RTA-10

Local Network Exclusion

Introduction

The purpose of this document is to provide the justification for the definitional exclusion of local networks (LN) from the definition of the Bulk Electric System (BES) as proposed in NERC Standards Development Project 2010-17. Presented herein are technical, logical, and practical considerations that provide such justification for exclusion of these facilities from the Bulk Electric System.

Summary of Justification

The local network exclusion proposal is shown to be justified through the following facts:

1. In accordance with Commission Orders 743 and 743a on the matter of the revision of the Definition of the Bulk Electric System, the facilities used in the local distribution of electric energy are to be excluded;
2. The exclusion for local networks, as provided in the revised definition of the BES, ensures that a candidate for local network exclusion must satisfy all of the exclusion principles thus demonstrating that the candidate facilities are not performing a transmission function;
3. The limit on connected generation within the local network is consistent with the existing threshold above which a generating plant in aggregate becomes subject to owner and operator registration in the ERO Statement of Compliance Registry Criteria;
4. The voltage cap applied to the qualifications for a local network is established at 300 kV, which is consistent with the distinction being made between Extra High Voltage and High Voltage in the NERC Board of Trustees-approved Reliability Standard on transmission planning, TPL-001-2;
5. The power flow "shifts" that would occur on the elements of a local network are but a negligible fraction of that which distributes upon the BES elements for a given power transfer and is fully eclipsed by the Load in the local network; and
6. The interaction of the local network with the BES is similar in character to that of a radial facility.

Description of Local Network

Local networks are defined in the draft BES Definition as:

A group of contiguous transmission Elements operated at or above 100 kV but less than 300 kV that distribute power to Load rather than transfer bulk power across the interconnected system. LN's emanate from multiple points of connection at 100 kV or higher to improve the level of service to retail customer Load and not to accommodate bulk power transfer across the interconnected system. The LN is characterized by all of the following:

a) *Limits on connected generation: The LN and its underlying Elements do not include generation resources identified in Inclusion I3 and do not have an aggregate capacity of non-retail generation greater than 75 MVA (gross nameplate rating) ;*
b) *Power flows only into the LN: The LN does not transfer energy originating outside the LN for delivery through the LN; and*
c) *Not part of a Flowgate or transfer path: The LN does not contain a monitored Facility of a permanent Flowgate in the Eastern Interconnection, a major transfer path within the Western Interconnection, or a comparable monitored Facility in the ERCOT or Quebec Interconnections, and is not a monitored Facility included in an Interconnection Reliability Operating Limit (IROL).*

Local networks are present to provide local electrical distribution service and are not planned, designed, nor operated to benefit or support the balance of the interconnected electrical transmission network. Their purpose is to provide local distribution service, not to provide transfer capacity for the interconnected electric transmission network. Their design and operation is such that at the point of connection with the interconnected electric transmission network, their effect on that network is similar to that of a radial facility, particularly in that flow always moves in a direction that is from the BES into the facility. Any distribution of parallel flows into the local network from the BES, as governed by the fundamentals of parallel electric circuits, is negligible, and, more importantly, is overcome by the Load served by the local network, thereby ensuring that the net actual power flow direction will always be into the local network at all interface points. The presence of a local network is not for the operability of the interconnected electric transmission network; neither will the local network's separation or retirement diminish the reliability of the interconnected electric transmission network.

Commission Determination on Exclusion of Local Distribution – Relation to Local Network

In Order 743a, the Commission made it clear that facilities that are used in the local distribution of electric energy will be excluded from the Bulk Electric System. Such clarification was provided in both paragraphs 22 and 25 of the Order. The Commission agreed with certain commenters that facilities used in the local distribution of energy should be excluded from the revised Bulk Electric System definition.

In response to this facet of the Order, in developing the BES definition, the SDT has followed this guidance. Exclusion E3 was specifically designed to capture for exclusion those high voltage non-radial facilities being used for the local distribution of energy.

The exclusion characteristics in items a, b, and c above are further explained in the next section. These exclusion principles serve to ensure that facilities excluded under the local network exclusion (E3) are not necessary for the reliable operation of the interconnected electric transmission network and are instead used in the local distribution of energy.

