Cluster 1 & 2 Deliverability Analysis without Expensive and Long-Lead Network Upgrades

Objective

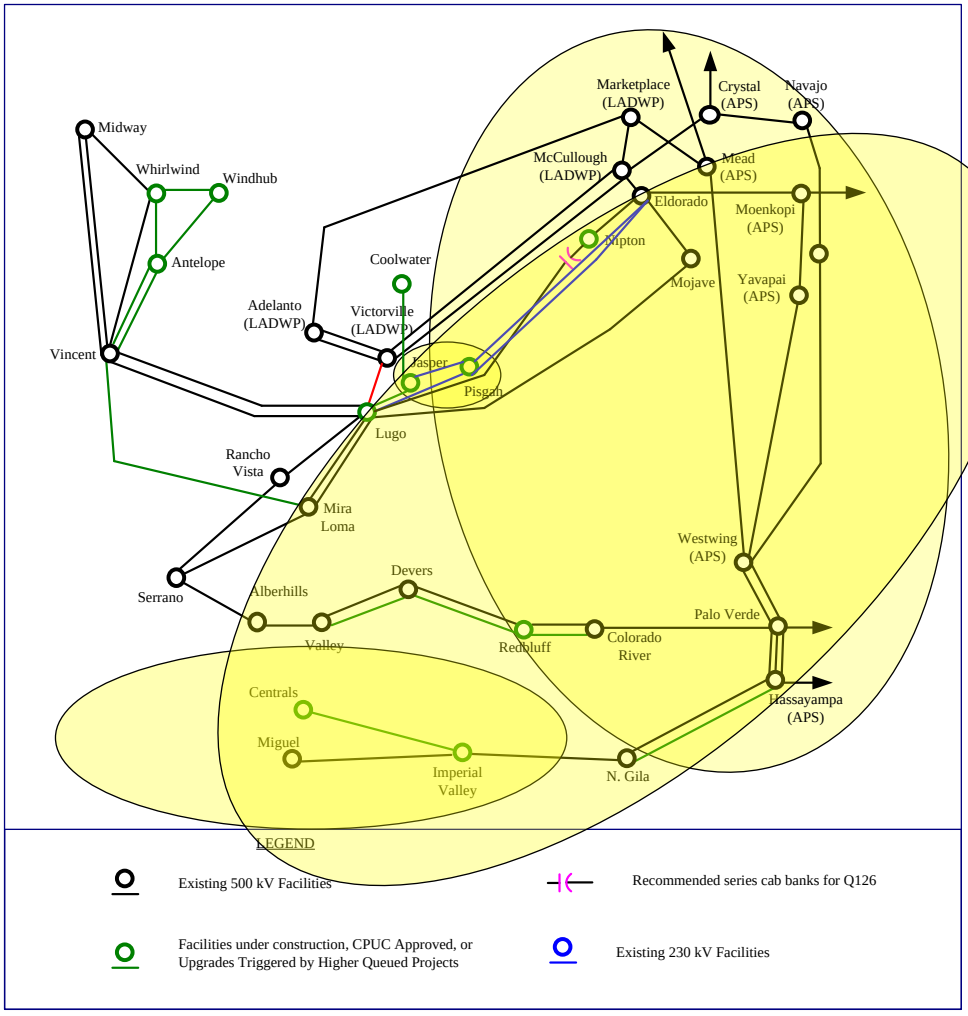
This analysis was performed pursuant to the October 31, 2012 Technical Bulletin on Cluster 1-4 Deliverability Procedures and for the sole purpose of applying those procedures to Cluster 1 & 2. The following projects and upgrades met the criteria for removal:

- Mohave–Lugo 500 kV line loop-in at Pisgah 500 kV Substation and series capacitor banks on both Pisgah–Nipton and Pisgah–Mohave 500 kV lines
- A 31 miles of new Colorado River – Red Bluff No.3 line
- A 103 miles of new Red Bluff – Valley 500 kV line with series cap banks
- Upgrade of Pisgah 230kV substation to 500kV substation and Lugo – Eldorado 500kV line loop-in at Pisgah 500kV bus
- Tearing down Pisgah – Lugo 230kV No. 2 line and the new Pisgah – Lugo 500kV No. 1 line
- Q72 and associated upgrades

The following network upgrades and modifications were modeled due to the removal of the above elements:

- The 3rd Lugo 500/230 kV transformer bank. The transformer bank is required for the Cluster 1 & 2 projects in the North of Lugo area. In addition, the deliverability sensitivity study on the 2011/12 Base 33% renewable portfolio has identified the need for the transformer bank if Pisgah 500kV upgrade were not built.
- New Coolwater – Jasper – Lugo 230 kV line. The line is required for Serial Group projects that have signed LGIA (Q125 and Q135), and Q125 has a CPUC approved PPA. The new Jasper – Lugo line is built by tearing down portion of the existing Lugo – Pisgah 230 kV No. 1 line. In this study we replace Lugo – Pisgah 230 kV No. 1 line with Lugo – Jasper 230 kV line and Jasper – Pisgah 230 kV line. The Lugo – Jasper 230 kV line is rebuilt with higher rating and the Jasper – Pisgah 230 kV line has the same rating as the existing line.
- Lugo – Eldorado 500kV loop-in at Nipton 500 kV substation is required to interconnect a Serial Group project Q126 and will be modeled. There are two existing series capacitors on the Lugo – Eldorado 500 kV line. The study assumes that the Eldorado series capacitor is replaced by a new series capacitor at Nipton to maintain the same level of compensation as the existing line. The existing series capacitor at Lugo substation has a low rating and is normally by-passed. In this study the Lugo series capacitor is initially assumed bypassed. Then a sensitivity study is performed with this series capacitor upgraded.

The figure below shows the transmission system to be modeled. The four shaded oval areas in the diagram below represent deliverability constraints and the general location of four groups of generation affected by those constraints.



