ENERGY CONTROL CENTER
SYSTEM OPERATIONS REFERENCE MANUAL CAROLINAS

I. Title:

Phase Angle Regulating Transformer (PART) Operating Procedure

II. Purpose:

The purpose of this procedure is to:

A. Provide information related to the 230kV phase shifters at the Rockingham 230kV Substation, which can be operated by remote control from the ECC.

B. Define the procedure the System Operators will follow in operating the phase shifters on the Rockingham-Lilesville Black and White 230kV Lines at the Rockingham 230kV Substation.

III. References:

March 27, 2014 Sam Waters Affidavit

VACAR South Operating Limits Procedure – Attachment A1-15

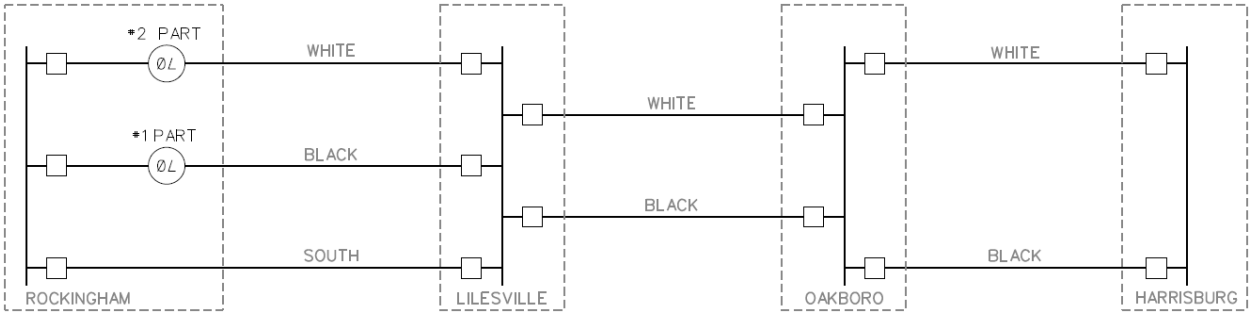
IV. General Information:

At the Rockingham 230kV Substation, the Lilesville-Rockingham 230kV Black and Lilesville-Rockingham 230kV White transmission lines are connected to a pair of 230kV 540MVA Phase Angle Regulating Transformers (PARTs), which can adjust automatically to limit the MW flow of these two lines.

The PARTs were originally placed into operation in 1980 in order to limit flows on the Rockingham-Oakboro 230kV Lines. At the time, transmission planning identified a contingency condition involving the loss of both Brunswick Units and the outage of the Richmond-Newport 500kV Line. However, due to changes in system conditions, including strengthening the path from Harrisburg to Oakboro to Lilesville and changes in load and generation patterns, the PARTs are no longer needed for this purpose.

Studies conducted during the Duke Energy/Progress Energy merger indicated that additional simultaneous import capability into the CPLE balancing authority was necessary in order to mitigate certain market screen failures. Operating the PARTs allows for increases in Simultaneous Import Limits (SIL) as required.

A commitment has been made to FERC to utilize the PARTs during the summer period (June 1 to August 31) to regulate flow on the Lilesville 230kV Black and White Lines to alleviate overloads on the Harrisburg-Oakboro 230kV Black and White Lines in order to maintain firm imports into the CPLE BA. The PARTs should be utilized on a pre-contingency basis from Step #28 (0.1° retard) to Step #20 (-7.64° retard), unless this burdens the Duke Energy Progress (DEP) system. Lowering the PARTs beyond Step #20 may be considered, but is beyond the commitment made to FERC.



V. Procedure:

A. If DEC notifies the ECC that the Harrisburg-Oakboro 230kV Black and White Lines are loading (pre-contingency or real-time) and requests DEP to step the PARTs in order to provide relief:

1. Place the #1 PART on manual via supervisory.
2. Place the #2 PART on manual via supervisory.
3. Lower the #2 PART one step via supervisory.
4. Verify the #1 PART has also moved one step.
5. While monitoring system power flows, continue to lower the #2 PART (and verify the #1PART has also stepped) until the necessary relief has been achieved.

Duke Energy has committed to utilizing the PARTs from Step 28 to Step 20 to alleviate the Harrisburg-Oakboro contingency. The PARTs may be stepped further if system conditions allow.