Exclusion Principles

Of key importance is that Exclusion E3 in the draft BES definition requires the facilities of a candidate network to meet all of the characteristics listed in the exclusion. The SDT adopted this approach to ensure that none of the characteristics typical of interconnected electric transmission networks, or necessary for the operation of the interconnected electric transmission system, would be permissible in those facilities that are qualified for Exclusion E3. In the discussion below, it is shown that these characteristics successfully prevent exclusion of facilities necessary for operating an interconnected electric transmission network, and allow only facilities that are not necessary for such operation to be excluded from the BES.

A. *First Exclusion Principle: Limits on Connected Generation*

> *Limits on connected generation: The LN and its underlying Elements do not include generation resources identified in Inclusion I3, and do not have an aggregate capacity of non-retail generation greater than 75 MVA (gross nameplate rating);*

This characteristic places restrictions on the type and size of generation resources that can be connected within the candidate facility. By placing this generation restriction on the local network, it is ensured that that the candidate facility will not under any circumstance act as a host to generation that exceeds the existing aggregate generation threshold in the ERO Statement of Compliance Registry Criteria (SCRC) and that the candidate facility will not contain Blackstart Resources. The SDT submits that this characteristic minimizes the contribution and influence the local network may have over the neighboring Elements of the BES by limiting both the magnitude and the function of the connected generation. The threshold of 75 MVA was chosen in a manner to provide consistency with the criteria applied in the ERO's SCRC regarding the registration for entities owning and operating generation plants in aggregate.

B. *Second Exclusion Principle: Power Flow and Function*

> *Power flows only into the LN: The LN does not transfer energy originating outside the LN for delivery through the LN;*

This characteristic ensures that the real power flow direction at all connection points to the BES is into the candidate local network, thereby ensuring that the candidate facilities behave in a manner that is radial in character. Further, the local network is restricted as to its use; i.e., it cannot be used for "wheel" transactions, or the transfer of energy originating outside the local network for delivery through the local network. By restricting the flow direction to be exclusively into the network at its connection points to the BES and precluding the network from providing transmission wheeling service, this exclusion characteristic further ensures that the local network is providing only a distribution service, and is not contributing to, nor is necessary for, the reliable operation of the interconnected electric transmission network. Regarding the location of the connection points to the BES, Exclusion E3 specifies that local networks "emanate from multiple points of connection at 100 kV or higher..." These points of emanation, where the local network begins and the BES ends, are established on a case-by-

case basis, but will necessarily be the points, below 300 kV, at which all of the qualifying exclusion principles are satisfied. As an example, see Appendix 1 to this document, which provides, among other things, a single line diagram depicting a local network and its interface with the BES.

C. *Third Exclusion Principle: Flowgates and Transfer Paths*

> *Not part of a Flowgate or transfer path: The LN does not contain a monitored Facility of a permanent Flowgate in the Eastern Interconnection, a major transfer path within the Western Interconnection, or a comparable monitored Facility in the ERCOT or the Quebec Interconnections, and is not a monitored Facility included in an Interconnection Reliability Operating Limit (IROL).*

This characteristic further ensures that the candidate local network facilities do not contain nor comprise facilities of well-established flowgates and transfer paths throughout the Interconnections of North America. These transfer paths are customarily used to provide bulk power transfers within the Interconnections, and therefore, the function and purpose of any candidate facilities included in or among such paths extends beyond the distribution function. A number of interchange coordination Reliability Standards apply to these transfer paths and flowgates. The SDT feels that such facilities are necessary for the reliable operation of an interconnected electric transmission network and would not be excluded from the definition of the BES.

The Use of a 300 kV Cap is Appropriate for Local Network Exclusion

The selection of a 300 kV cap for the applicability of an exclusion for a local network was based upon recent NERC Standards Development work in Project 2006-02 "Assess Transmission Future Needs and Develop Transmission Plans." As conveyed in its work product, TPL-001-2, the Project 2006-02 SDT sets a voltage level of 300 kV to differentiate Extra High Voltage (EHV) facilities from High Voltage facilities acting as a threshold to distinguish between expected system performance criteria.[1] The Project 2010-17 SDT seeks to establish consistency in the limitations placed on the exclusion applicability for local network facilities, and has therefore adopted this 300 kV level to ensure that EHV facilities, which under the TPL-001-2 Standard are held to a higher standard of performance, are not subject to this exclusion.

