SWITCHYARD EVALUATION

A.B. Brown 2x0 F-Class

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PREPARED FOR

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Executive Summary

In developing this report, Black & Veatch evaluated the suitability of the existing A.B. Brown 138 kilovolt (kV) switchyard for interconnection of two new combustion turbine generators (CTG) operating as a 2x0 Simple Cycle Power Plant (SCPP). This evaluation was performed with existing Units 1 and 2 removed from operation. Black & Veatch considered preliminary heat balance data for a GE 7FA.05 SCPP for this evaluation. The switchyard was evaluated with the new CTGs 5 and 6 connected to the positions that existing Units 2 and 1 were connected respectively.

The continuous current loading of the 3000 Ampere (A) main buses 1 and 2 as well as the 2000 A interpass conductors are not exceeded for the switchyard configurations evaluated. The loading evaluation does not identify any major bus work necessary to independently connect the generators associated with the 2x0 SCPP. In general, the existing switchyard is capable of a single point of interconnection for 430,000 kW and below.

The existing 138 kV switchyard is comprised of 20 circuit breakers, [redacted]

The available fault current contribution at the existing 138 kV switchyard is marginal, but not exceeded, for the 40 kA circuit breakers [redacted]

The calculated values included in this evaluation are based on preliminary information. Evaluation of final generator data is necessary to determine suitability of the existing 138 kV switchyard.

1.0 Introduction

The A.B. Brown 2x0 SCPP is a multi-shaft arrangement, with each combustion turbine (CT) individually coupled to its respective generator rated to convert maximum turbine capabilities to electric power. Electric power is transmitted via dedicated isolated phase bus duct (IPBD) to dedicated generator step-up transformers (GSU). Each GSU is sized to permit maximum real electric power to be transmitted to the electric power grid, with minimal losses, and to permit reactive electric power to be delivered to and absorbed from the electric power grid. Each turbine generator will also provide source power to 100 percent redundant unit auxiliary transformers (UAT). The high voltage side of each GSU will be independently connected to the existing 138 kV switchyard. Interconnection of the CTGs to the existing 138 kV switchyard requires consideration of fault current availability and system load flow relative to existing equipment ratings. Black & Veatch considered preliminary heat balance data for a GE 7FA.05 SCPP for this evaluation. Each of the new generators were modelled with independent connections to the existing 138 kV switchyard, with existing Units 1 & 2 removed from operation and CTG5 and CTG6 connected to the positions that existing Units 2 and 1 were connected respectively.

The method of connection for each generator in a given configuration to the existing 138 kV switchyard is based upon the electrical ratings of the switchyard components, switchyard expansion capability, and operation of existing Units 3 and 4. The existing 138 kV switchyard is a breaker and a half configuration with two main buses, rated 3000 A continuous. [redacted]

2.0 Switchyard Evaluation

2.1 LOAD FLOW

The interpass connections between Bus 1 and Bus 2 are rated 2,000 A, therefore a single connection to the switchyard is acceptable when the kilowatts (kW) transmitted remain below 430,000 kW at a power factor equal to 0.9. For a single connection above 430,000 kW and less than 645,000 kW, upgrades are required to the entire 138 kV switchyard, such as circuit breaker and disconnect switch replacement with 3000 A continuous rating. Generation exceeding 645,000 kW at a single connection point is not practical at a voltage level of 138 kV as equipment rated above 3000 A continuous is typically not available.

The maximum gross output of each CTG based on the GE 7FA.05 considered for this evaluation is [redacted] kW and corresponds to approximately [redacted] A at 138 kV and at a power factor of 0.9. Detailed load flow modeling of the 138 kV switchyard with case permutations of outgoing transmission lines in and out of service is necessary in order to verify the suitability of the 138 kV switchyard to accommodate the connection of two new CTGs and identify any overload cases. Initial analysis indicates that the 138 kV switchyard is generally suitable to accommodate independent connection of the new 2x0 CTGs with existing Units 1 & 2 removed from operation.

