Interoffice Memorandum
System Planning

MEMO: SP-2012-14
DATE: October 4, 2012
TO: Scott Waples
FROM: Richard Maguire
SUBJECT: 2013 IRP Generation Study – Cabinet Gorge HED

Introduction

This brief study addresses a request from Avista's Power Supply Department for the 2013 IRP regarding adding up to 110 MW of new generation capacity in the form of two new units to Cabinet Gorge HED.

History

The Cabinet Gorge project started generating power in 1952 with two units. The plant was expanded with two additional generators in the following year. The current maximum capacity of the plant is 270.5 MW; it has a nameplate rating of 265.2 MW. Upgrades at this project began with the replacement of the turbine for Unit 1 in 1994. Unit 3 was upgraded in 2001 and Unit 2 was upgraded in 2004. The final unit, Unit 4, received a $6 million turbine upgrade in 2007, increasing its generating capacity from 55 MW to 64 MW, and adding 2.1 aMW of additional energy.[1]

Study Methodology and Assumptions

Two of Avista's five year planning horizon cases are modified with the following projects prior to analysis:

- Spokane Valley Transmission Reinforcement Project
- Moscow Transformer Replacement Project
- Lancaster Loop-In Project
- Palouse Wind Phase I (LGIP #5)

The two cases used in this study are:

- AVA-16hs2a-16BA2213; Heavy Summer High Hydro (HSHH)
- AVA-11ls1ae-16BS1328-WOH4140; Light Loading High Transfer (HT)

These cases represent two seasonal times when maximum hydro generation is possible.

Table 1 below shows the power flow values with an additional 110 MW of generation at Cabinet Gorge. All changes in generation are coupled with:

- Limiting *Western Montana Hydro* to 1650 MW by reducing outputs of Libby and Hungry Horse
- Limiting *West of Hatwai* to 4277 MW via control of off-system generation

[1] Cabinet Gorge history taken from Avista 2011 Electric Integrated Resource Plan

Heavy Summer High Hydro		Light Spring High Transfer	
West of Hatwai (Path 6)	813.1 MW	**West of Hatwai (Path 6)**	4275.0 MW
Montana-Northwest (Path 8)	758.7 MW	**Montana-Northwest (Path 8)**	2101.2 MW
Western Montana Hydro	1650.0 MW	Western Montana Hydro	1650.0 MW
Noxon Rapids (562MW)	570.6 MW	Noxon Rapids (562MW)	570.6 MW
Cabinet Gorge (265MW)	397.0 MW	Cabinet Gorge (265MW)	397.0 MW
Libby (605MW)	395.9 MW	Libby (605MW)	395.9 MW
Hungry Horse (430MW)	286.5 MW	Hungry Horse (430MW)	286.5 MW
Colstrip 1 (330MW)	329.3 MW	Colstrip 1 (330MW)	330.8 MW
Colstrip 2 (330MW)	329.3 MW	Colstrip 2 (330MW)	330.8 MW
Colstrip 3 (823MW)	789.1 MW	Colstrip 3 (823MW)	796.5 MW
Colstrip 4 (823MW)	803.3 MW	Colstrip 4 (823MW)	801.8 MW
Rathdrum Thermal (175MW)	0.0 MW	Rathdrum Thermal (175MW)	140.0 MW
Lancaster Thermal (270MW)	248.4 MW	Lancaster Thermal (270MW)	249.4 MW
Spokane River Hydro	88.2 MW	Spokane River Hydro	183.8 MW
Boundary Hydro (1040MW)	633.6 MW	Boundary Hydro (1040MW)	976.5 MW
Northwest Load	26444.8 MW	Northwest Load	17948.5 MW
Idaho Load	4087.0 MW	Idaho Load	2326.0 MW
Montana Load	1940.3 MW	Montana Load	1339.5 MW
Avista Native Load	-1701.7 MW	Avista Native Load	-959.6 MW
Avista Balancing Area Load	1671.7 MW	Avista Balancing Area Load	911.6 MW
Clearwater Load	58.2 MW	Clearwater Load	58.2 MW