There is Minimal Effect to Flow in the Local Network due to BES Power Transfer

Similar to the character of a radial facility, and in order to qualify for exclusion from the BES under Exclusion E3.b, a local network must only have power flow into the network at all connection points to the BES. As demonstrated below, while this flow at the connection points is always into the local

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[1] Per footnote #3 in TPL-001-2, "Bulk Electric System (BES) level references include extra-high voltage (EHV) Facilities defined as greater than 300 kV and high voltage (HV) Facilities defined as the 300 kV and lower voltage Systems. The designation of EHV and HV is used to distinguish between stated performance criteria allowances for interruption of Firm Transmission Service and Non-Consequential Load Loss."

network, the magnitude of the flow at these connection points will exhibit very slight shifts as bulk power transactions are implemented on neighboring BES facilities. This occurs because local network facilities are electrically parallel to Elements comprising the BES, and hence, the local network will experience a small effect due to changes in power angle across the parallel network as BES dispatch and flow patterns change. However, such flow shift is shown to be minimal, and the resultant power flow at all BES interface points is dominated by the superimposed load flow serving the distribution Load connected within the local network. Again, Exclusion E3.b ensures that flow shall always be from the BES into the local network in order to qualify for exclusion.

In order to provide a realistic example of the electrical interaction between a typical local network and the BES, an electric system in the western United States was examined from a power transfer distribution factor (PTDF) perspective. In a PTDF analysis, the branch elements of an electrical network are examined on the basis of the percentage split of a given power flow as it propagates through the network. In the simplest example of two identical lines operated at the same voltage, arranged in parallel between a given sending bus and receiving bus, the total power transfer will divide equally among the two parallel line elements, and hence, each element would be found to have a 50% PTDF. In a more complicated network, the line elements will carry a portion of the total flow in a manner that is inversely proportional to their impedance; i.e., the lower the impedance of the network branch, the higher portion of the flow that will distribute along that branch.

The electric system in question is depicted in Appendix 1. The station name identifiers and the network topology (but not electrical connectivity) have been changed to respect the confidentiality of the information. In the represented system, a bulk power transfer was simulated, with a point of receipt (injection) at BES bus T9 and a point of delivery at the other end of the system at BES bus T10. With this simulated power transfer, power flow analysis tools were used to determine the distribution of this simulated transfer as it propagates across the various parallel branches of the network. As depicted in Appendix 1, the facilities that are presumed to be excluded via the local network exclusion (E3) are shown to carry negligible flow, with the largest PTDF at a mere 0.23% of the total transfer. Note that a PTDF analysis shows only the *incremental* shift in power flow and does not imply that this 0.23% actually flows in and then back out of the network. The power flow results demonstrate that the flow measured at the interface points of the BES continues to flow into the local network, and is essentially unchanged, as it is only shifted in magnitude by a mere 0.23% of the modeled transaction amount.

In addition to the PTDF analysis, another analysis of Line Outage Distribution Factors (LODF), examines the re-distribution of flow that occurs on parallel elements after a subject element is removed from service. For example, if a BES element is carrying 500 MW, and is taken out of service, LODF describes how that flow re-distributes among all parallel paths in a given network. LODF factors are measured in percent of the pre-outage flow on the outaged element. Conducting this analysis on the example network and modeling the worst case outage, which is the loss of the line element between BES buses T9 and T10, shows that the net shift in flow for the local network is 4.0% of the pre-outage flow, and the largest shift in flow on any of the individual local network elements is 2.7%. The flow direction at the interface points between the local network and the BES continues to be into the local network.

This degree of flow shift on the local network facilities is *de minimus*, and neither diminishes or improves the reliability of the parallel BES facilities. From both a PTDF and an LODF analysis perspective, the local network exhibits qualities equivalent to radial facilities in that the power flow emanates from the point of BES connection in one direction – the only difference being that in the case of the local network, in order to provide source reliability to the distribution Load, more than one connection is provided to the BES.