Summary of Results – Desert[1] Area Constraints

Table 1 provides a very high level summary of the range of MWs that are deliverable without the delivery network upgrades identified above. Given that there is approximately 11,300 MW of generation in the ISO queue that significantly flow across the deliverability constraints described in detail later, approximately 6,000 MW to 7,900 MW can be accommodated as fully deliverable without the need for the major upgrades listed above. Approximately 8,100 MW to 9,300 MW can be accommodated as fully deliverable with the series capacitor in the Lugo – Nipton 500kV line upgraded. As a comparison, the renewable portfolios under study in the 2011/2012 ISO transmission planning process have no more than approximately 7000 MW of renewable generation that significantly flow across these constraints.

[1] The Desert Area refers to generating resources electrically located in the following renewable energy zones: Pisgah, Mountain Pass, Nevada C, New Mexico, Palm Springs, Riverside East, San Diego South, Imperial, and Arizona.

Table 1. Summary of Results – SCE Area

Deliverable MW in Desert area	Low End of Range	High End of Range
Without upgrading Nipton – Lugo series cap at Lugo	6058	7887
With upgrading Nipton – Lugo series cap at Lugo	8177	9302

Summary of Results – SDG&E Area Constraint

Table 2 provides the approximate number of MWs that are deliverable if Q72 and its associated transmission upgrades are not in-service. Given that there is approximately 3,800 MW of generation in the ISO queue that significantly flow across the deliverability constraint described in detail later, approximately 2,400 MW to 3,200 MW can be accommodated as fully deliverable without the need for major upgrades similar to Q72 upgrades. As a comparison, the renewable portfolios under study in the 2011/2012 ISO transmission planning process have no more than approximately 1,000 MW to 2,000 MW of generation that significantly flow across the constraint.

Table 2. Summary of Results – SDG&E Area

	Low End of Range	High End of Range
Deliverable MW in SDG&E area	2400	3200

Methodology and Assumptions

The total generation in the generation interconnection queue up to Cluster 1 & 2 exceeds the deliverability provided by the transmission system. Some of the generation projects were removed to determine the deliverable amount of MW in the affected areas. The amount of deliverable MW depends on where the generator projects are removed. Therefore a range, instead of a fixed number, of the deliverable MW was identified in the analysis.

The analysis consisted of the following major steps for the Desert area study (similar assumptions are used for the SDG&E area study):

1. The Cluster 1 & 2 East of Lugo (EOL) base case (SDG&E area base case for the SDG&E area study) was modified to represent the transmission system described above.
2. Ran deliverability assessment and identified all the deliverability constraints.
3. Built minimum generation withdrawal scenario based on the deliverability study results.
4. Tested deliverability for the minimum generation withdrawal scenario. Step 3 and 4 were repeated until there were no more deliverability constraints identified.
5. Built maximum generation withdrawal scenario based on the deliverability study results.
6. Tested deliverability for the maximum generation withdrawal scenario. Step 5 and 6 were repeated until there were no more deliverability constraints identified.

Two scenarios associated with the series capacitor bank in the Lugo – Nipton 500kV line at Lugo Substation were studied.

- Scenario A: bypass the Lugo series capacitor in the Lugo – Nipton line
- Scenario B: upgrade the Lugo series capacitor in the Lugo – Nipton line

Results – Desert Area

Table 3 and 4 list all the deliverability constraints identified in the Desert area study.

Table 3. Deliverability constraints – Scenario A

Contingency	Limiting Facility
Normal condition	Lugo - Pisgah 230 kV No. 2
Lugo - Jasper 230 kV No. 1 & Lugo - Pisgah 230 kV No. 2	Pisgah - Cima - Eldorado 230 kV No. 1
	Pisgah - Eldorado 230 kV No. 2
	Kramer - Lockhart 230 kV No. 1
Devers - Red Bluff 500 kV No. 1 & No. 2	N. Gila - Imperial Valley 500 kV No. 1
	Lugo - Victorville 500 kV No. 1
Red Bluff - Colorado River 500 kV No. 1 & No. 2	N. Gila - Imperial Valley 500 kV No. 1
	Lugo - Victorville 500 kV No. 1

Table 4. Deliverability constraints – Scenario B

Contingency	Limiting Facility
Normal condition	Lugo - Pisgah 230 kV No. 2
Lugo - Jasper 230 kV No. 1 & Lugo - Pisgah 230 kV No. 2	Pisgah - Cima - Eldorado 230 kV No. 1
	Pisgah - Eldorado 230 kV No. 2
	Kramer - Lockhart 230 kV No. 1
Eldorado – Mohave 500 kV No. 1	Lugo – Nipton 500 kV No. 1
Palo Verde – Colorado River 500 kV No. 1	Lugo – Nipton 500 kV No. 1
Lugo – Victorville 500 kV No. 1	Eldorado – Nipton 500 kV No. 1
Lugo - Nipton 500 kV No. 1	Lugo – Victorville 500 kV No. 1
Devers - Red Bluff 500 kV No. 1 & No. 2	N. Gila - Imperial Valley 500 kV No. 1
Red Bluff - Colorado River 500 kV No. 1 & No. 2	N. Gila - Imperial Valley 500 kV No. 1
	Eldorado – Nipton 500kV No. 1

<u>Lowest level of generation withdrawal need under Scenario A</u>

Approximately 3420 MW generation are needed to withdraw:

- 600 MW in San Diego area
- 1250 MW at Pisgah
- 1570 MW in Riverside East area

The withdrawal amount at Pisgah is driven by the normal overload on Lugo – Pisgah 230 kV No. 2 line. The withdrawal amount in Riverside East area is driven by the emergency overload on the series capacitor in the N. Gila – Imperial Valley 500 kV line

Highest level of generation withdrawal need under Scenario A

Approximately 5249 MW generation are needed to withdraw if the withdrawals are not at the most effective locations:

- 600 MW in San Diego area
- 1650 MW at Pisgah
- 1070 MW in Riverside East area
- 1929 MW in Mountain Pass area

The withdrawal amount at Pisgah is driven by the normal overload on Lugo – Pisgah 230 kV No. 2 line. The withdrawal amounts in Riverside East area and Mountain Pass area are driven by the emergency rating on the series capacitor in the N. Gila – Imperial Valley 500 kV line

Lowest level of generation withdrawal need under Scenario B

Approximately 2005 MW generation are needed to withdraw:

- 600 MW in San Diego area
- 1250 MW at Pisgah
- 155 MW in Mountain Pass

The withdrawal amount at Pisgah is driven by the normal rating on Lugo – Pisgah 230 kV No. 2 line. The withdrawal amount in Mountain Pass area is driven by the emergency rating on the Eldorado – Nipton 500kV line and Lugo – Nipton 500 kV line.