B. After system conditions improve and DEC and DEP agree to return the PARTs to their normal settings:

1. Verify the #1 and #2 PARTs are on manual and on the same step.
2. Raise the #2 PART one step via supervisory.
3. Verify the #1 PART has also moved one step.
4. Continue to raise the #2 PART (and verify the #1 PART has also stepped) until both PARTs are on step 28.

5. Place the #1 PART on automatic via supervisory.
6. Place the #2 PART on automatic via supervisory.

Refer to Appendix 1 for information about the controls for the #1 & #2 PARTs.

VI. Approval:

Recommend: _____ Date: 5-16-14
C. Wesson
System Operations Engineering

Concur: _____ Date: 5-16-14
Supervisor-System Operations

Approve: _____ Date: 5-16-2014
D. S. Roberts
Director-System Operations-ECC

VII. Editorial Change Approval:

Approve: _____ Date: _____
D. S. Roberts
Director-System Operations-ECC

VIII. Editorial Change Approval:

Approve: _____ Date: _____
D. S. Roberts.
Director-System Operations-ECC

NOTE: Original signatures can be found in the Master copy at the ECC.

General PART Information

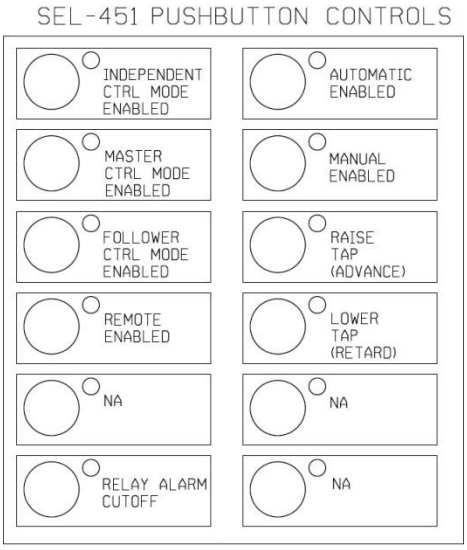
The PARTs have 33 positions. Positions 1 through 27 restrict power flow into Rockingham. Positions 29 through 33 restrict power flow out of Rockingham. The PARTs will normally operate at zero phase shift, which is Position 28 (actually 0.1° retard). The PARTs can be stepped manually or automatically.

A. Normal Operation

1. Under normal operating conditions, the PARTs will remain at zero degrees (actually 0.1 degree retard), Position Setting 28.
2. The PARTs can be controlled individually, but normally operate in parallel with #2 PART (Lilesville White) being the "MASTER" and #1 PART (Lilesville Black) being the "FOLLOWER."
3. As the line loading reaches 375 MW, the PART controls will operate automatically to limit the flow to 375MW.
4. The PART will automatically shift the phase angle to control line loading but will have to be stepped manually back to zero shift (Position 28) by the System Operator.

B. Controls

The PART controls are located in the relay building. The #1 & #2 PART LTC Control Panel contains two SEL-451 control relays, one for each PART. The keypad on the each SEL-451 has the following push buttons.



1. INDEPENDENT CTRL MODE ENABLED

   Places both PARTs into “Independent” mode.

2. MASTER CTRL MODE ENABLED

Places the associated PART into “Master” mode and the other PART into “Follower” mode.

3. FOLLOWER CTRL MODE ENABLED

   Places the associated PART into “Follower” mode and the other PART into “Master” mode.

   NOTE: Only one mode can be selected at a time. The SEL-451 relays communicate with each other and have logic associated with them such that the selected mode on one PART will initiate the corresponding mode on the other PART.

4. REMOTE ENABLED

   Enables supervisory control of the associated PART.

5. AUTOMATIC ENABLED

   Enables automatic operation of the PART controls.

6. MANUAL ENABLED

   Disables automatic operation of the PART controls.

   NOTE: Turning off Automatic Enabled will turn on Manual Enabled and vice versa.

7. RAISE TAP (ADVANCE)

   Manually steps the associated PART LTC in the raise direction

8. LOWER TAP (RETARD)

   Manually steps the associated PART LTC in the lower direction

9. RELAY ALARM CUTOFF

   Disables the PART Control Relay alarm

C. Mode of Operation (INDEPENDENT/MASTER/FOLLOWER)

1. Independent Mode

   a. Independent mode allows for each PART to be operated separately from one another.

   b. When one PART is placed into Independent, the other PART will also be placed into Independent.

   c. Independent mode would only be used when one PART is out-of-service and bypassed.