Appendix 1
Local Network Technical Justification
Power Transfer Distribution Factor Analysis

This appendix provides Power Transfer Distribution Factor (PTDF) and Line Outage Distribution Factor (LODF) analyses and assessments using a relevant power flow case used in actual operating studies in the Western interconnection to assess reliable Operating Transfer Capability on a rated path in the Western Electricity Coordinating Council ("WECC"). The electrical system representation is accurate; however, the bus names and topology have been graphically rearranged to address any Critical Energy Infrastructure Information ("CEII") concerns.

Although linear analyses, such as these, are relatively independent of actual power transfer levels, the modeled system conditions represented peak load demand and high power transfer conditions. The PTDF analyzes the injection of power from BES electrical bus T9 and delivering it to BES bus T10, which is consistent with the use of the BES transfer path. Based on the PTDF assessment, 92% of the power flow is transferred over the 500 kV line that directly connects BES buses T9 and T10. The remaining flow appears on the underlying 230 kV lines and adjacent 345 kV and 500 kV lines. The largest PTDF on any local network is 0.23 percent.

The LODF analysis considers the "worst-case" outage of the strongest (lowest impedance) transmission element, the line between BES buses T9 and T10. The LODF values that are computed represent the percentage of the pre-outage T9-T10 flow that re-distributes on each of the remaining branches. The analysis shows that the net shift in flow for the local network is 4.0% of the pre-outage flow, and the largest shift in flow on any of the individual local network elements is 2.7%. The 2.7% shift occurs on the local network branch between buses LN19 and LN28, and a 1.3% shift occurs on the branch between LN27 and LN33. The flow direction at the interface points between the local network and the BES continues to be into the local network.

Below are three single line diagrams, which depict the 1) powerflow, 2) percentage distribution of flows for the PTDF analysis, and 3) the percent of flow distribution for the LODF analysis. In these diagrams, the local network elements are indicated by a green line color, and the local network station buses are indicated with an "LN" designation, for example, "LN23".

Following the single line diagrams are two tables: Table 1 - a tabulation of the PTDF values for the network, and Table 2 - depicting the LODF values for the T9-T10 line outage case.

