ERCOT Independent Review of the AEPSC Airline/North Padre Island Area Improvements Project

Version 1.0

Document Revisions

Date	Version	Description	Author(s)
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1. Introduction

American Electric Power Service Corporation (AEPSC) received ERCOT Board of Director endorsement for projects in the Corpus Christi Area in December of 2009. Two of the Corpus Christi Area projects, the Barney Davis-Laguna 138 kV line and Laguna 138/69 kV autotransformer, were in the Airline/North Padre Area, which is served by a 69 kV system sourced from the 138 kV system at Airline and Aransas Pass Substations.

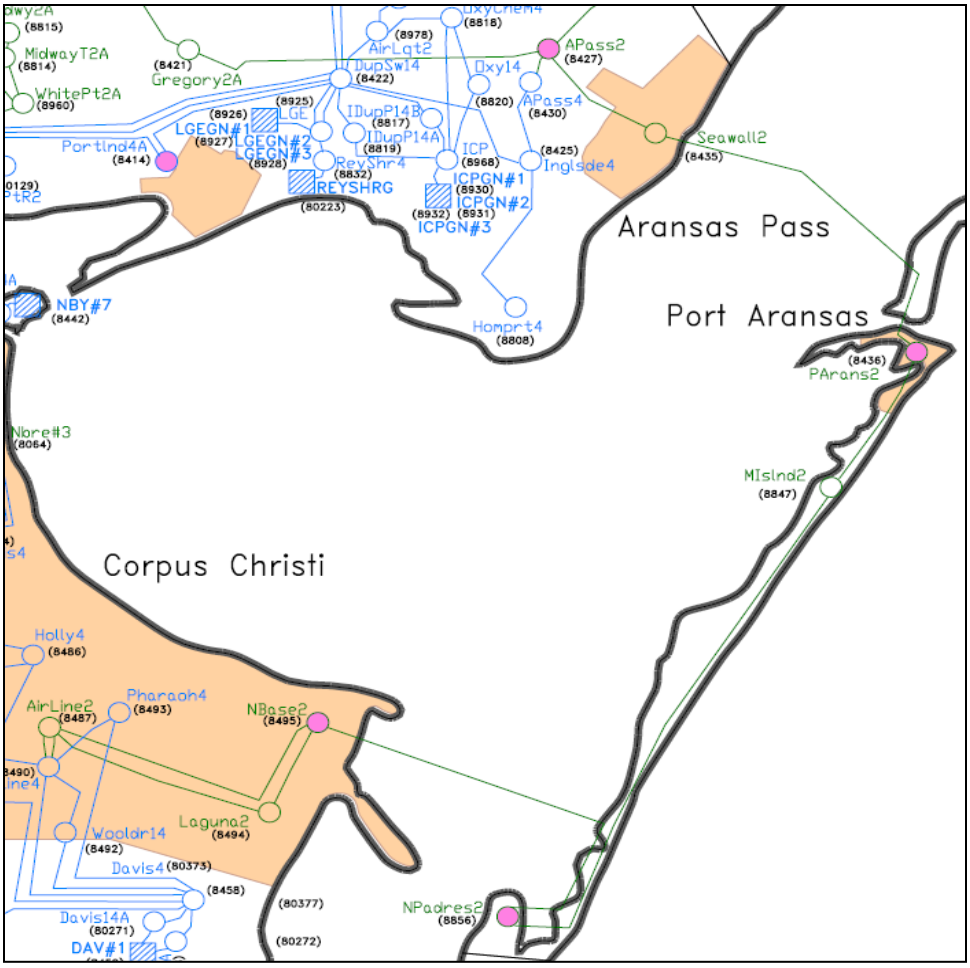

Figure 1: Airline/North Padre Area

Without the Barney Davis-Laguna 138 kV line and Laguna 138/69 kV autotransformer projects, when one of the Airline 138/69 kV autotransformer is out of service on maintenance and the other autotransformer is forced out of service under contingency, the entire 69 kV load in the area will be supplied via the Aransas Pass substation. The resulting power flow analysis for this condition indicates low voltage and severe thermal overloads on the 69 kV system in the area. A similar situation will occur when the 69 kV lines from Naval Base to Laguna and Naval Base to Airline are out of service. It should be noted that Naval Base is considered a critical load in this area.