2. Master/Follower Mode

   a. Master/Follower mode allows for the both PARTs to be operated in parallel.

b. Either PART can be operated in Master or Follower mode. Placing one PART into Master mode will automatically place the other PART into Follower mode.

c. There is no SCADA indication of what mode a PART is in. The #2 PART should be in Master mode and the #1 PART in Follower mode.

3. Manually stepping a PART

a. Place both PARTs on manual.

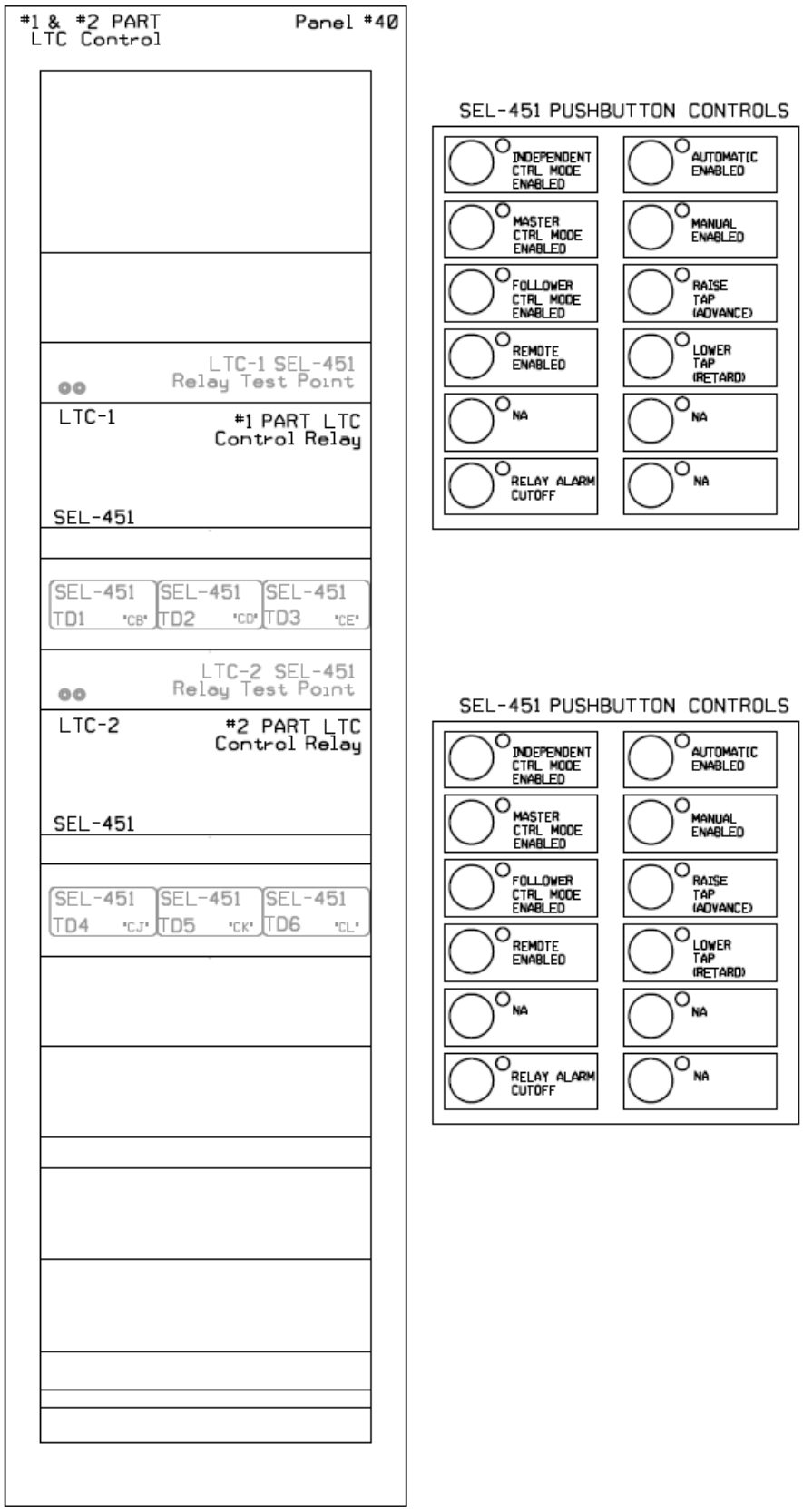
b. Raise or Lower the #2 PART one position and verify that the #1 PART follows the #2 PART to the desired position.