Highest level of generation withdrawal need under Scenario B

Approximately 3130 MW generation are needed to withdraw if the withdrawals are not at the most effective locations:

- 600 MW in San Diego area
- 1650 MW at Pisgah
- 310 MW in Mountain Pass
- 570 MW in Riverside East area

The withdrawal amount at Pisgah is driven by the normal rating on Lugo – Pisgah 230 kV No. 2 line. The withdrawal amounts in Mountain Pass area and Riverside East area are driven by the emergency rating on the Eldorado – Nipton 500kV line and Lugo – Nipton 500 kV line.

Table 5 lists the combined set of proposed generation projects for all the deliverability constraints and Table 6 and 7 list the shift factors on the constraints. The dispatch of proposed generation by CREZ in the lowest level of withdrawal cases are also shown in Table 6 and 7.

Table 5. Generation Projects Contributing to the Desert Area Deliverability Constraints

Generation Projects Contributing to the SCE Area Deliverability Constraints			
Project Q#	POI	Pmax	CREZ
17	Colorado River 500kV	520	Riverside East (500 kV)
32	Boulevrd 138 kV	201	San Diego South
58	Control 115 kV	62	Kramer
68	Pisgah 230kV	850	Pisgah
103	Border 69 kV	27	SDG&E Non-CREZ
124	Imperial Valley 230 kV	600	Imperial – SDG&E
126	Nipton 230kV	500	Mountain Pass
131	Ivanpah 230kV	100	Mountain Pass
135	Jasper 230kV	60	San Bernardino - Lucerne
146	Redbluff 230 kV	150	Riverside East (500 kV)
147	Redbluff 230 kV	400	Riverside East (500 kV)
150	Border 69 kV	47.4	SDG&E Non-CREZ
156	Jasper 230kV	201	San Bernardino - Lucerne
162	Ivanpah 230kV	114	Mountain Pass
163	Ivanpah 230kV	300	Mountain Pass
193	Colorado River 230kV	500	Riverside East (500 kV)
219	Colorado River 500kV	50	Riverside East (500 kV)
233	Ivanpah 230kV	200	Mountain Pass
240	Pisgah 230kV	400	Pisgah
241	Pisgah 230kV	400	Pisgah
294	Colorado River 230kV	1000	Riverside East (500 kV)
297	Neenach 66 kV	66	Tehachapi 230kV
365	Redbluff 230 kV	500	Riverside East (500 kV)
421	Blythe 161 kV	49.5	Riverside East (161 kV)
429	Imperial Valley 230 kV	100	Imperial - SDG&E
442	Imperial Valley 230 kV	125	Imperial - SDG&E
467	Primm 230kV	230	Mountain Pass
493	IV - Central 500kV	299	Imperial - SDG&E
502	Primm 230kV	20	Mountain Pass
503	Eldorado 230kV	155	Mountain Pass
510	Imperial Valley 230 kV	200	Imperial - SDG&E
512	Neenach 66 kV	26	Tehachapi 230kV
552	Jasper 230kV	60	San Bernardino - Lucerne
561	Imperial Valley 230 kV	200	Imperial - SDG&E
565	Miguel - Sycamore 230 kV	100	SDG&E Non-CREZ
574	Otay Mesa 230 kV	308	SDG&E Non-CREZ
576	Colorado River 230kV	485	Riverside East (500 kV)
588	Redbluff 230 kV	200	Riverside East (500 kV)

590	Imperial Valley 230 kV	150	Imperial - SDG&E
593	Mohave 500kV	310	Mountain Pass
608	Imperial Valley 230 kV	250	Imperial - SDG&E
106A	Boulevrd 138 kV	160	San Diego South
159A	ECO 230 kV	400	San Diego South
WDT190	Vestal 66 kV	49.9	SCE Non-CREZ
WDT235	Goleta 66 kV	49.9	SCE Non-CREZ
WDT315	Casa Diablo 34 kV	40.7	Kramer
WDT425	Vestal 66 kV	51	SCE Non-CREZ
WDT433	Vestal 66 kV	40	SCE Non-CREZ
Total MW		11307.4	

Table 6: Shift factors by CREZ – Scenario A

Shift Factors and Dispatch by CREZ (Nipton-Lugo series capacitors bypassed at Lugo)							
Limiting Facility		Lugo - Pisgah 230kV No. 2		N. Gila - IV 500kV		Lugo - Victorville 500kV line	
Contingency		Normal		Red Bluff - Devers No. 1 & No. 2		Red Bluff - Devers No. 1 & No. 2	
	PMAX	Shift Factors	PGEN	Shift Factors	PGEN	Shift Factors	PGEN
Pisgah	1650	0.31	340	0.06	272	<.05	272
San Bernardino - Lucerne	321	0.06	192.4	0.06	113.1	<.05	113.1
Riverside East (500 kV)	3805	<.05	896.8	0.26	609	0.19	869.5
Riverside East (161 kV)	49.5	<.05	0	<.05	0	0.10	0
Mountain Pass	1929	<.05	1131.7	0.08 ~ 0.11	1131.7	0.08 ~ 0.24	1131.7
Imperial Valley - SDG&E	1924	<.05	0	<.05	0	0.10	382.5
San Diego South	761	<.05	96	<.05	96	0.09	352
SDG&E non-CREZ	482.4	<.05	0	<.05	0	0.05 ~ 0.06	0
SCE Non-CREZ	190.8	<.05	0	<.05	0	0.11 ~ 0.15	0
Kramer	102.7	<.05	42.2	<.05	42.2	0.09	42.2
Tehachapi 230kV	92	<.05	0	<.05	0	0.08	0