Table 1: Base Case Power Flow Summary

Study Results

Thermal Performance during N-0 conditions

The study indicates that the Avista transmission system has enough capacity to integrate an additional 110 MW of generation at Cabinet Gorge HED with all lines in service during some, but not all, conditions. One example of a limiting condition occurs during hot summer months when the loading is high and full hydro generation is possible. During this heavy summer, high hydro scenario, the present Avista transmission system has just enough transmission capacity for existing generation. Figure 1 below shows the Avista system isolated from neighbor systems for the purpose of determining transmission capacity. This is a unique test for this study, and no other cases are evaluated with the system isolated in this way. The image represents flows in the 2016 heavy summer high hydro case with Cabinet Gorge and Noxon operating at maximum capacity.

Note:

- This study uses existing line ratings. Avista has projects underway raising line ratings in the area, which will result in more transmission capacity once the projects are completed.
- Generation at Cabinet Gorge HED and Noxon Rapids HED could be governed within a nomogram to mitigate thermal overloads during summer conditions when electric loading is high.
- NOTE: these conclusions are contingent upon further detailed studies

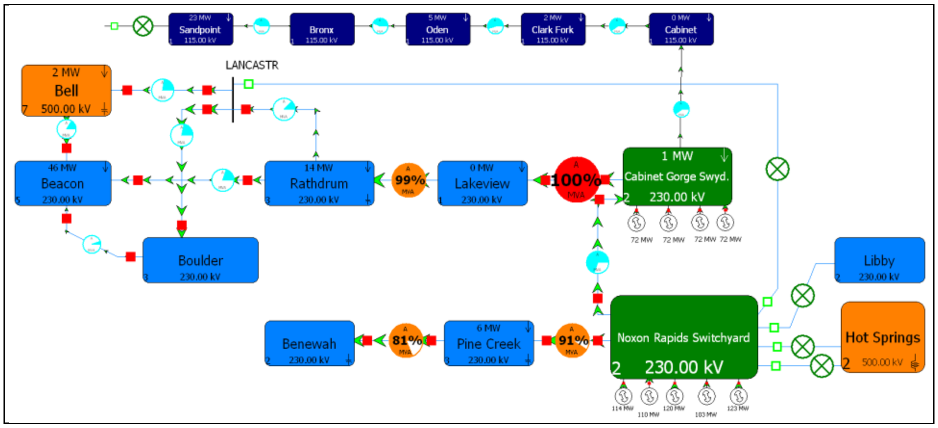

Figure 1: 2016 HSHH, all facilities in service, Cabinet Gorge @287MW

Thermal Performance during N-1 conditions

Given the current study reveals Cabinet Gorge HED must be limited to zero additional capacity when operating under conditions similar to those used in the Heavy Summer, High Hydro case, *only the High Transfer case is used to consider N-1 contingency violations.*

All new N-1 contingency violations found during this study are in the immediate vicinity of the Cabinet Gorge HED. Figure 2 shows the most limiting contingency occuring when the Cabinet to Noxon 230 kV line overloads with a loss of the 230 kV line to Rathdrum for a failure of breaker R404.[2] As noted in the notes above, Avista has transmission projects underway that lessen the severity of all of the N-1 contingency violations found in this study, and further detailed study will determine what, if any, N-1 violations still exist once the local projects are completed.

Note: Reducing the new generation at Cabinet Gorge to values less than the requested 110 MW directly impacts the new limiting N-1 contingency violations. This behavior likely reduces the steady state nomogram discussed above.