After the environmental assessment and routing analysis conducted for the Barney Davis to Laguna 138 kV line, AEPSC received input from open house meetings on proposed line routes. As a result of the input,

AEPSC proposed the following improvements to replace the previously endorsed Barney Davis-Laguna 138 kV line and Laguna 138/69 kV autotransformer projects:

- Construct a new 138 kV transmission line from Barney Davis to Naval Base
- Install a 138/69 kV autotransformer at Naval Base
- Rebuild the existing Laguna to Naval Base 69 kV transmission line

The total cost for these improvements is estimated to be $58 million.

It should be noted that the Laguna to Naval Base 69 kV rebuild was identified in the ERCOT 2011 Five-Year Transmission Plan and LCRA TSC is presently evaluating the scope of this project and plans to implement this upgrade as well as addressing other non-capacity-related needs associated with this line.

ERCOT analyzed the system needs and reviewed the proposed project along with several other alternative projects.

2. Study Approach

The 2013 Steady State Working Group (SSWG) spring peak and fall peak cases were used to determine reliability criteria adherence in the Airline/North Padre Island area. The spring and fall cases were studied since planned maintenance outages typically occur during the spring and fall time periods. NERC Planning Criteria recommends planning for maintenance outages at system demand levels under which maintenance is performed. An N-1-1 contingency screening study was performed using TARA software. The total load for the 69 kV system in the Airline/North Padre Island region is shown in the Table -1:

Table-1: Load summary for Airline/North Padre Island area in SSWG 2013 cases

Substation	**SSWG 2013 cases load (MW)**		
	Spring Case	Fall Case	Summer Case
Aransas	15	15	17
Seawall	9	9	11
Port Aransas	21	20	23
Mustang	3	3	4
North Padre	22	21	24
Naval Base	39	38	41
Laguna	17	16	19
Airline	59	55	66
Total	**185**	**177**	**205**

The results of the N-1-1 screening indicated that several maintenance outage conditions in the Airline/North Padre Island region would causes severe overloads and voltage problems. The summary of results of the N-1-1 study for the 2013 spring peak case is shown in Table-2. The detail N-1-1 screening results are included in Appendix A.

Table-2 Identified contingency summary for 2013 spring peak case

Contingency	Violations	Load Shed MW to resolve the violations
Airline 138/69 Transformer 1 Airline 138/69 Transformer 2	Voltage collapse results in power flow divergence	101 MW (after first contingency)
Laguna to Naval Base 69 kV line Airline to Naval Base 69 kV line	Low voltage at Naval Base (0.87 pu) and North Padre (0.89 pu), Branch violations: Aransas -> Seawall ckt 1 (136%) Seawall -> Port Aransas ckt 1 (119%)	25 MW (N-1-1 post contingency)
Airline to Laguna 69 kV line Airline to Naval Base 69kV line	Voltage Collapse Branch violations: Aransas -> Seawall ckt 1 (206%) Seawall -> Port Aransas ckt 1 (188%) N Padre -> Naval Base ckt 1 (117%) Mustang -> North Padre ckt 1 (141%)	42 MW (N-1-1 post contingency)
Aransas Pass to Seawall 69 kV line Airline to Naval Base 69 kV line	Branch violations: Laguna -> Naval Base ckt 2 (124%) Airline -> Laguna ckt 2 (107%)	39 MW (N-1-1 post contingency)
Seawall to Port Aransas 69 kV line Airline to Naval Base 69 kV line	Branch violation: Laguna -> Naval Base ckt 2 (112%)	27 MW (N-1-1 post contingency)
Naval Base to North Padre 69 kV line Ingleside to DupSW 138 kV line	Branch violations: Rincon -> Gregory ckt 1 (103%) Rockport 138/69 kV auto transformer (103%)	7 MW (N-1-1 post contingency)

A load shed analysis was performed to determine the amount of load shed that would be needed to resolve the N-1-1 overloads. The results of the load shed analysis are included in Table-2. Since the Naval Base substation is considered critical load, it was not considered in the load shed analysis.

