Facility Study
For
Generator Interconnection
Request
GEN-2012-026

SPP Generator
Interconnection Studies

(#GEN-2012-026)

October 2013

Revision History

Date	Author	Change Description
10/17/2013	SPP	Facility Study Report Issued

Summary

Midwest Energy, Inc. (MIDW) performed a detailed Facility Study at the request of Southwest Power Pool (SPP) for Generation Interconnection request GEN-2012-026 (90 MW in the Summer Peak and 100 MW in the Winter Peak/ Combustion Turbines) located in Thomas County, Kansas. The originally proposed in-service date for GEN-2012-026 was December 31, 2014. SPP has proposed the in-service date will be after the assigned Interconnection Facilities and Non-Shared network upgrades are completed. Full Interconnection Service will require the Network Upgrades listed in the "Other Network Upgrades" section. The request for interconnection was placed with SPP in accordance with SPP's Open Access Transmission Tariff, which covers new generation interconnections on SPP's transmission system.

Phases of Interconnection Service

It is not expected that interconnection service will require phases however, interconnection service will not be available until all interconnection facilities and network upgrades can be placed in service.

Interconnection Customer Interconnection Facilities

The Interconnection Customer will be responsible for all of the transmission facilities connecting the customer owned substation to the Point of Interconnection (POI), at Midwest Energy, Inc. (MIDW) owned 115kV Colby bus at the Colby Substation. The Interconnection Customer will also be responsible for any equipment located at the Customer substation necessary to maintain a power factor of 0.95 lagging to 0.95 leading at the POI.

Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades

To allow interconnection the Transmission Owner will need to construct an addition terminal and breaker along with associated terminal equipment for acceptance of the Interconnection Customer's Interconnection Facilities. At this time GEN-2012-026 is responsible for $7,892,160.00 of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades.

Potential Stability Impacts on Colby Power Station

In the DISIS 2012-002 Impact Study, voltage oscillations were observed at the Colby 115kV bus for faults on the Colby – Seguin Tap and Colby – Atwood 115kV lines. Using updated reclose and breaker timings on these lines supplied by MIDW, these oscillations were found to be no longer observed for the addition of the GEN-2012-026 Interconnection Request. Please refer to Appendix A for more information about this analysis of the stability for Colby Power Station,

Shared Network Upgrades

The Interconnection Customer was studied within the DISIS-2012-002 Impact Study. At this time, the Interconnection Customer is allocated $0.00 for Shared Network Upgrades. If higher queued interconnection customers withdraw from the queue, suspend or terminate their GIA, restudies will have to be conducted to determine the Interconnection Customers' allocation of Shared Network Upgrades. All studies have been conducted on the basis of higher queued interconnection requests and the upgrades associated with those higher queued interconnection requests being placed in service. At this time, the Interconnection Customer is allocated the following cost for Shared Network Upgrade:

Share Network Upgrade Description	Allocated Cost	Total Cost
None at this time	$0.00	$0.00
Total	$0.00	

Other Network Upgrades

Certain Other Network Upgrades are currently not the cost responsibility of the Customer but will be required for full Interconnection Service. These Other Network Upgrades include:

1. Hitchland – Woodward 345kV double circuit, scheduled for 6/30/2014 in-service
2. Beaver County 345kV Expansion, assigned to DISIS-2011-001 Customers
3. Spearville – Clark – Thistle – Wichita 345kV double circuit, scheduled for 12/31/2014 in-service
4. Holcomb 345/115/13.2 Transformer circuit #2, assigned to DISIS-2012-001 Customers
5. Mathewson 345kV Substation – Tap and Tie on Tatonga – Northwest 345kV circuit #1 and Cimarron – Woodring 345kV circuit #1, assigned to DISIS-2011-001 Customers
6. Tatonga – Mathewson – Cimarron 345kV circuit #2, assigned to DISIS-2011-001 Customers
7. Spearville – Mullergren – Reno 345kV double circuit, assigned to DISIS-2011-001 Customers

Depending upon the status of higher or equally queued customers, the Interconnection Customer's in-service date is at risk of being delayed or their Interconnection Service is at risk of being reduced until the in-service date of these Other Network Upgrades.