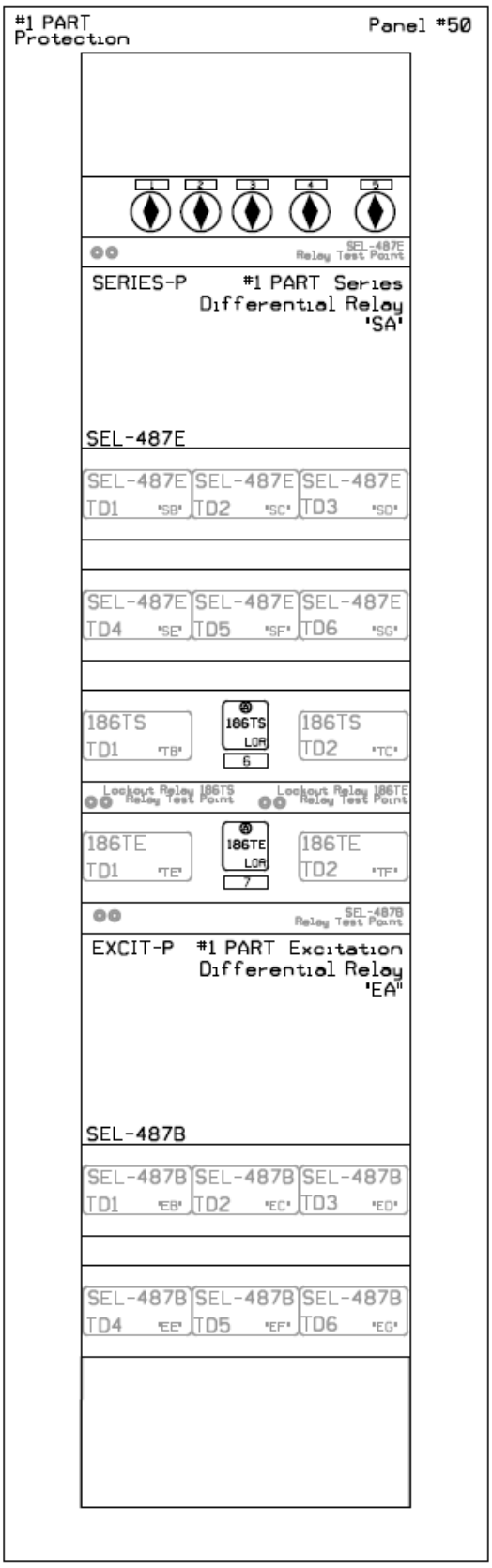
c. The PARTs can be stepped one position at a time.

PART Tapchanger Name Plate

CAUTION: TAP CHANGER FOR DE-ENERGIZED OPERATION						LOAD TAP CHANGER			
POSITION A		POSITION B		POSITION C					
CONNECTS ON EACH PHASE						POSITION	CONNECTS ON EACH PHASE		
11 TO 14, 12 TO 13		11 TO 13, 12 TO 13		11 TO 13, 12 TO 14					
PHASE ANGLE DEGREES							Y TO	Z TO	N TO
25.18		15.02		4.61		33	9	9	1
24.28		14.09		3.67	ADVANCE	32	8	9	1
23.37		13.16		2.73		31	8	8	1
22.47		12.22		1.78		30	7	8	1
21.56		11.29		0.84		29	7	7	1
20.64		10.35		0.10		28	6	7	1
19.73		9.42		1.05		27	6	6	1
18.81		8.48	ADVANCE	1.99		26	5	6	1
17.89		7.54		2.94		25	5	5	1
16.97		6.60		3.88		24	4	5	1
16.05		5.66		4.82		23	4	4	1
15.12		4.72		5.76		22	3	4	1
14.19		3.77		6.70		21	3	3	1
13.26		2.83		7.64		20	2	3	1
12.33		1.89		8.58		19	2	2	1
11.39		0.94		9.52		18	N	2	1
10.46		0.00		10.46		17	N	N	10
9.52		0.94		11.39		16	9	N	10
8.58		1.89		12.33		15	9	9	10
7.64		2.83		13.26		14	8	9	10
6.70		3.77		14.19		13	8	8	10
5.76		4.72		15.12		12	7	8	10
4.82		5.66		16.05		11	7	7	10
3.88		6.60		16.97		10	6	7	10
2.94		7.54		17.89		9	6	6	10
1.99		8.48		18.81		8	5	6	10
1.05		9.42		19.73		7	5	5	10
0.10		10.35		20.64		6	4	5	10
0.84		11.29		21.56		5	4	4	10
1.78		12.22		22.47		4	3	4	10
2.73		13.16		23.37		3	3	3	10
3.67		14.09		24.28		2	2	3	10
4.61		15.02		25.18		1	2	2	10