Red lines are 345 kV to 500 kV

Orange lines are 230 kV

Green lines are 115 kV

The size of the arrow is proportional to the magnitude of powerflow in MWs

Arrows do not appear when the level of powerflow is very low
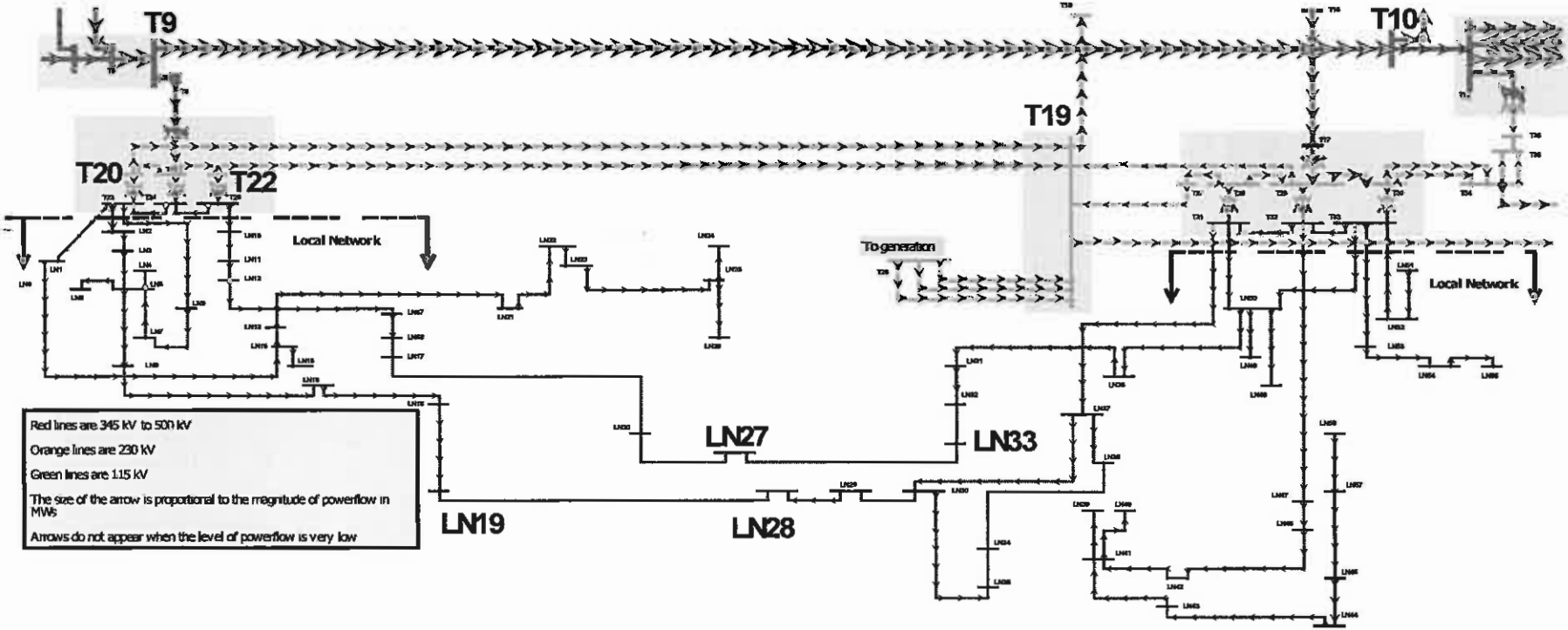
The Power Transfer Distribution Factors ("PTDF") Single Line
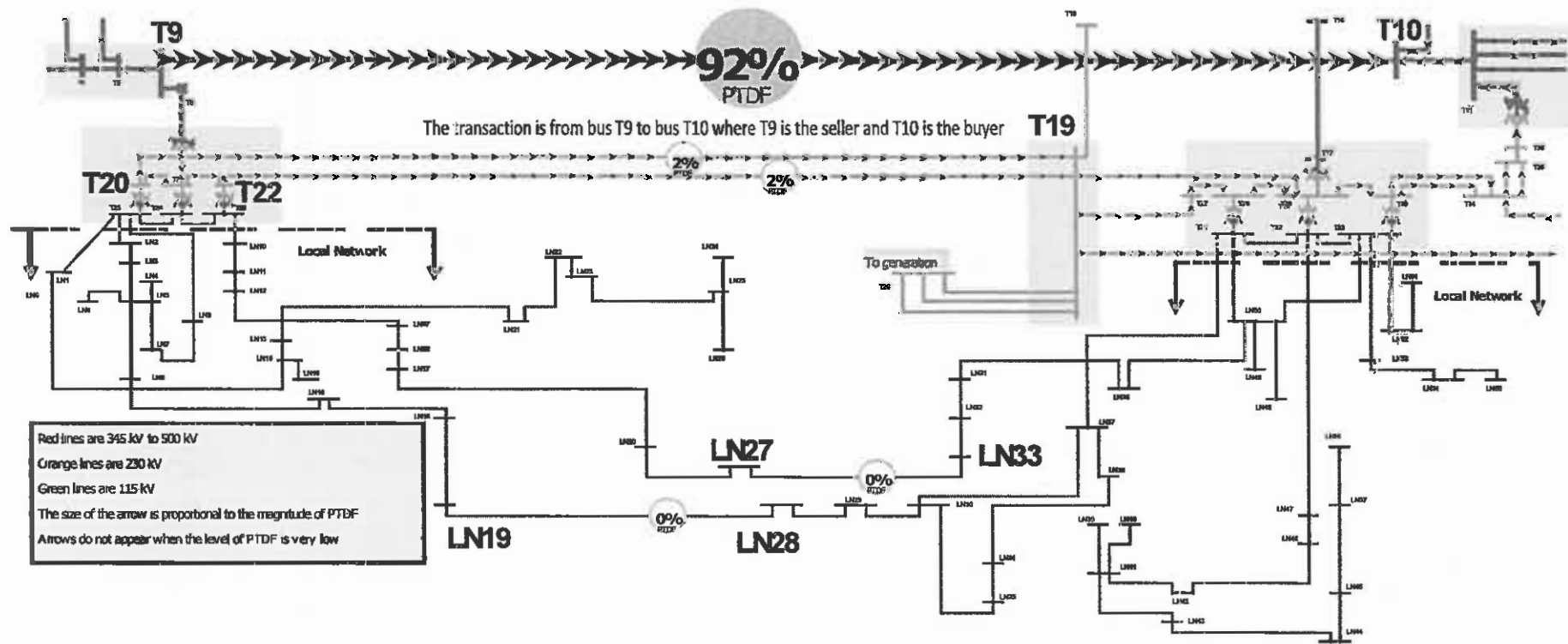
92% PTDF