Conclusion

Interconnection Service for GEN-2012-026 will be delayed until the Transmission Owner Interconnection Facilities, Non-Shared Network Upgrades and Shared Network Upgrades are constructed. The Interconnection Customer is responsible for $7,892,160.00 of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades. At this time, the Interconnection Customer is allocated $0.00 for Shared Network Upgrades. After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 90 MW in the summer and 100 MW in the winter, as requested by GEN-2012-026, can be allowed. At this time the total allocation of costs assigned to GEN-2012-026 for Interconnection Service are estimated at $7,892,160.00.

Appendix A

Summary

In the DISIS 2012-002 Impact Study, voltage oscillations were observed at the Colby 115kV bus for faults on the Colby – Seguin Tap and Colby – Atwood 115kV lines in the 2014 winter peak case. Using updated reclose and breaker timings on these lines supplied by MIDW, these oscillations are no longer observed for the simulated outages in the 2014 winter peak case.

Methodology

The four (4) contingencies were identified for use in this study. These faults are listed within 1. These contingencies included three-phase faults and single-phase line faults at locations defined by SPP. Single-phase line faults were simulated by applying fault impedance to the positive sequence network at the fault location to represent the effect of the negative and zero sequence networks on the positive sequence network. The fault impedance was computed to give a positive sequence voltage at the specified fault location of approximately 60% of pre-fault voltage. This method is in agreement with SPP current practice.

Table 1: Contingencies Evaluated for GEN-2012-026

Contingency Number and Name		Description
1	FLT_01_COLBY_SEGUINTAP_115kV_3PH	3-Phase fault on the Colby – Seguin Tap 115kV CKT 1 near the Colby 115kV bus. a. Apply fault at the Colby 115 kV bus. b. Clear fault after 3 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 3 cycles, then trip the line in (b) and remove fault.
2	FLT_02_COLBY_SEGUINTAP_115kV_1PH	Single phase fault similar to previous faults.
3	FLT_03_COLBY_ATWOOD_115kV_3PH	3-Phase fault on the Colby – Seguin Tap 115kV CKT 1 near the Colby 115kV bus. a. Apply fault at the Colby 115 kV bus. b. Clear fault after 3 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 3 cycles, then trip the line in (b) and remove fault.
4	FLT_04_COLBY_ATWOOD_115kV_1PH	Single phase fault similar to previous faults.

Results

With the reclose timings supplied by MIDW for the Colby substation equipment, the oscillations seen in DISIS 2012-002 were not observed. Results of the transient stability analysis are summarized within Table 2. The results indicate that the transmission system remains stable for all contingencies studied. The plots are available below.

Table 2: Fault Analysis Results for GEN-2012-026

Contingency Number and Name		2014WP
1	FLT_01_COLBY_SEGUINTAP_115kV_3PH	Stable
2	FLT_02_COLBY_SEGUINTAP_115kV_1PH	Stable
3	FLT_03_COLBY_ATWOOD_115kV_3PH	Stable
4	FLT_04_COLBY_ATWOOD_115kV_1PH	Stable