The maximum current flow in the main and interpass buses for each analyzed case are represented in Table 2-1.

Table 2-1 Max Load in Main and Interpass Buses - 2026 Summer Peak

138 kV Switchyard Loading 2x0				
Case	Current in 3kA Main Bus (A)	Percent Loading (%)	Current in 2kA Interpass (A)	Percent Loading (%)
All In Service	1109	36.97	577	28.85
Bus 1 Outage	2057	68.57	860	43.00
Bus 1 and Line Z95 Outage	2366	78.87	995	49.75
Bus 1 and Line Z96 Outage	2306	76.87	995	49.75
Bus 1 and Line Z94 Outage	2163	72.10	1172	58.60
Bus 1 and Line Z73 Outage	2147	71.57	834	41.70
Bus 1 and Line Z98 Outage	2031	67.70	942	47.10
Bus 1 and Line Z99 Outage	1979	65.97	1119	55.95
Bus 1 and Line Z93 Outage	1977	65.90	1051	52.55
Bus 1 and Line to Culley Outage	1982	66.07	991	49.55
Bus 1 and Francisco to Gibson Outage	2041	68.03	1055	52.75
Bus 1 and AB Brown – BREC Reid Outage	1848	61.60	940	47.00
Bus 2 Outage	2056	68.53	994	49.70
Bus 2 and Line Z95 Outage	2366	78.87	999	49.95

138 kV Switchyard Loading 2x0				
Case	Current in 3kA Main Bus (A)	Percent Loading (%)	Current in 2kA Interpass (A)	Percent Loading (%)
Bus 2 and Line Z96 Outage	2306	76.87	995	49.75
Bus 2 and Line Z94 Outage	2162	72.07	1172	58.60
Bus 2 and Line Z73 Outage	2146	71.53	997	49.85
Bus 2 and Line Z98 Outage	2031	67.70	995	49.75
Bus 2 and Line Z99 Outage	1978	65.93	1118	55.90
Bus 2 and Line Z93 Outage	1976	65.87	1051	52.55
Bus 2 and Line to Culley Outage	1981	66.03	994	49.70
Bus 2 and Francisco to Gibson Outage	2040	68.00	1056	52.80
Bus 2 and AB Brown – BREC Reid Outage	2056	68.53	994	49.70

2.2 FAULT CAPABILITY

[redacted]. The interrupting capability of the 40 kA rated circuit breakers is marginal, but not exceeded, for single phase to ground faults for this evaluated case.

The results of the fault study are represented in Table 2-2.

Table 2-2 138 kV Switchyard Fault Currents

Fault Current Availability 2x0			
Fault type	Fault Component	Value	Margin (%)
3-phase fault	Fault Current (A)	33212	16.97%
	Phase Angle (°)	-86.1	-
	Calculated X/R	14.847	-
1-phase fault	Fault Current (A)	36708	8.23%
	Phase Angle (°)	-86	-
	Calculated X/R	14.377	-

3.0 Switchyard Connection

[redacted]

- [redacted]
- [redacted]

4.0 Conclusions

The withstand and interrupting rating of 40 kA for 13 of the 20 existing 138 kV switchyard circuit breakers is marginal, but not exceeded, for the fault conditions evaluated. The evaluated load flow of the existing 138 kV switchyard permits independent connection of the new 2x0 SCPP considering a fired GE 7FA.05 and associated preliminary heat balance gross output. In general, the existing switchyard is capable of a single point of interconnection for 430,000 kW and below. This evaluation did not identify any major circuit breaker, bus or interpass modifications for the existing 138 kV switchyard to accommodate the new SCPP.

The calculated values included in this evaluation are based on preliminary information. Evaluation of final generator data is necessary to determine suitability of the existing 138 kV switchyard.

Appendix A. Switchyard Connection Diagram