The load shed results showed that with Airline 138/69 kV autotransformer out of service (maintenance outage), the contingency loss of the remaining Airline 138/69 kV autotransformer would result in local voltage collapse in the Airline/North Padre Island area under the spring peak condition. To prevent this, approximately 101 MW of load shed (out of total 185 MW total load in the area) would be needed following the first contingency.

3. Description of Project Alternatives and Reliability Analysis

Eight project alternatives were initially analyzed for solving the N-1-1 reliability issues that were identified in the 2013 spring peak condition. The eight project alternatives studied for initial consideration are discussed below:

3.1. Description of Studied project alternatives

In the ERCOT analysis, the Laguna to Naval Base 69 kV line rebuild (Rate B approximately 115 MVA) was considered as a planned upgrade in the base case.

Option 1

- Construct a new 138 kV transmission line from Barney Davis to Laguna such the circuit Rate B is approximately 320 MVA
- Install a 138/69 kV autotransformer at Laguna such the circuit Rate B is approximately 165 MVA
- Rebuild the existing Aransas to Seawall and Seawall to Port Aransas 69 kV line such the circuit Rate B is approximately 173 MVA

Total cost is estimated at $51.7M

Option 2 (AEP proposed Option)

- Construct a new 138 kV transmission line from Barney Davis to Naval Base such the circuit Rate B is approximately 320 MVA
- Install a 138/69 kV autotransformer at Naval Base such the circuit Rate B is approximately 165 MVA

The total cost is estimated at $54.7M

Option 3

- Construct a new 138 kV transmission line from Pharaoh to Naval Base such the circuit Rate B is approximately 320 MVA
- Install a 138/69 kV autotransformer at Naval Base such the circuit Rate B is approximately 165 MVA

Total cost is estimated at $56.7M

Option 4

- Convert two of the four Airline 69 kV distribution banks to 138 kV
- Convert two Naval Base 69 kV distribution banks to 138 kV
- Install a 138/69 kV autotransformer at Naval Base such that the Rate B is at least 165 MVA
- Convert the Airline to Naval Base 69 kV transmission line to 138 kV service (note: the line is currently constructed for 138 kV service)
- Rebuild the existing Laguna to Naval Base 69-kV transmission line such that the Rate B is approximately 173 MVA

Total cost is estimated at $40.3M

Option 5 (based on ERCOT previous endorsement)

- Construct a new 138 kV transmission line from Barney Davis to Laguna such the circuit Rate B is approximately 320 MVA
- Install a 138/69 kV autotransformer at Laguna such the circuit Rate B is approximately 165 MVA

Total cost is estimated at $37.7

Option 6

- Construct a new 138/69 kV substation (Wooldridge) to tie into the Airline to Pharaoh 138 kV line and the Airline to Laguna 69 kV line
- Install a 138/69 kV autotransformer at Wooldridge such the circuit Rate B is approximately 165 MVA
- Modify relaying and line terminals for tie to new Wooldridge Substation

Total cost is estimated at $22.2M

Option 7

- Install a 138/69 kV autotransformer at Wooldridge such the circuit Rate B is approximately 165 MVA
- Modify relaying and line terminals for tie to new Wooldridge Substation
- Rebuild the existing Aransas to Seawall and Seawall to Port Aransas 69 kV line such the circuit Rate B is approximately 173 MVA
- Rebuild a portion of the Mustang to North Padre 69 kV line such that the circuit Rate B is approximately 173 MVA
- Add a 5 Mvar capacitor at Naval Base.
- Add a 12 Mvar capacitor at Laguna

Total cost is estimated at $55.5 M

Option 8

- Convert four Airline 69 kV distribution banks to 138 kV
- Convert two Naval Base 69 kV distribution banks to 138 kV
- Install a 138/69 kV autotransformer at Naval Base such the circuit Rate B is approximately 165 MVA
- Convert the Airline to Naval Base 69 kV transmission line to 138 kV such that the circuit Rate B is approximately 173 MVA
- Rebuild the Laguna to Naval Base 69 kV transmission line and convert to 138 kV such that the circuit Rate B is approximately 173 MVA
- Convert one Laguna 69 kV distribution bank to 138 kV
- Convert the Airline to Laguna 69 kV transmission line to 138 kV