The transaction is from bus T9 to bus T10 where T9 is the seller and T10 is the buyer

Red lines are 345 kV to 500 kV

Orange lines are 230 kV

Green lines are 115 kV

The size of the arrow is proportional to the magnitude of PTDF

Arrows do not appear when the level of PTDF is very low

For the LODF assessment the transmission line from bus T9 to bus T10 is opened and the PTDF are recalculated (See the LODF table for additional details)

Red lines are 345 kV to 500 kV

Orange lines are 230 kV

Green lines are 115 kV

The size of the arrow is proportional to the magnitude of PTDF

Arrows do not appear when the level of PTDF is very low
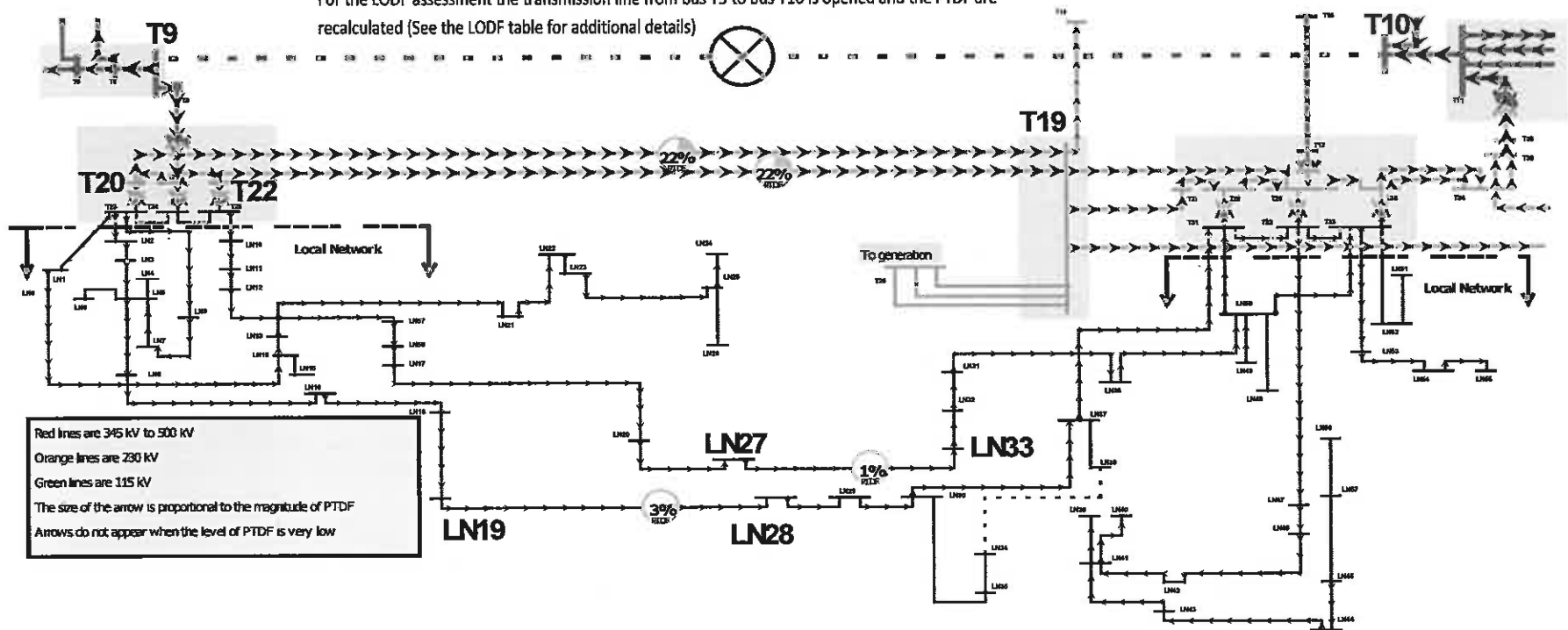
Table 1 - Power Flow Transfer Distribution Factor Results