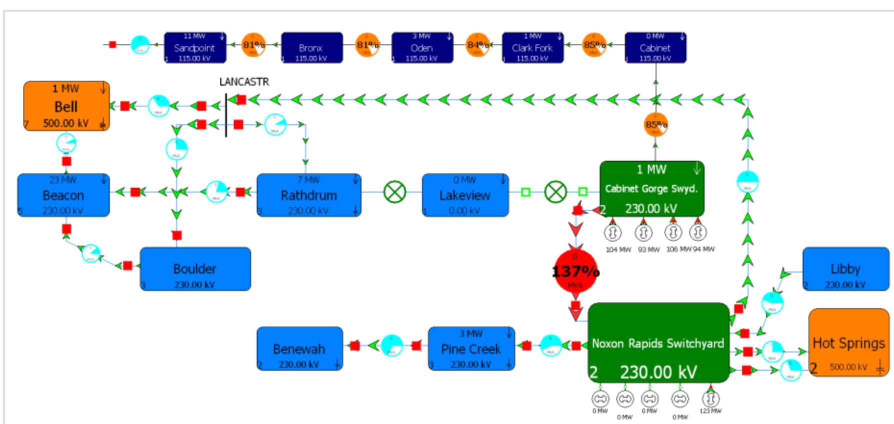

Figure 2: Cabinet-Noxon 230 kV overload during R404 breaker failure

Voltage Stability

With all lines in service, an addition of 110 MW at Cabinet Gorge does not introduce any new voltage violations during N-0 conditions. However, this study indicates several new voltage violations are present during N-1 conditions. The limiting contingency regarding voltage stability occurs at Bus 48057, the Cabinet Gorge 230 kV bus, during the N-1: Cabinet – Noxon 230 kV contingency. The voltage limit used is 1.015 pu, the initial value is 1.045 pu, and the value during contingency is 1.0049 pu. Figure 3 shows the violation.

[2] BF: R404 Cabinet-Rathdrum, Rathdrum #2 230/115 Transformer

All of the newly created voltage violations can be mitigated by reducing generation at Cabinet Gorge to levels above present values but below the requested 110 MW addition. Additionally, existing and planned projects on the Avista transmission system positively influence these new voltage violations. Further detailed studies are necessary to fully characterize voltage performance.

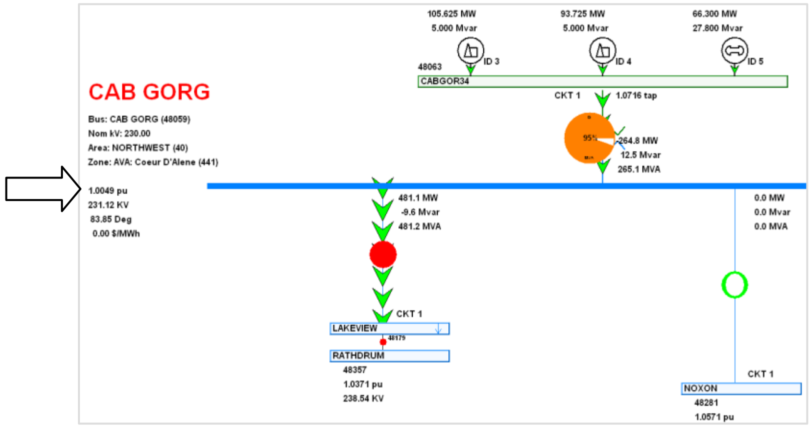

Figure 3: 2016 HT, Voltage Limit Violation, N-1: Cabinet – Noxon 230 kV

Transient Stability

Preliminary studies indicate new generation at Cabinet Gorge adds stability violations during N-1 conditions, and additional generation exacerbates stability issues addressed by the existing Clark Fork remedial action scheme (i.e. RAS). Adding any new generation to the existing RAS scheme clears several of the new N-1 violations, but further studies are necessary to accurately assess solutions for the other violations. Possible solutions could be changes to the existing RAS, a nomogram as discussed above, and/or transmission projects to mitigate violations.

Conclusions

This study indicates the requested new generation at Cabinet Gorge performs adequately on the local transmission system with potential updates to the Clark Fork RAS and limits to Cabinet Gorge and Noxon combined output via a seasonally adjusted nomogram determined by further study.

If operating Cabinet Gorge without limitation is desired, preliminary studies show this is possible via potential projects on one or more of the 230 kV transmission lines carrying power to the load center.

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