Table 7: Shift factors by CREZ – Scenario B

Shift Factors and Dispatch by CREZ (Nipton-Lugo series capacitors in-service at Lugo)									
Limiting Facility		Lugo - Pisgah 230kV No. 2		N. Gila - IV 500kV		Lugo - Nipton 500kV		Lugo - Victorville 500kV	
Contingency		Normal		Red Bluff - Devers No. 1 & No. 2		Palo Verde - Colorado River 500 kV		Lugo - Nipton 500kV	
	PMAX	Shift Factors	PGEN	Shift Factors	PGEN	Shift Factors	PGEN	Shift Factors	PGEN
Pisgah	1650	0.31	340	0.06	136	0.06	272	<.05	136
San Bernardino - Lucerne	321	0.06	192.4	0.06	113.1	0.05	113.1	<.05	113.1
Riverside East (500kV)	3805	<.05	620	0.26	1945	<.05	620	<.05	620
Riverside East (161kV)	49.5	<.05	0	<.05	0	0.12	0	0.13	0
Mountain Pass	1929	<.05	1026.3	0.07 ~ 0.1	1026.3	0.14 ~ 0.61	1155.9	0.11 ~ 0.3	1155.9
Imperial - SDG&E	1924	<.05	0	<.05	0	0.12	977.5	0.10	510
San Diego South	761	<.05	96	<.05	96	0.11	454.4	0.09	352
SDG&E Non-CREZ	482.4	<.05	0	<.05	0	0.05 ~ 0.08	478	0.05 ~ 0.06	478
SCE Non-CREZ	190.8	<.05	0	<.05	0	<.05	0	0.11 ~ 0.15	0
Kramer	102.7	<.05	42.2	<.05	42.2	<.05	42.2	0.09	42.2
Tehachapi 230kV	92	<.05	0	<.05	0	<.05	0	0.08	0

Results – SDG&E Area

Table 8 lists the deliverability constraints identified in the SDG&E area study.

Table 8. Deliverability constraints

Contingency	Limiting Facility
Normal condition	Path 43 (North of SONGS) path rating

Generation withdrawal need

Between 600 and 1400 MW of generation in the SDG&E area are required to withdraw. The first number is based on the assumption that Encina units 4, 5 and GT (644 MW total) and Cabrillo II generation (188 MW) will not choose to be repowered. If these units choose to be repowered, their deliverability may need to be preserved, and more generation may be needed to withdraw from the Queue.

Table 9 lists the set of proposed generation projects for the deliverability constraint and Table 10 lists the shift factors on the constraint. The proposed generation dispatch by CREZ in the lower level of withdrawal case is also shown in Table 10.

Table 9. Generation Projects Contributing to the North of SONGS Deliverability Constraint

Generation Projects Contributing to the North of SONGS Deliverability Constraint			
Project Q#	POI	Pmax	CREZ
13	Olivehain-Bernardo-Rancho Santa Fe 69kV line	40	Non-CREZ
32	Boulevard Station 138kV Bus	201	San Diego South
103	Border Sub 69 kV Bus	27	Non-CREZ
124	Imperial Valley Substation 230kV bus	600	Imperial – SDG&E
137	Encina Substation 230kV bus	260	Non-CREZ
150	Border Substation	47.4	Non-CREZ
189	Encina 138kV Substation	260	Non-CREZ
337	Borrego Substation 69kV	25.75	Non-CREZ
429	Imperial Valley Substation	100	Imperial - SDG&E
442	Imperial Valley 230kV	125	Imperial - SDG&E
493	Sunrise Powerlink 500kV line	299	Imperial - SDG&E
510	Imperial Valley Substation 230kV bus	200	Imperial - SDG&E
561	Imperial Valley Sub 230kV bus	200	Imperial - SDG&E
565	Miguel-Mission 230kV	100	Non-CREZ
574	Otay Mesa Sub 230kV Bus	308	Non-CREZ
590	Imperial Valley Sub 230kV bus	150	Imperial - SDG&E
608	Imperial Valley Sub 230kV bus	250	Imperial - SDG&E
106A	Boulevard Sub 138kV Bus	160	San Diego South
159A	Imperial Valley-Miguel new 230/500kV Sub 230kV bus	400	San Diego South
Total MW		3753	

Table 10: Shift Factors by CREZ

Shift Factors and Dispatch by CREZ			
Limiting Facility		Path 43 (North of SONGS)	
Contingency		Normal	
	PMAX	Shift Factors	PGEN
Imperial - SDG&E	1924	0.26	868.6
San Diego South	761	0.33	275.5
Non-CREZ	1068.15	0.59 - 0.42	1037.2