	Line PTDF Records			
From Name	To Name	% PTDF From	% PTDF To	Nom kV (Max)
T10	T9	-91.61	91.61	500
T10	T11	-5.4	5.4	500
T5	T9	-4.77	4.77	500
T11	T36	-4.13	4.13	230
T36	T35	-3.08	3.08	230
T12	T11	-2.4	2.4	500
T19	T20	-1.84	1.84	230
T19	T22	-1.81	1.81	230
T22	T21	-1.74	1.74	230
T34	T30	-1.3	1.3	230
T34	T30	-1.29	1.29	230
T41	T40	-0.57	0.57	230
T40	T39	-0.55	0.55	230
T37	T38	-0.49	0.49	230
LN16	LN8	-0.23	0.23	115
LN29	LN19	-0.23	0.23	115
LN19	LN18	-0.23	0.23	115
T30	T33	-0.11	0.11	115
LN50	LN36	-0.11	0.11	115
LN32	LN33	-0.11	0.11	115
LN31	LN32	-0.11	0.11	115
LN20	LN17	-0.11	0.11	115
LN12	LN11	-0.11	0.11	115
LN11	LN10	-0.11	0.11	115
LN3	LN2	-0.1	0.1	115
T29	T32	-0.09	0.09	115
T29	T17	-0.09	0.09	230
LN30	LN29	-0.09	0.09	115
LN9	T23	-0.08	0.08	115
LN5	LN7	-0.08	0.08	115
T28	T31	-0.07	0.07	115
T32	T31	-0.07	0.07	115
LN50	LN49	-0.07	0.07	115
LN53	T33	-0.06	0.06	115
LN55	LN54	-0.06	0.06	115
LN41	LN43	-0.06	0.06	115
T33	T32	-0.05	0.05	115
LN39	LN41	-0.05	0.05	115
T42	T39	-0.04	0.04	230
LN47	T32	-0.04	0.04	115
LN1	T23	-0.04	0.04	115
LN41	LN42	-0.04	0.04	115
LN25	LN23	-0.04	0.04	115

Line PTDF Records				
From Name	To Name	% PTDF From	% PTDF To	Nom kV (Max)
LN22	LN21	-0.04	0.04	115
LN13	LN15	-0.04	0.04	115
LN15	LN1	-0.04	0.04	115
LN45	LN57	-0.03	0.03	115
LN57	LN56	-0.03	0.03	115
LN50	LN48	-0.03	0.03	115
T1	T2	0	0	500
LN51	LN52	0	0	115
T33	LN52	0	0·	115
LN4	LN5	0	0	115
LN6	LN5	0	0	115
LN38	LN37	0	0	115
LN30	LN35	0	0	115
LN35	LN34	0	0	115
LN38	LN34	0	0	115
LN24	LN27	0	0	115
LN26	LN25	0	0	115
T25	LN23	0	0	115
LN26	LN20	0	0	115
LN14	LN15	0	0	115
LN22	LN11	0	0	115
LN17	LN10	0	0	115
LN23	LN10	0	0	115
T25	T24	0.01	-0.01	115
T24	T23	0.02	-0.02	115
T6	T4	0.03	-0.03	500
T19	T26	0.03	-0.03	230
T19	T26	0.03	-0.03	230
T19	T26	0.03	-0.03	230
LN47	LN46	0.04	-0.04	115
LN46	LN42	0.04	-0.04	115
LN25	LN24	0.04	-0.04	115
LN22	LN23	0.04	-0.04	115
LN13	LN21	0.04	-0.04	115
LN53	LN54	0.06	-0.06	115
LN45	LN44	0.06	-0.06	115
LN44	LN43	0.06	-0.06	115
LN41	LN40	0.06	-0.06	115
LN9	LN7	0.08	-0.08	115
LN37	T31	0.09	-0.09	115
T16	T17	0.09	-0.09	345
LN30	LN37	0.09	-0.09	115
T20	T23	0.1	-0.1	115
LN3	LN5	0.1	-0.1	115
T24	LN2	0.1	-0.1	115