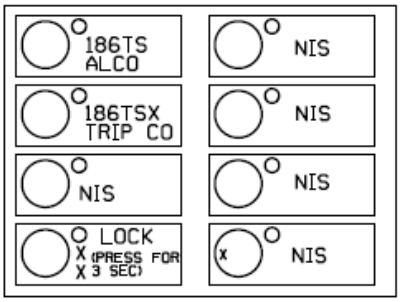
ADVANCE (spans rows 25.18 through 0.10)
RETARD (spans rows 0.84 through 4.61)
ADVANCE (spans rows 20.64 through 11.39)
RETARD (spans rows 9.52 through 0.10)
RETARD (spans rows 0.84 through 4.61)


#1 & #2 PART LTC Control
Panel #40
LTC-1 SEL-451 Relay Test Point
LTC-1
#1 PART LTC Control Relay
SEL-451
SEL-451 TD1 "CB"
SEL-451 TD2 "CD"
SEL-451 TD3 "CE"
LTC-2 SEL-451 Relay Test Point
LTC-2
#2 PART LTC Control Relay
SEL-451
SEL-451 TD4 "CJ"
SEL-451 TD5 "CK"
SEL-451 TD6 "CL"
SEL-451 PUSHBUTTON CONTROLS
INDEPENDENT CTRL MODE ENABLED
AUTOMATIC ENABLED
MASTER CTRL MODE ENABLED
MANUAL ENABLED
FOLLOWER CTRL MODE ENABLED
RAISE TAP (ADVANCE)
REMOTE ENABLED
LOWER TAP (RETARD)
NA
NA
RELAY ALARM CUTOFF
NA
SEL-451 PUSHBUTTON CONTROLS
INDEPENDENT CTRL MODE ENABLED
AUTOMATIC ENABLED
MASTER CTRL MODE ENABLED
MANUAL ENABLED
FOLLOWER CTRL MODE ENABLED
RAISE TAP (ADVANCE)
REMOTE ENABLED
LOWER TAP (RETARD)
NA
NA
RELAY ALARM CUTOFF
NA



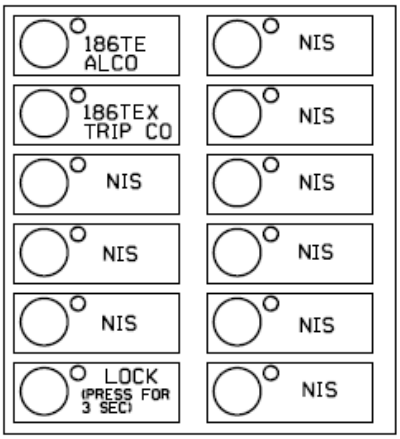
1) Relay Alarm Cutoff
2) Transient Recorder Trigger Cutoff
3) Transformer Alarm Cutoff
4) 63FPS Trip Cutoff
5) 63FPE Trip Cutoff

