200,000
	230KV Bay	$900,000	1	$900,000
	115KV Bay	$750,000	1	$750,000
Substation Subtotal				$2,850,000

TOTAL COST **$98,490,000**

ALTERNATIVE K

Substation	Item	Unit Cost	Number	Total Costs
Archer Tap	230KV Bay	$900,000	2	$1,800,000
	345KV Bay	$1,300,000	3	$3,900,000
	345/230KV Transformer	$3,000,000	1	$3,000,000
Cheyenne	230KV Bay	$900,000	1	$900,000
Substation Subtotal				$9,600,000
Line		Cost per Mile	Miles	Total Costs
Archer-Cheyenne 230 KV		$315,000	10	$3,150,000
Line Subtotal				$3,150,000

Substation	Item	Unit Cost	Number	Total Costs
Stegall	230KV Bay	$900,000	1	$900,000
Ault	230KV Bay	$900,000	2	$1,800,000
Substation Subtotal				$2,700,000
Line		Cost per Mile	Miles	Total Costs
Stegall-Ault 230 KV		$315,000	105	$33,075,000
Line Subtotal				$33,075,000

Substation	Item	Unit Cost	Number	Total Costs
Stegall	230KV Bay	$900,000	1	$900,000
Dave Johnston	230KV Bay	$900,000	2	$1,800,000
Substation Subtotal				$2,700,000
Line		Cost per Mile	Miles	Total Costs
Stegall-Dave Johnston 230 KV		$315,000	126	$39,690,000
Line Subtotal				$39,690,000
2nd Sidney 230/115KV	230/115KV Transformer	$1,200,000	1	$1,200,000
	230KV Bay	$900,000	1	$900,000
	115KV Bay	$750,000	1	$750,000
Substation Subtotal				$2,850,000

TOTAL COST **$93,765,000**