Attachment – Power Flow Plots

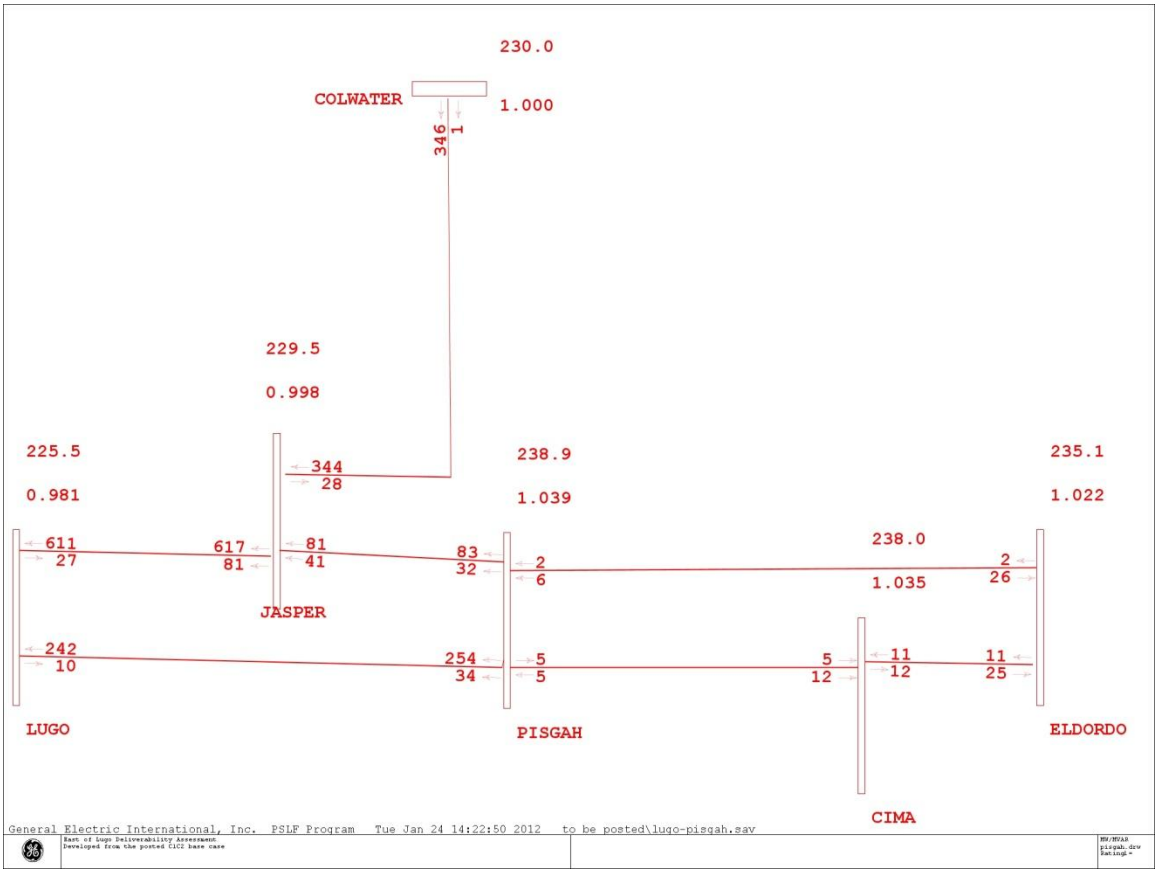


Figure 1: Lowest level of generation withdrawal under Scenario A: Lugo – Pisgah 230 kV is the limiting facility with all lines in service.

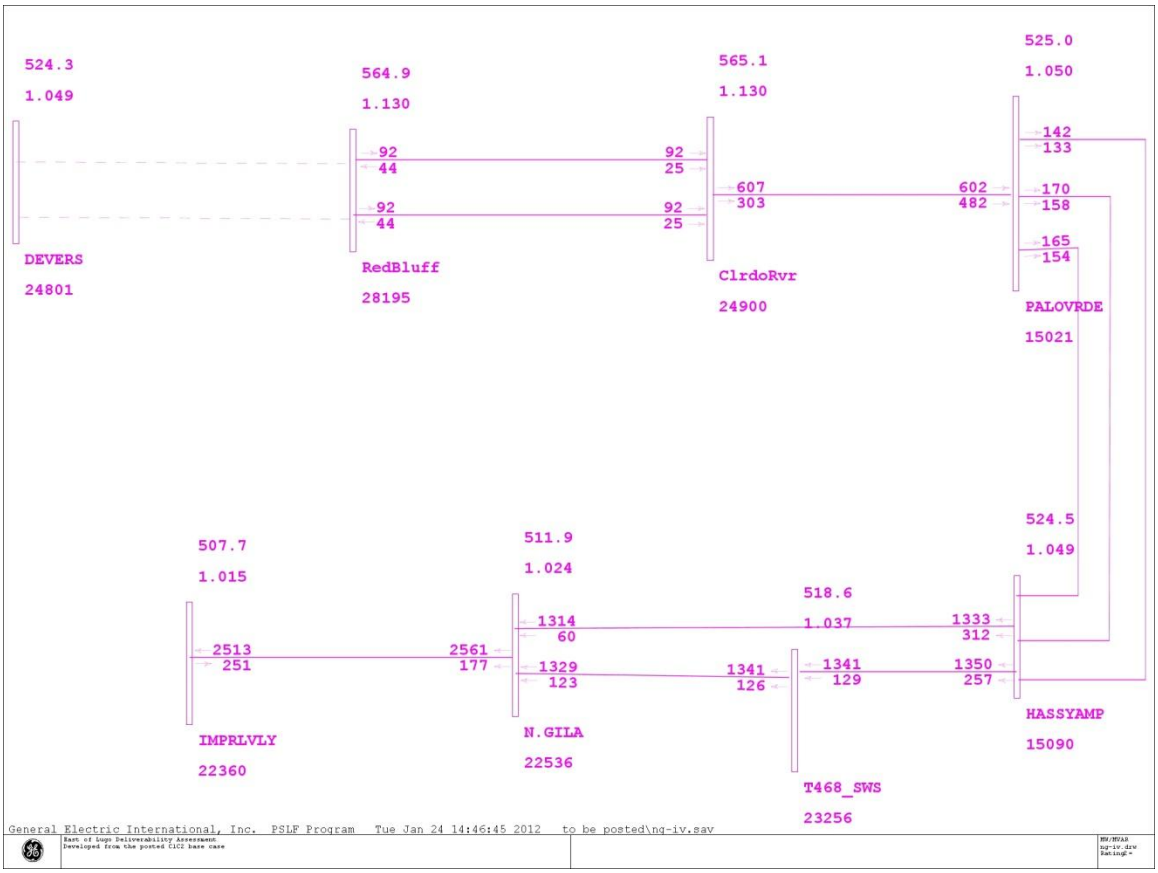


Figure 2: Lowest level of generation withdrawal under Scenario A: N. Gila – Imperial Valley 500 kV is a limiting facility with the outage of both Devers-Red Bluff 500 kV lines.