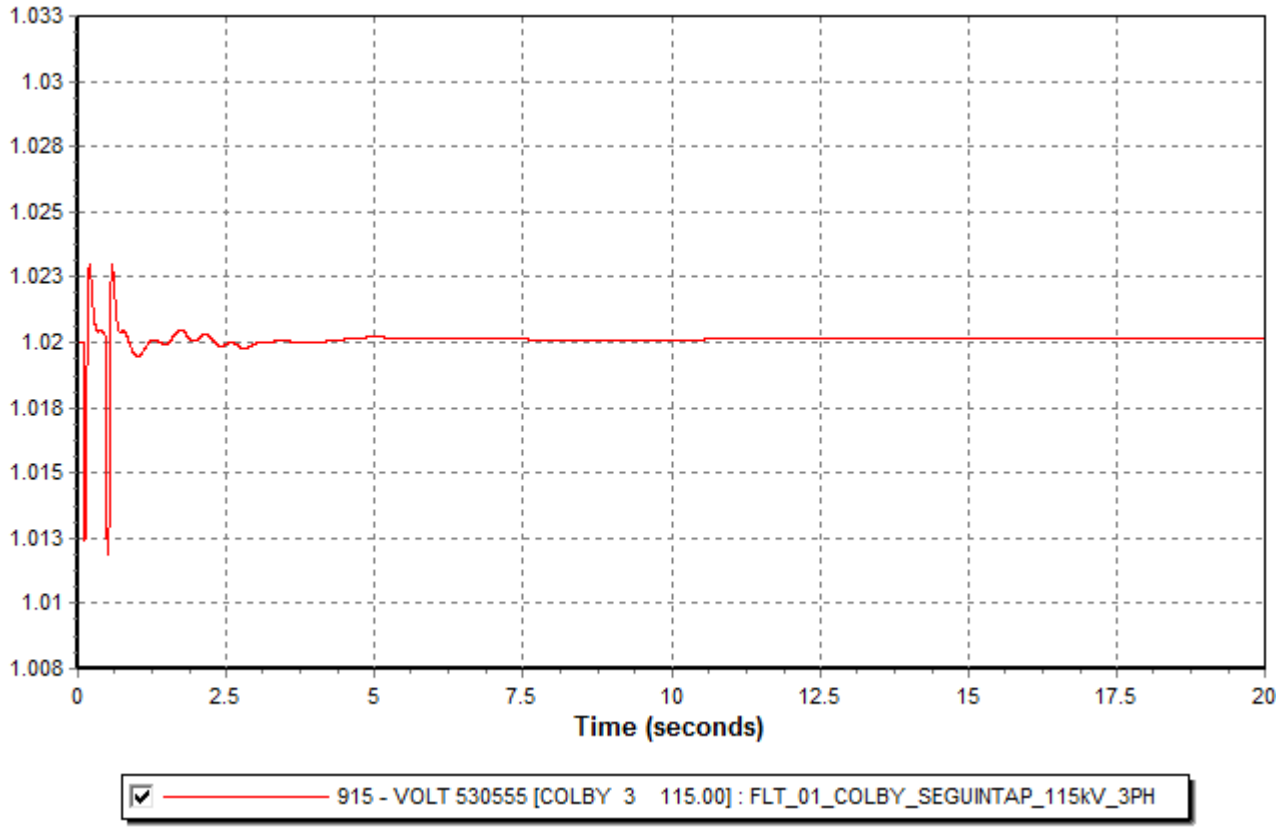


Figure 1: Voltage response at Colby for FLT-01 2014WP

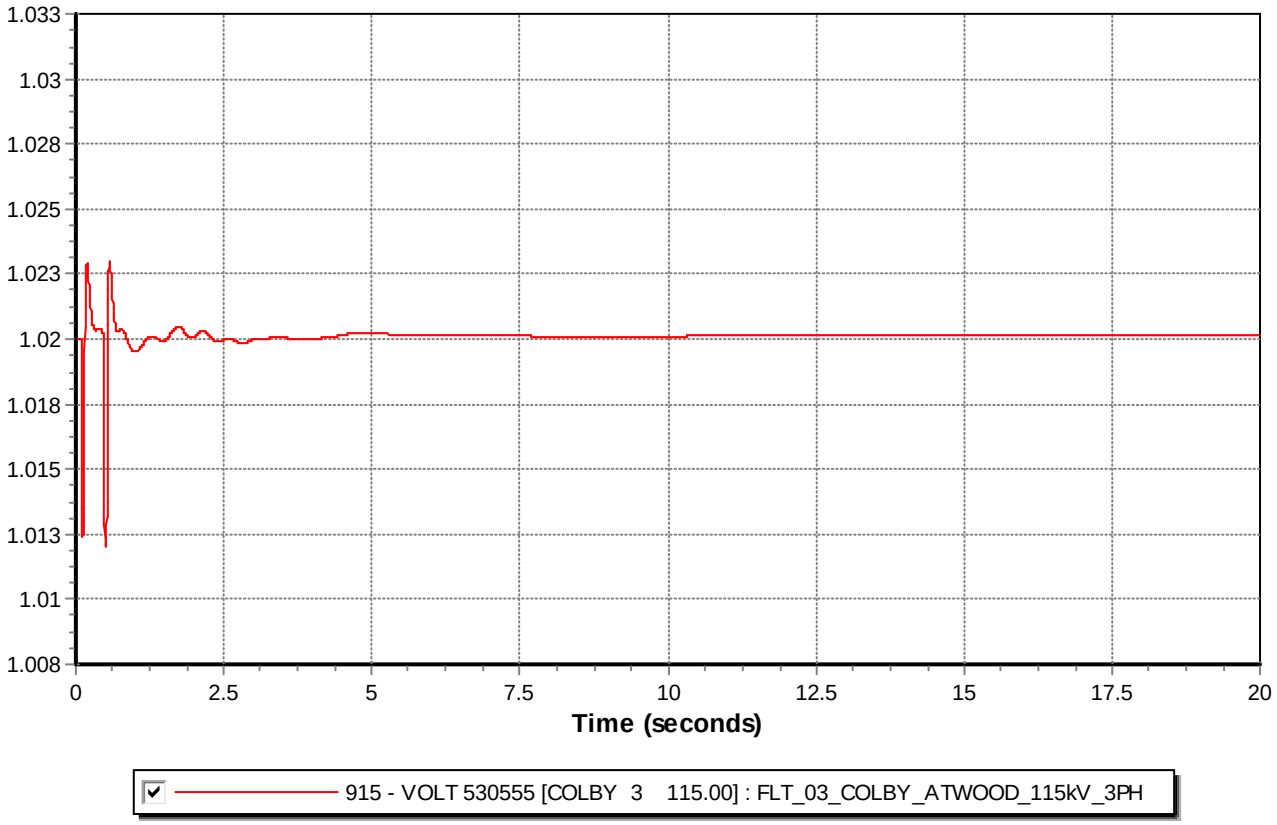


Figure 1: Voltage response at Colby for FLT-03 2014WP

Midwest Energy Inc.

Facility Study for Generation Interconnection Request GEN-2012-026

June 6, 2013

Contents

Study Overview

At the request of Southwest Power Pool (SPP), Midwest Energy developed the following generation interconnection facility study for request GEN-2012-026 based on the results of Definitive Interconnection System Impact Study 2012-002 (DISIS-2012-002 and DISIS-2012-002-1). As studied in DISIS-2012-002, GEN-2012-026 consists of 100 MW of natural gas internal combustion generation interconnecting to the 115 kV bus at Midwest Energy's Colby substation.

The purpose of this study is to provide estimated costs of facilities required for interconnection of the proposed generation to Midwest Energy's transmission system and network upgrades required on Midwest Energy's transmission system as identified in DISIS-2012-002. Additional network upgrades required for facilities of other transmission owners are not included in this study. The 115 kV transmission line required between the proposed generation site and the point of interconnection is not addressed in this study and are considered the responsibility of the Interconnection Customer.

Interconnection Facilities and Network Upgrades

A one-line diagram for the existing Colby 115 kV substation, with the addition of a terminal for the proposed generation, can be found in Attachment A. A conceptual one-line diagram for the upgrade of the Colby 115kV substation to accommodate the GEN-2012-026 Interconnection Facilities can is provided as Attachment B.

A fault study was conducted by Midwest Energy to determine if the addition of the proposed generation and contingent system upgrades caused fault levels on the Midwest Energy transmission system to exceed circuit breaker interrupting capabilities. The results of the fault analysis indicate that 115 kV fault levels at the Colby 115 kV bus will increase from approximately 5.1 kA before GEN-2012-026 to approximately 7.6 kA after interconnection of GEN-2012-026. This increase will exceed the fault interrupting capability of circuit switchers 3802 and 3803 protecting T2 115/34.5 kV transformer and T1 115/69 kV transformer respectively. Both 3802 and 3803 have nameplate interrupting capability of 7 kA. Costs for replacing these two devices are included in the network upgrades below. All other interrupting devices are expected to remain within their nameplate fault interrupting capability.

Upgrade of Colby Substation

Several considerations were included in the resulting requirement to upgrade the existing Colby substation:

- The existing substation is a radial bus design, with three line terminals for existing 115kV transmission lines, three terminals for existing 115/34kV transformer/generator step-up connections, and one terminal for a 115/12kV transformer currently under development. Traditional substation engineering practices limit the use of radial bus configurations to approximately 4 terminals.