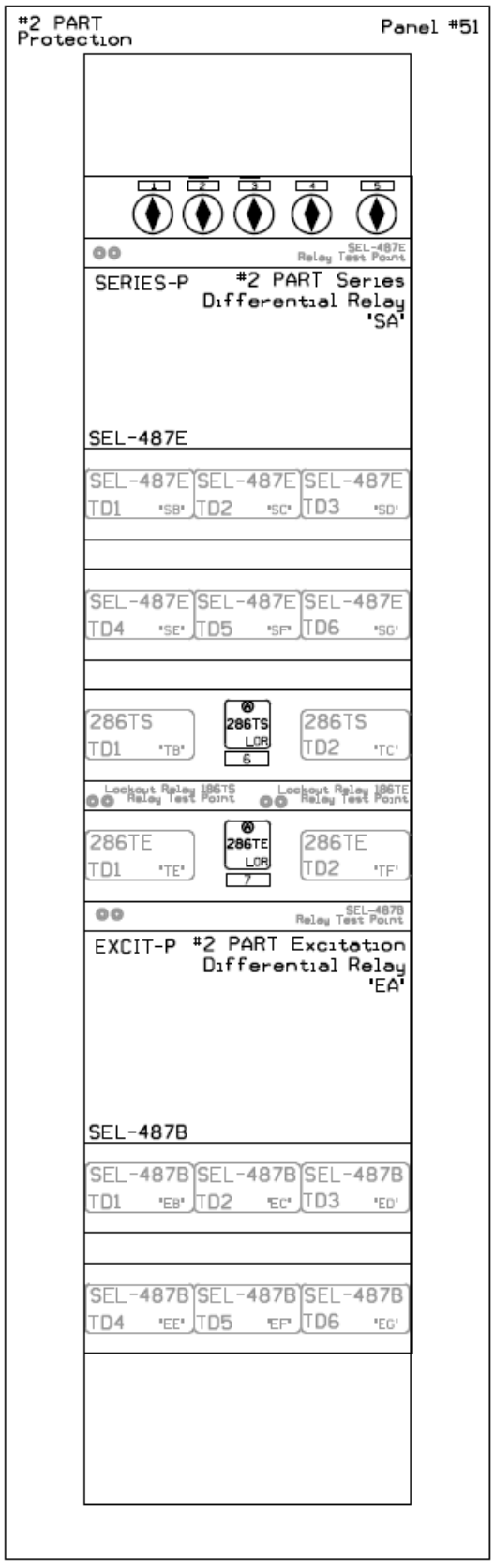
SEL-487E PUSHBUTTON CONTROLS



6) Series Differential Lockout Relay "TA"
7) Excitation Differential Lockout Relay "TD"

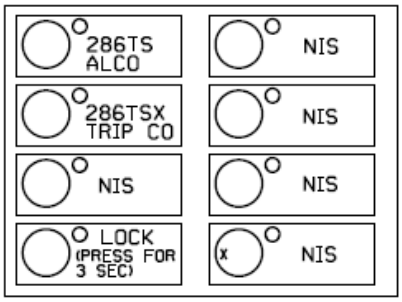
SEL-487B PUSHBUTTON CONTROLS





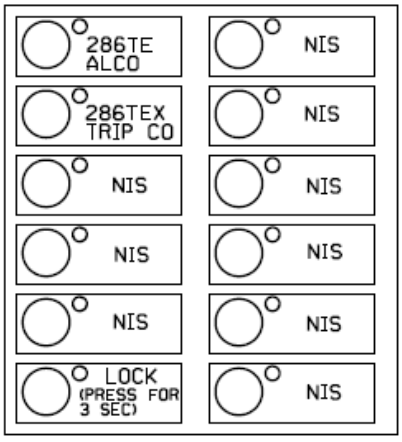
1) Relay Alarm Cutoff
2) Transient Recorder Trigger Cutoff
3) Transformer Alarm Cutoff
4) 63FPS Trip Cutoff
5) 63FPE Trip Cutoff

SEL-487E PUSHBUTTON CONTROLS



6) Series Differential Lockout Relay 'TA"
7) Excitation Differential Lockout Relay "TD'

SEL-487B PUSHBUTTON CONTROLS



Supplemental Affidavit of Sam Waters

Purpose of Supplemental Affidavit:

My name is Samuel Waters, and I am the General Manager of Transmission Planning for Duke / Energy Corporation ("Duke"). In testimony filed earlier in this proceeding, I sponsored the transmission mitigation measures on the Progress Energy system that were the basis for the Phase 2 mitigation in this proceeding. The purpose of this Supplemental Affidavit is to respond to questions posed by the FERC in a letter dated March 4, 2014, regarding aspects of the Phase 2 mitigation, specifically the use of Phase Shifters on two 230kV Lilesville-Rockingham lines owned by Progress Energy to increase import capability into the Progress Energy east system.

Removal and Return to Service of Phase Shifters:

The Phase Shifters on each of the two Lilesville-Rockingham transmission lines were removed from service on December 16, 2008, following a failure of one of the tap changer mechanisms during a routine maintenance procedure. Both Phase Shifters were taken out of service following that failure while an analysis was done to determine the need for repairing the failed tap changer mechanisms and placing them back in service. The results of the analysis indicated that although the repair cost was relatively small, estimated to be $200,000 -300,000, there was no operational need to return the Phase Shifters to service. The Phase Shifters were left in place at the site for potential future use at that or another location on the system.