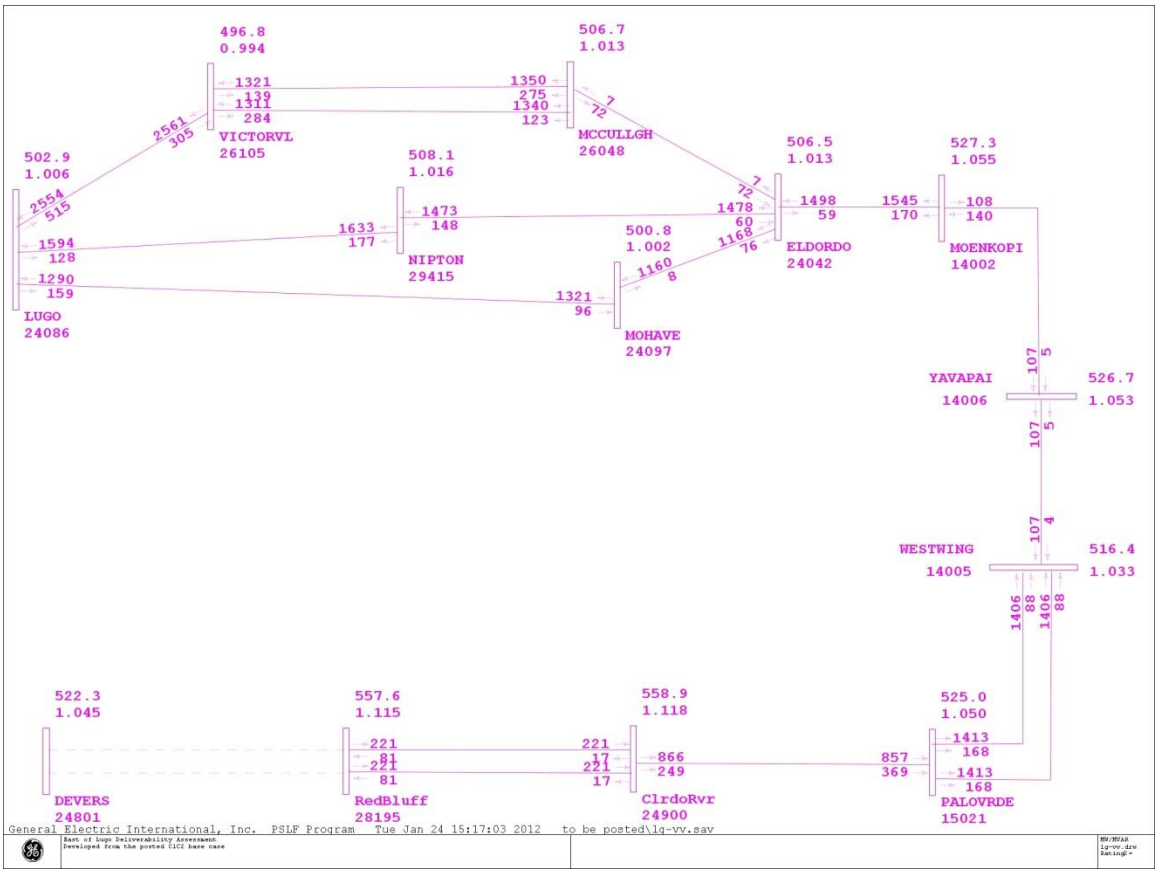


Figure 3: Lowest level of generation withdrawal under Scenario A: Lugo – Victorville 500 kV is a limiting facility with the outage of both Devers-Red Bluff 500 kV lines.