Total cost is estimated at $60.5M

The initial screening contingency analysis results showed that only Option 1, Option 2 and Option 3 could resolve all violations without shedding a significant amount of load for N-1-1 conditions in the SSWG 2013 spring peak case. Option 2 and Option 3 had similar reliability performance while cost for Option 2 was less than Option 3. The reliability study results of all the options can be found in Appendix B.

3.2. Reliability Analysis based on Spring/Fall Peak Cases for Option 1 and Option 2

Based on the N-1-1 screening study, the major violations are caused by the loss of the Airline autotransformers and the loss of the Laguna-Naval Base and Airline-Naval Base 69 kV lines.

Option 1 and Option 2 were identified as the most reliable solutions to solve the voltage and thermal violations.

Option 1 (based on ERCOT previous endorsement)

The below diagram illustrates the transmission topology related to Option 1 upgrades:

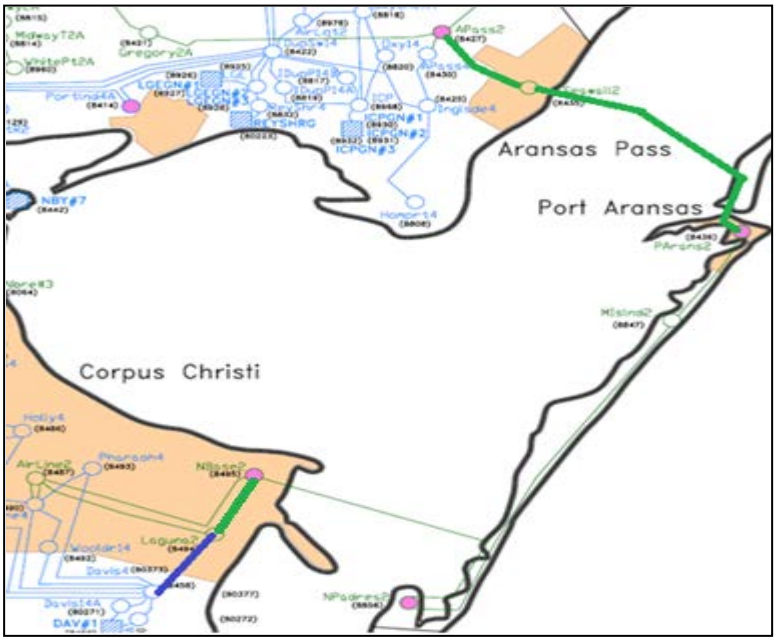

Figure 2: Option 1 Upgrades

Table-3 Option 1 contingency analysis results for spring/fall case

Contingency	Violations		Load Shed MW to resolve the violations	
	Spring Case	Fall Case	Spring Case	Fall Case
Airline 138/69 Transformer 1 Airline 138/69 Transformer 2	-	-	-	-
Laguna to Naval Base 69 kV line Airline to Naval Base 69 kV line	-	-	-	-
Airline to Laguna 69 kV line Airline to Naval Base 69kV line	-	-	-	-
Aransas Pass to Seawall 69 kV line Airline to Naval Base 69 kV line	-	-	-	-
Seawall to Port Aransas 69 kV line Airline to Naval Base 69 kV line	-	-	-	-
Naval Base to North Padre 69 kV line Ingleside to DupSW 138 kV line	Branch violations: Rincon -> Gregory ckt 1 (104%) Rockport 138/69 kV auto (103%)	-	7 MW	-

Option 1 resolved all of the violations[1]. It should be noted that the load at Naval Base was served radial under the loss of 69 kV lines from Naval Base to Laguna and Airline.