- Any fault or failure on the main bus results in an outage of all lines/transformers until all repairs can be completed. In contrast, a ring bus configuration allows a damaged segment of bus to be removed from service without requiring that the line terminals or transformers be removed from service during the repair process.
- The existing 115kV strain bus, supported on lattice steel box structures, will just barely be adequate with the addition of the 100MW generating facility. In order to limit extensive outages at a later date should an upgrade be required, the strain bus should be upgraded prior to the interconnection of the proposed generation facility if the existing substation is used in the existing radial bus design.
- Although further structural analysis of the existing box structure would be required, a significant increase in the size of the strain bus may require reinforcing some structural members on the box structure.
- Replacement of the existing S&C Mark IV circuit switchers, which will have their fault interrupting capability exceeded with the addition of the proposed generation, will be problematic. S&C no longer makes a circuit switcher with integral disconnect switch available in configuration suitable for vertical mounting on the vertical face of the box structure as the existing switches are. This will require modification of the existing box structure trusses to accommodate a circuit switcher in a candle-stick configuration suitable for horizontal mounting, with a separate air-break disconnect switch.
- There is no room left in the existing control house where the protection and control equipment for the existing 115kV substation is located. This is a concrete shelter, and a simple expansion of the control house will be quite difficult at best.
- Given the location of the existing control house, the control cable runs to a new breaker to accommodate the generator interconnection would be quite lengthy, even on the most direct route through the center of the substation, where hand-digging would be required. To avoid this significant construction delay and cost a route around the perimeter of the substation would further increase the length of these control leads.
- The construction outages required to accommodate the upgrades noted above, as well as the addition of a new terminal for the proposed generation interconnection, will be lengthy – the current estimate is that parts or the entire 115kV substation will have to be out of service for up to six months. This includes the three existing 115kV lines, the three transformers providing 34kV service to the local area transmission system, and the generator step-up capabilities for the gas turbine generator. It is not clear if we would be able to schedule simultaneous outages of the three 115kV lines, let alone provide service to the 34kV transmission system in the area from other sources; at minimum we would be restricted to certain portions of the year when the work could be done, and perhaps spread over multiple seasons. As to the connection for the gas turbine generator, there would be no recourse if the transformer T1 is out of service, as the turbine is connected to the tertiary of that transformer.

Based on these and other considerations, Midwest Energy will require that a new 115kV ring bus substation be constructed. The layout of this substation will utilize part of the existing box structure, though the circuit switchers will still need to be replaced. This will

allow Midwest Energy to avoid the necessity of relocating transformers T1, T3 and T2. It will also allow Midwest Energy to plan the construction to limit significant outages, with most of the construction work on the new ring bus being completed prior to any significant outages being required. When T1, T2, and T3 are out of service Midwest Energy will still be able to service its local 34kV load throughT4, and careful planning will minimize the outages on the three 115kV transmission lines. Midwest Energy already owns sufficient property at this site to accommodate the construction of the new ring bus substation without the need for the acquisition of additional property.

Table 1 below provides an estimate of the costs of construction for the Transmission Owner's Interconnection Facilities and Network Upgrades in support of a future Generation Interconnection Agreement.

Stability Issues

The report produced in connection with DISIS-2012-002 (2-18-2013 revision) indicates that some stability concerns may arise with the connection of the proposed generation to the Colby substation. The proposed mitigation is to disable automatic high speed reclosing on the three existing 115kV transmission lines connected to the Colby substation.

Midwest Energy is unwilling at this time to accept the removal of automatic reclosing capabilities from these transmission lines, and encourages SPP to work with Midwest Energy, and perhaps with other nearby transmission owners as well, to find other mitigation initiatives that will address the stability concerns raised in the DISIS study.