The Phase Shifters were originally placed into operation in 1980 in order to limit flows on the Rockingham-Oakboro transmission lines. The need for the Phase Shifters was identified by then Carolina Power & Light Company's ("CP&L") transmission planning department under a contingency condition involving the loss of both generating units at the Brunswick generating station (the Brunswick generating units were placed in service in 1975 and 1977), and the outage of the Newport-Richmond 500 kV tie between Duke and CP&L. However, due to changes in system conditions on both the Duke and CP&L/Progress Energy systems, including strengthening the path from Harrisburg to Oakboro to Lilesville and changes in load and generation patterns, the Phase Shifters were no longer needed for this purpose, and in fact had not been used for many years prior to the failure of the tap changer described above. Therefore, Progress Energy took them out of service in order to eliminate the cost of maintaining the Phase Shifters. However, the Phase Shifters were not removed and were always available to be restored and placed into service if they were needed.

In connection with the Phase 2 transmission mitigation, Duke Energy began restoring the Phase Shifters shortly after the merger was consummated with the intent that they be placed back into service by the time that the Phase 2 mitigation was scheduled to commence. This work began in 2013. Upon examination of the failed tap changer on one Phase Shifter, and a thorough evaluation of both Phase Shifters, it was determined that bringing the Phase Shifters back to a serviceable condition would require a greater investment than originally estimated. In addition, the Phase Shifters were thoroughly inspected and any issues addressed, including replacement of the tap changing mechanisms on both Phase Shifters. Accordingly, Duke has spent approximately $6 Million in order to put the Phase Shifters back into service. This work has been completed, the Phase

Shifters have been tested in the field, and they are now ready to be placed in service. They will be placed in service prior to the summer period, starting June 1 of this year, and before the Phase 2 mitigation is scheduled to take effect.

Duke considered restoration and return to service of the Phase Shifters to be an obligation associated with our Phase 2 transmission commitments. We understood that under the methodology employed by Dr. Hieronymus, who testified in support of the Duke Energy - Progress Energy merger application, additional simultaneous import capability into the Progress Energy east balancing authority area was necessary in the summer off peak period for mitigation of certain market screen failures. Restoring the Phase Shifters to operational status permitted us to achieve sufficient increases in that simultaneous import capability. That is why the Company spent $6 Million to restore the Phase Shifters and make them available for operations on the system in advance of using the Phase 2
mitigation.

Treatment of Phase Shifters in Mitigation Filing:

In the Applicants' transmission mitigation filing, we considered the Phase Shifters to be part of the existing Progress Energy system that could be used to increase import capability rather than new facilities like the other Phase 2 transmission projects proposed for the Progress Energy system, due to their presence on the system and the relatively low repair costs initially estimated. However, I do not consider this difference to be material from a technical standpoint. Whether restoration of the Phase Shifters is modeled as an update of the existing system or considered to be an additional transmission mitigation project, the results are the same. Operation of the Phase Shifters at the settings used in the studies supporting the transmission mitigation filing allow the increases in Simultaneous Import Limits ("SIL") reported in the transmission mitigation filing to be achieved.

In short, we have restored the Phase Shifters, we are committed to operate them to provide increased transmission import capability in Phase 2, and their operation produces the SIL increase shown in the mitigation filing.

Difference in SIL and ATC Modelling:

The FERC has asked Duke to explain why the Phase Shifters were modeled as being in service and operated at the proposed tap setting for purposes of calculating SIL but were modeled as being bypassed in the calculation of Available Transmission Capability ("ATC") for the merger mitigation filing in 2012. At the time we were putting together the Phase 2 mitigation, we treated the two calculations separately. We performed the post-mitigation SIL calculation to provide an accurate picture of the amount of transmission import capability that will be available into the Progress Energy east balancing authority area at one time, once the Phase 2 mitigation is in place. As I will discuss below, we thought that we were properly applying the Commission's rules in calculating SIL, and I still believe that.

ATC calculations for Progress Energy were typically performed by System Operations, but because the Phase 2 merger commitments were intended to identify future conditions that would occur following the installation of proposed transmission upgrades, system planning took responsibility for

calculating ATC for the transmission mitigation filing. The Phase Shifters had not been used in the past for calculating ATC. When we performed our ATC calculations for the mitigation filing, because the Phase Shifters had not been used to calculate ATC in the past, we did not include them in calculating post-merger ATC. Because we were viewing the SIL and ATC as separate calculations, we never focused on the inconsistency between the SIL and ATC modeling and never analyzed what would happen to the DPT results if we made a different assumption. This issue was also never discussed with our economic consultants or attorneys. I was the person responsible for the transmission analysis supporting the Progress Energy transmission mitigation, and in retrospect I understand that we should have modeled the ATC consistently with our post-mitigation SIL calculation.