Option 2

The transmission topology of Option 2 is shown as below:

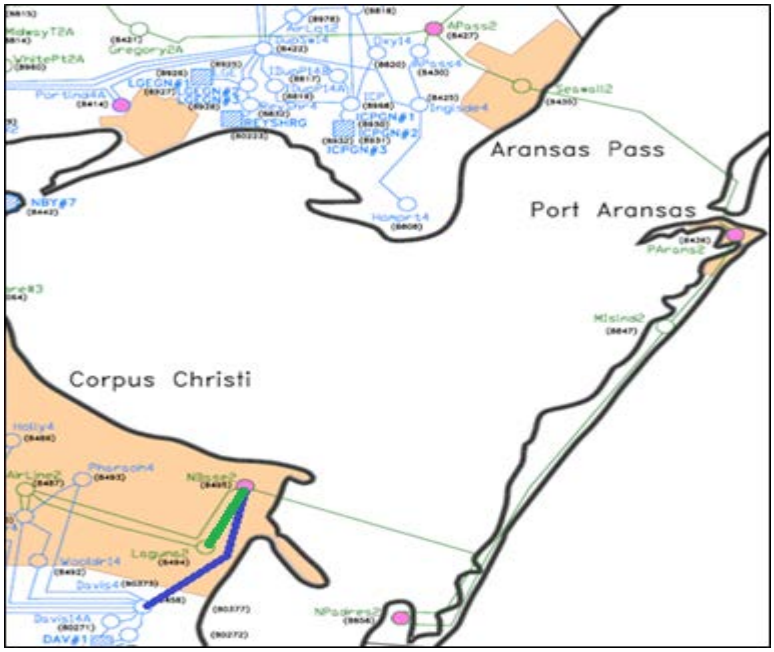

Figure 3: Option 2 Upgrades

[1] The violations caused by the loss of Naval Base to North Padre 69 kV line and Ingleside to DupSW 138 kV line exist for both Option 1 and Option 2 in the spring case. This violation was not considered critical since the overload percentages were relatively small and can be managed effectively in real-time.

Table-4 Option 2 contingency analysis results for spring/fall case

Contingency	Violations		Load Shed MW to resolve the violations	
	Spring Case	Fall Case	Spring Case	Fall Case
Airline 138/69 Transformer 1 Airline 138/69 Transformer 2	-	-	-	-
Laguna to Naval Base 69 kV line Airline to Naval Base 69 kV line	-	-	-	-
Airline to Laguna 69 kV line Airline to Naval Base 69kV line	-	-	-	-
Aransas Pass to Seawall 69 kV line Airline to Naval Base 69 kV line	-	-	-	-
Seawall to Port Aransas 69 kV line Airline to Naval Base 69 kV line	-	-	-	-
Naval Base to North Padre 69 kV line Ingleside to DupSW 138 kV line	Branch violations: Rincon -> Gregory ckt 1 (104%) Rockport 138/69 kV auto (103%)	-	7 MW	-

Option 2 also resolved all of the violations[1].

3.3. Sensitivity Analysis on Load Growth Scenario for Option 1 and Option 2

AEPSC stated that an additional 13.2 MW of load will be added at Naval Base by the end of 2012. A sensitivity analysis was performed to study the impact of additional load growth in the area. Option 1 and Option 2 were tested on the following two sensitivity scenarios:

a. The 2013 SSWG spring case with 13.2 MW more load at Naval Base.

b. 10% load scale up in the whole South weather zone based on Scenario a.

Table-5 Option 1 contingency analysis results for Scenario a

Contingency	Violations	Load Shed MW to resolve the violations
Airline 138/69 Transformer 1 Airline 138/69 Transformer 2	-	-
Laguna to Naval Base 69 kV line Airline to Naval Base 69 kV line	Low Voltage at Naval Base (0.59 pu), Mustang (0.74 pu), North Padre (0.64 pu) and Port Aransas (0.83 pu). Branch violations: N Padre -> Naval Base ckt 1 (108%) Mustang -> N Padre ckt 1 (131%)	12 MW
Airline to Laguna 69 kV line Airline to Naval Base 69kV line	-	-
Aransas Pass to Seawall 69 kV line Airline to Naval Base 69 kV line	-	-
Seawall to Port Aransas 69 kV line Airline to Naval Base 69 kV line	-	-
Naval Base to North Padre 69 kV line Ingleside to DupSW 138 kV line	Branch violations: Rincon -> Gregory ckt 1 (104%) Rockport 138/69 kV auto (103%)	7 MW

It should be noted that although the loss of Laguna to Naval Base and Airline to Naval Base 69 kV lines resulted in very low voltages (below 0.8 pu) at some buses in the simulation, it is likely that the voltage stability at these buses would not be achievable and voltage collapse would be experienced at these locations.