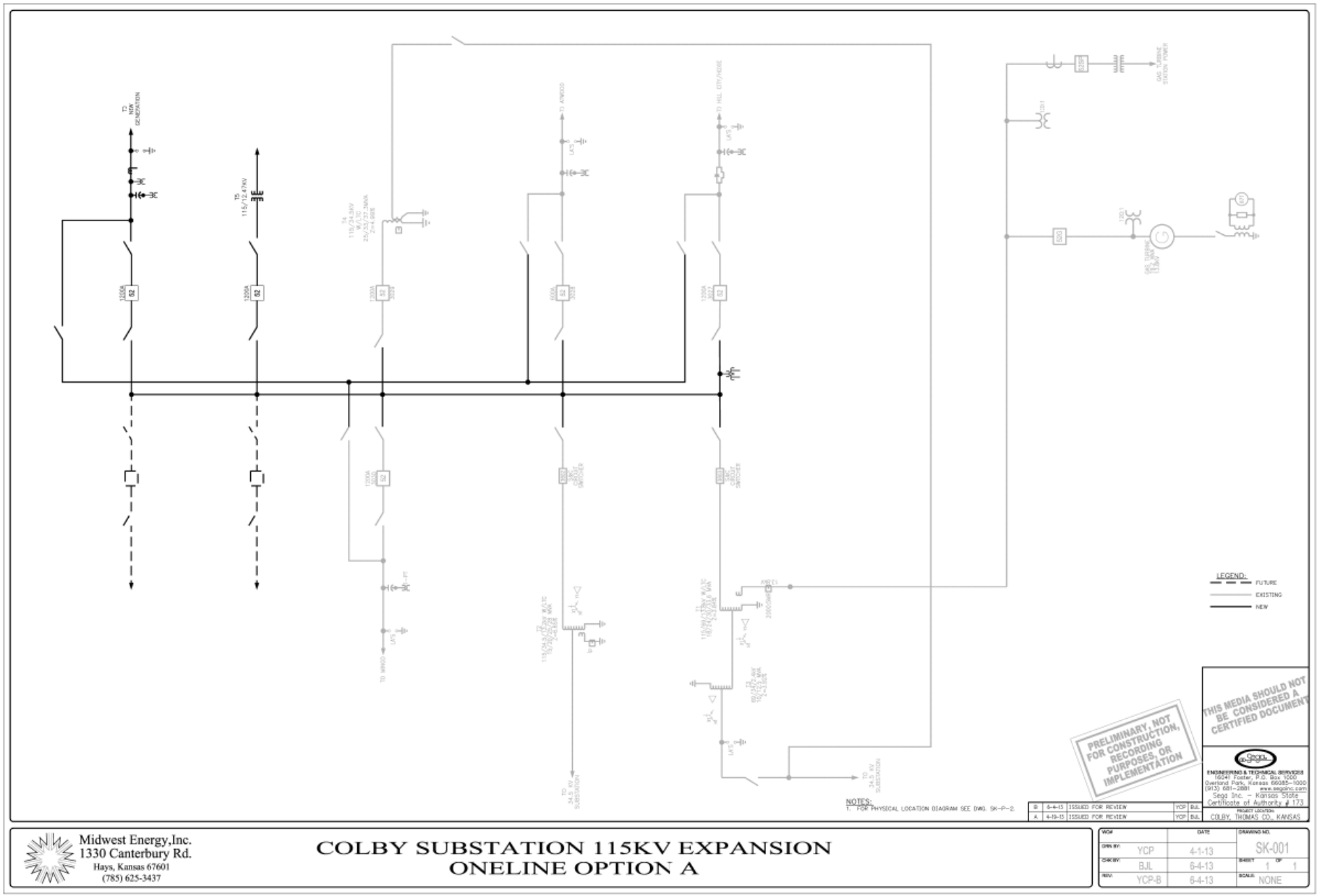
Table 1 - Interconnection Facility and Network Upgrade Cost Estimate

Description	Total Cost
Interconnection Facilities	**$ 990,196**
Midwest Energy Network Upgrades	
Construction of 10-position ring bus, with eight positions/terminals installed	**$ 6,901,964**
Total Interconnection Facilities and Network Upgrades	**$ 7,892,160**

Attachment A

Conceptual One-Line Diagram

Existing Colby 115 kV Substation
With the Addition of a Terminal for the Proposed Generation Interconnection