SIL Assumptions:

The FERC's letter states that the calculation of SIL should be based on historical system operating conditions and "must reasonably reflect its OASIS operating practices." In calculating pre-merger SIL, it makes perfect sense to rely on historical operating conditions and historical OASIS practices, and indeed that is what the Applicants did. However, the SIL calculation performed for the Phase 2 transmission mitigation filing was designed to show the future conditions on the system after the transmission mitigation projects are placed into service. It is by necessity a forward looking calculation that evaluates a situation where the historical configuration of the grid and operating conditions are changed. It is not clear to me how one would calculate the effects of future investments in transmission projects on SIL and OASIS operating practices by looking at historical conditions. This would seem to be inconsistent with the purpose of the analysis, which is to show how the transmission projects will change historical conditions.

To be clear, our calculation of SIL for the DPT study that preceded the analysis of the transmission mitigation, i.e. the pre-merger base case, was based entirely on historical system conditions, including the assumption that the Phase Shifters were not operating. We changed only study parameters that reflect the future effects of the transmission mitigation. Moreover, as explained below, we will change our OASIS operating practices to reflect the operation of the Phase Shifters. Thus, our transmission mitigation analysis reflected the actual conditions that will exist once the mitigation is in place.

Commitments Regarding Operation of the Phase Shifters:

Because there has been some misunderstanding regarding the role of the phase shifters in the proposed transmission mitigation, I propose that the following commitments be added to the existing Phase 2 transmission mitigation to provide assurances to FERC and the marketplace that the increase in transmission import capability into the Progress Energy east balancing authority area that was reported in the transmission mitigation filing will be achieved in actual operations.

1. Duke will calculate short-term and long-term ATC from PJM and Duke into the Progress Energy east balancing authority area for all summer periods (from June 1 to August 31) using the assumption that the Phase Shifters are modeled consistently with the modeling used in the SIL calculation presented in the Phase 2 mitigation filing. Specifically, the Phase Shifters will be used to regulate the flow on the Lilesville-Rockingham lines such that overloads on the Harrisburg-Oakboro lines are

alleviated under contingency. It is the overloading of these Harrisburg-Oakboro lines under contingency that determined the final Progress Energy east SIL value that was used in the Phase 2 merger mitigation filing. Consistent application of this assumption will produce a corresponding increase in ATC on the PJM-to-Progress Energy east and Duke-to-Progress Energy east interfaces when compared to a case without application of the Phase Shifters. Duke will treat this assumption as part of our ATC calculation methodology under Attachment C to the OATT and will make a filing to revise Attachment C to confirm that this assumption will be used in calculating ATC before the Phase 2 transmission mitigation takes effect.

2. Duke will operate the Phase Shifters during the entire summer period in a manner that will support delivery of firm imports, consistent with the calculations performed in the DPT analysis submitted with the Phase 2 mitigation filing and the calculation and posting of ATC described above. Duke will establish an operating procedure for this purpose, and the operating procedure will be posted on OASIS. Specifically, the operating procedure will instruct the system operator to implement the phase shifter tap setting required to alleviate overloads of the Harrisburg-Oakboro lines that are identified by real time contingency analysis, in order to maintain firm transactions across the Duke-Progress Energy east and PJM Progress Energy east interfaces. The operating procedure will be implemented as a pre contingency action by the system operator to maintain firm transactions.

In simple terms, Duke will calculate and post summer ATC values based on modeling of the Phase Shifters on the Lilesville-Rockingham lines consistent with their modeling to obtain the SIL values presented in the Phase 2 mitigation analysis, and will operate the Phases Shifters to support firm delivery of transactions into the Progress Energy east balancing authority area that are entered into based on those posted ATC results.

This completes my Affidavit.

Samuel Waters

0-8: See Transmission Services Unit

11/05/2010 SORMC was retired

9: 05/15/2014

- SORMC was rewritten.
- PARTs rebuilt after mechanical failure and new controls installed.
- Operating procedure for PARTs required to fulfill FERC obligation from Duke/Progress merger.

10: 05/16/2014

- Removed footer.
- Changed language to more closely reflect Affidavit.