Table-6 Option 1 contingency analysis results for Scenario b

Contingency	Violations	Load Shed MW to resolve the violations
Airline 138/69 Transformer 1 Airline 138/69 Transformer 2	-	-
Laguna to Naval Base 69 kV line Airline to Naval Base 69 kV line	Voltage collapse	25 MW
Airline to Laguna 69 kV line Airline to Naval Base 69kV line	-	-
Aransas Pass to Seawall 69 kV line Airline to Naval Base 69 kV line	-	-
Seawall to Port Aransas 69 kV line Airline to Naval Base 69 kV line	-	-
Naval Base to North Padre 69 kV line Ingleside to DupSW 138 kV line	Branch violations: Rincon -> Gregory ckt 1 (116%) Rockport 138/69 kV auto (113%)	23 MW

To resolve the thermal and voltage violations, Scenario a and Scenario b would require approximately 12 MW and 25 MW load shed respectively (at non-Naval Base substations).

Option 2 showed no thermal or voltage violations[1] under both load growth Scenarios a and b.

3.4. Voltage Stability Analysis for Option 1 and Option 2

Option 1 and Option 2 could both resolve the reliability violations in the SSWG 2013 spring peak and fall peak cases without shedding any critical load. For load growth scenarios, Option 1 required a certain amount of load shed at non critical locations while Option 2 had no thermal or voltage violations[1].

N-1-1 voltage stability analysis using VSAT was performed using the 2013 SSWG spring peak case to assess the voltage stability margin for each option.

Table-7 PV analysis results

	Voltage Stability Margin (MW)	Limiting Contingency
Option 1	20	Laguna -> Naval Base ckt 2 Airline -> Naval Base ckt 1
Option 2	122	Naval Base -> North Padre ckt 1 Ingleside -> DupSW ckt 1

4. Conclusion

Both Option 1 and Option 2 resolved the N-1-1 maintenance outage violations studied under 2013 spring and fall peak conditions. The cost for Option 1, estimated at $51.7M, was slightly less than Option 2, estimated at $54.7 M. However, Option 2 resulted in better support of future load growth when compared to Option 1. Also the voltage stability margin for Option 2 was significantly higher than Option 1. Based on this result, the facilities associated with Option 2 appear to be the best alternative to meet the needs of the Airline/North Padre Island area. The following are the transmission system improvements associated with Option 2:

- Construct a new 138 kV transmission line from Barney Davis to Naval Base such the circuit Rate B is approximately 320 MVA
- Install a 138/69 kV autotransformer at Naval Base such the circuit Rate B is approximately 165 MVA

5. Designated Provider of Transmission Facilities

In accordance with the ERCOT RPG Planning Charter and Procedures Section 2.3.4, ERCOT staff is to designate transmission providers for projects reviewed in the RPG. The default providers will be those that own the end points of the new projects. These providers can agree to provide or delegate the new facilities or inform ERCOT if they do not elect to provide them. If different providers own the two ends of the recommended projects, ERCOT will designate them as co-providers and they can decide between themselves what parts of the recommended projects they will each provide.

Electric Transmission Texas (ETT) and American Electric Power Texas Central Company (AEP TCC) own the endpoints of the new 138 kV line from Barney Davis to Naval Base. Therefore, ERCOT designates Electric Transmission Texas (ETT) and American Electric Power Texas Central Company (AEP TCC) as co-providers of all transmission facilities recommended in this report.

6. Appendix

Appendix A

N-1-1_Screening.xlsx

Appendix B

ContingencyAnalysisResults.xlsx