LEGEND:
FUTURE
EXISTING
NEW
NOTES:
1. FOR PHYSICAL LOCATION DIAGRAM SEE DWG. SK-P-2.
PRELIMINARY, NOT FOR CONSTRUCTION, RECORDING PURPOSES, OR IMPLEMENTATION
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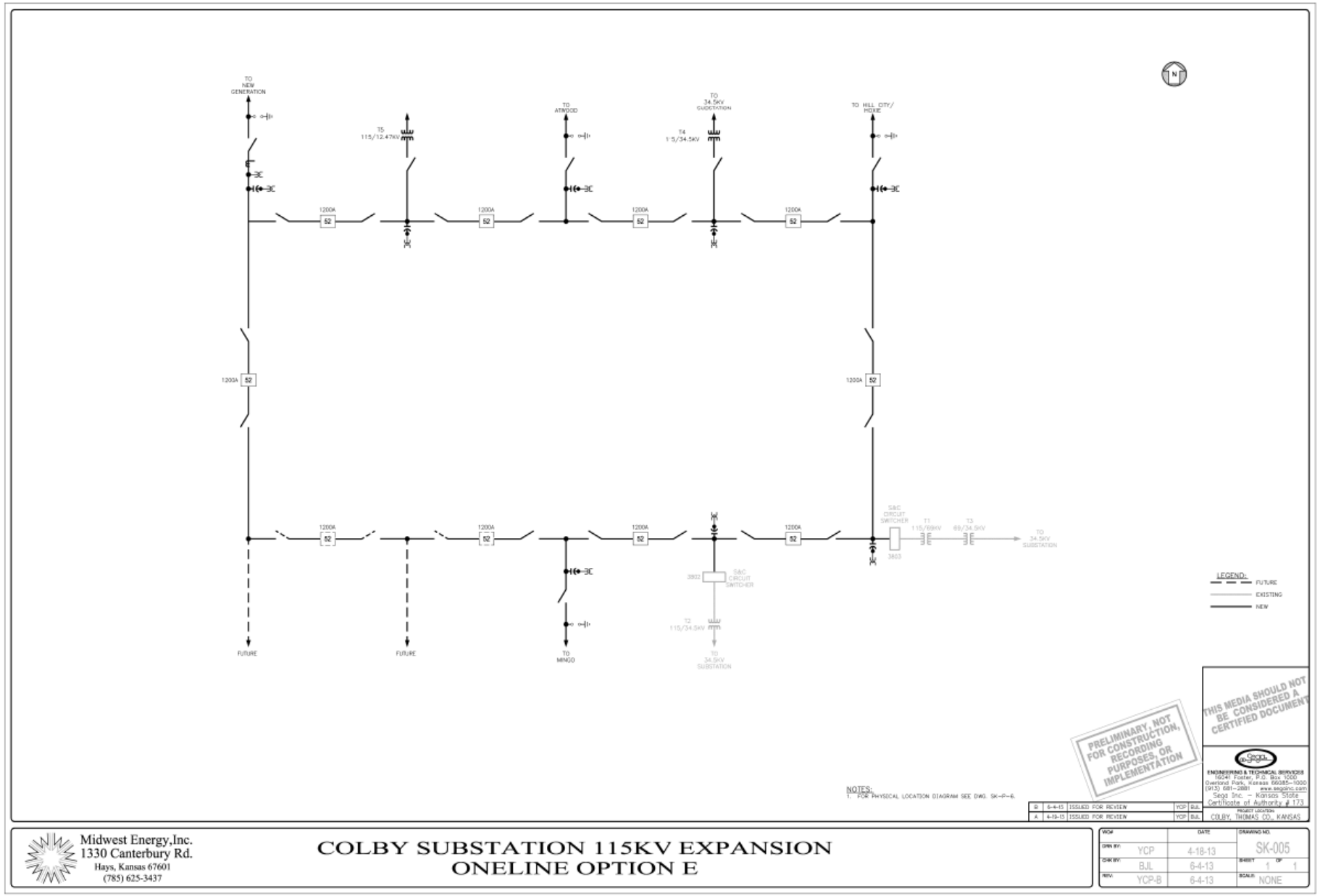
COLBY SUBSTATION 115KV EXPANSION
ONELINE OPTION A
SK-001
NONE

Attachment B

Conceptual One-Line Diagram

Upgrade of the Colby 115 kV Substation
To Accommodate the GEN-2012-026 Interconnection


TO NEW GENERATION
T5 115/12.47KV
TO ATWOOD
T4 115/34.5KV
TO 34.5KV GUDGEON
TO HILL CITY/ HIXIE
1200A
52
1200A
52
1200A
52
1200A
52
1200A
52
1200A
52
1200A
52
1200A
52
1200A
52
1200A
52
S&C CIRCUIT SWITCHER
3803
T1 115/69KV
T3 69/34.5KV
TO 34.5KV SUBSTATION
3802
S&C CIRCUIT SWITCHER
T2 115/34.5KV
TO 34.5KV SUBSTATION
FUTURE
FUTURE
TO MINGO
LEGEND:
FUTURE
EXISTING
NEW
NOTES:
1. FOR PHYSICAL LOCATION DIAGRAM SEE DWG. SK-P-6.
B 6-4-13 ISSUED FOR REVIEW YCP BJL
A 4-19-13 ISSUED FOR REVIEW YCP BJL
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COLBY SUBSTATION 115KV EXPANSION
ONELINE OPTION E
DRAWN BY: YCP 4-18-13
CHK'D BY: BJL 6-4-13
REV: YCP-B 6-4-13
DRAWING NO. SK-005
SHEET 1 OF 1
SCALE: NONE