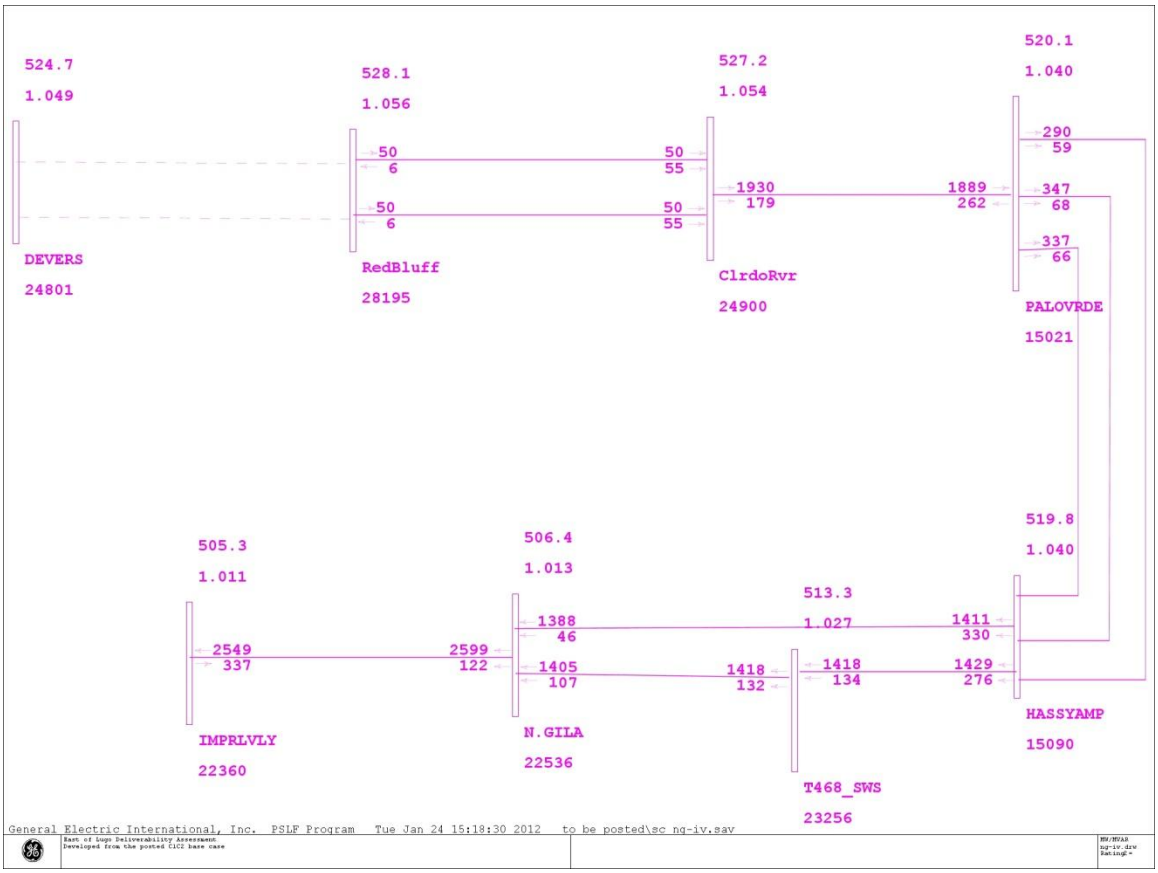


Figure 4: Lowest level of generation withdrawal under Scenario B: N. Gila – Imperail Valley 500 kV is a limiting facility with the outage of both Devers-Red Bluff 500 kV lines.

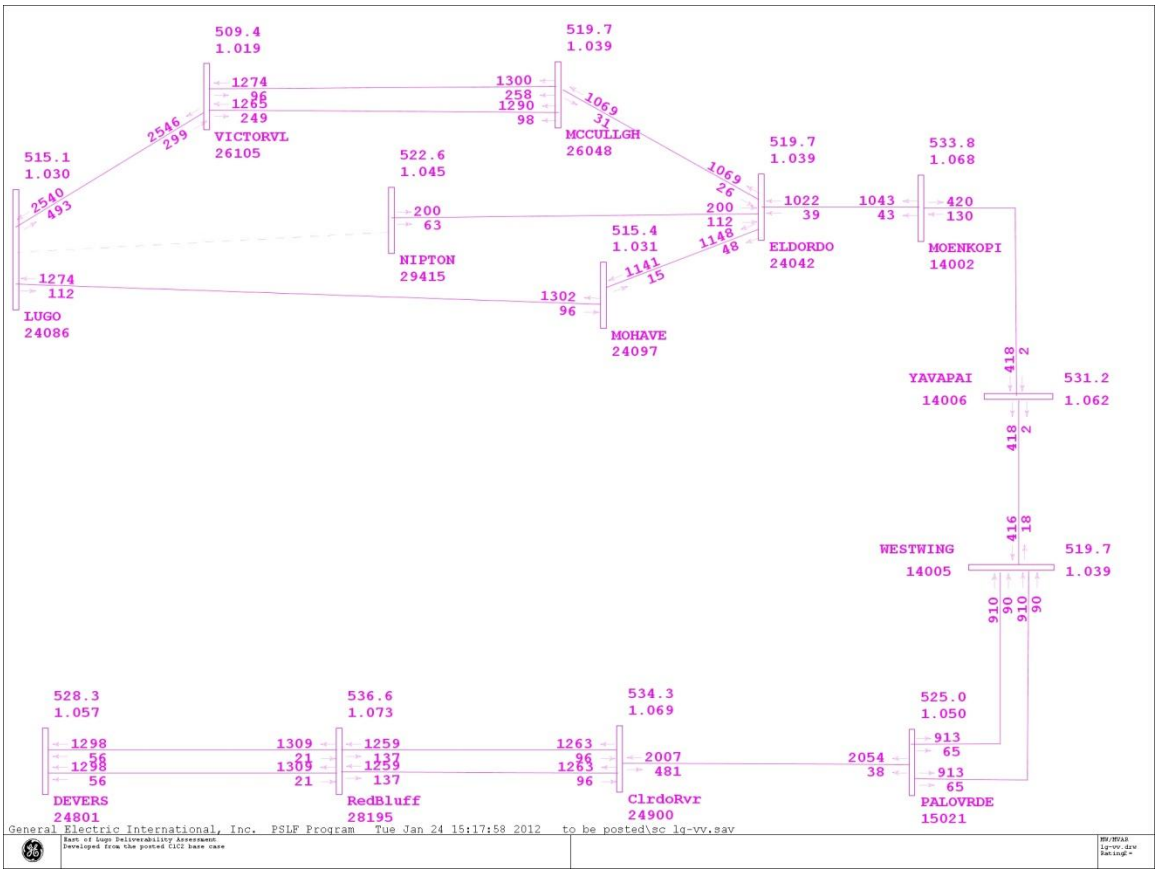


Figure 5: Lowest level of generation withdrawal under Scenario B: Lugo – Victorville 500 kV is a limiting facility with the outage of Lugo - Nipton 500 kV line.

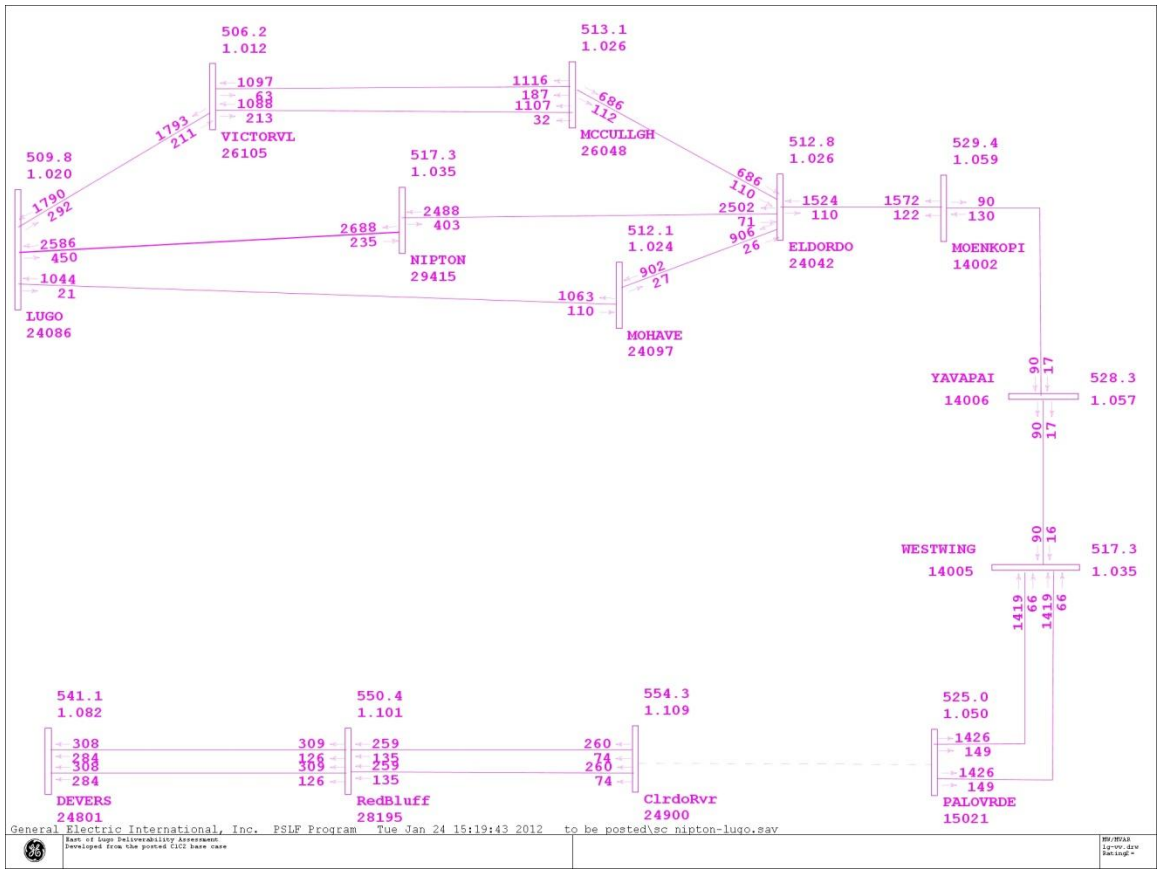


Figure 6: Lowest level of generation withdrawal under Scenario B: Lugo – Nipton 500 kV is a limiting facility with the outage of Palo Verde-Colorado River 500 kV line.

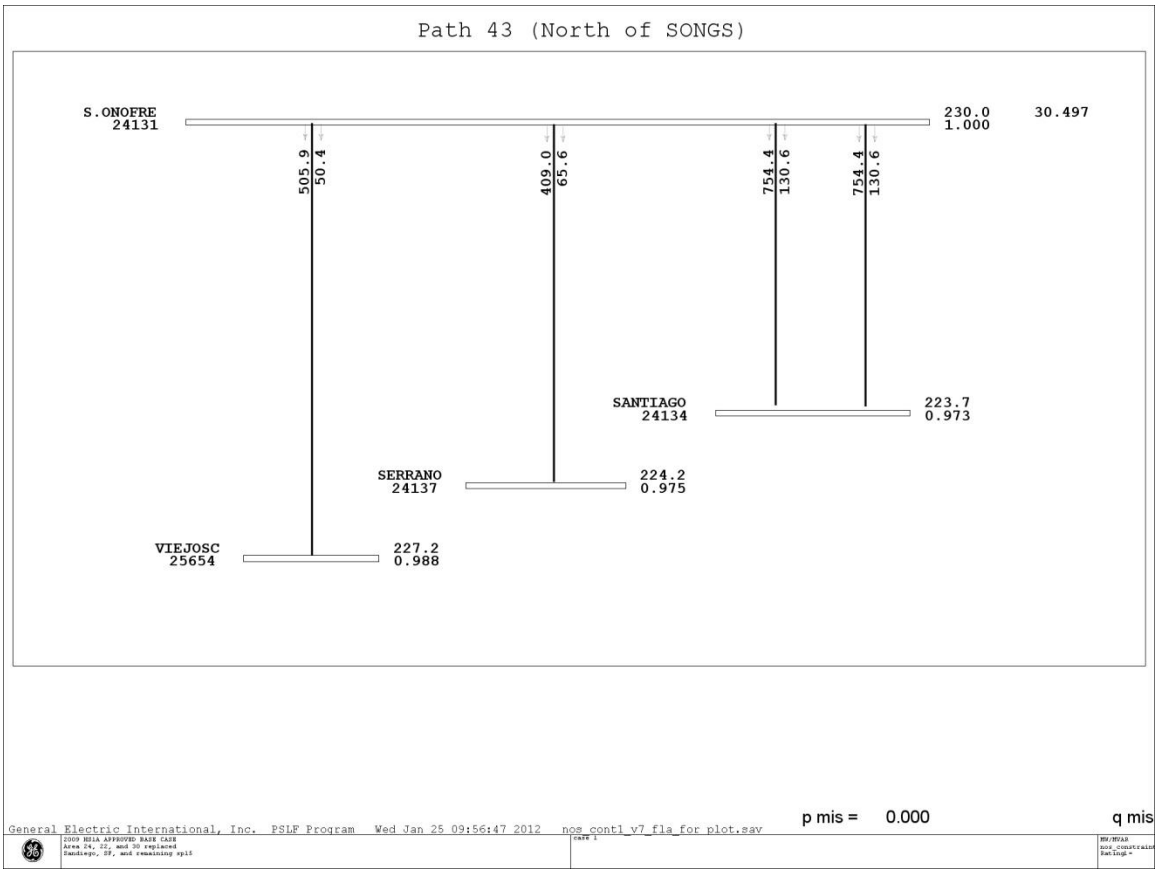


Figure 7. Lower level of generation withdrawal: NOS is the limiting constraint with all lines in service.