Line PTDF Records				
From Name	To Name	% PTDF From	% PTDF To	Nom kV (Max)
LN50	T31	0.11	-0.11	115
T22	T25	0.11	-0.11	115
LN57	LN58	0.11	-0.11	115
LN12	LN57	0.11	-0.11	115
LN31	LN36	0.11	-0.11	115
LN27	LN33	0.11	-0.11	115
LN20	LN27	0.11	-0.11	115
LN58	LN17	0.11	-0.11	115
T25	LN10	0.11	-0.11	115
LN50	T33	0.12	-0.12	115
T21	T24	0.12	-0.12	115
T19	T18	0.13	-0.13	230
LN5	LN8	0.23	-0.23	115
LN28	LN29	0.23	-0.23	115
LN16	LN18	0.23	-0.23	115
T2	T7	0.3	-0.3	500
T2	T7	0.34	-0.34	500
T37	T34	0.49	-0.49	230
T13	T12	0.59	-0.59	500
T14	T11	0.71	-0.71	500
T38	T39	0.78	-0.78	230
T27	T28	0.94	-0.94	230
T28	T29	1.1	-1.1	230
T4	T3	1.15	-1.15	500
T19	T29	1.21	-1.21	230
T19	T27	1.22	-1.22	230
T19	T38	1.26	-1.26	230
T1	T7	1.28	-1.28	500
T4	T1	1.28	-1.28	500
T34	T35	1.54	-1.54	230
T34	T35	1.54	-1.54	230
T21	T20	1.77	-1.77	230
T6	T2	2.34	-2.34	500
T5	T6	2.37	-2.37	500
T5	T4	2.4	-2.4	500
T29	T30	2.48	-2.48	230
T15	T11	2.97	-2.97	500
T12	T10	3	-3	500
T9	T8	3.62	-3.62	500
T8	T21	3.62	-3.62	230

Table 2 - Line Outage Distribution Factor Results (Outage of T9-T10)

From Name	To Name	% LODF	MW From	MW To	CTG MW From	CTG MW To
Line LODF Records
T10	T9	-100	-1482.1	1483.7	0	1.6
T9	T8	-43.2	217.9	-217.8	857.5	-857.4
T8	T21	-43.2	217.8	-217.5	857.4	-857.1
T12	T10	-35.7	-937.2	937.2	-408.3	408.3
T15	T11	-35.4	1632.1	-1596.9	2156.2	-2120.9
T29	T30	-29.5	404.1	-404.1	841.8	-841.8
T5	T4	-28.6	-835.5	835.5	-411.4	411.4
T5	T6	-28.2	-873.5	873.5	-455.2	455.2
T6	T2	-27.8	-911.5	912.6	-499	500.1
T21	T20	-21	69	-69	380.8	-380.8
T34	T35	-18.3	29.2	-29.1	300.9	-300.9
T34	T35	-18.3	29.2	-29.1	300.9	-300.9
T4	T1	-15.3	-1783.5	1802.5	-1557.4	1576.4
T1	T7	-15.3	-1802.5	1802.5	-1576.4	1576.4
T19	T38	-15	107.3	-107	330.4	-330
T19	T27	-14.5	-53.1	53.2	162.3	-162.2
T19	T29	-14.4	-50.9	51	162.8	-162.7
T4	T3	-13.8	986	-985	1189.8	-1188.9
T28	T29	-13.1	155.8	-155.8	349.4	-349.4
T27	T28	-11.2	-154.7	154.7	11.3	-11.3
T38	T39	-9.2	326.8	-319.7	463.7	-456.6
T14	T11	-8.4	-1656.8	1684.2	-1532.1	1559.6
T13	T12	-7.1	-1308.7	1329.4	-1204.2	1224.8
T37	T34	-5.8	-219.8	220.1	-133.7	133.9
T2	T7	-4.1	-826.9	833.1	-766.2	772.4
T2	T7	-3.5	-714.3	719.6	-661.9	667.2
LN5	LN8	-2.7	21.8	-21.8	62.3	-62.3
LN16	LN18	-2.7	21.1	-21.1	61.6	-61.6
LN28	LN29	-2.7	-8.4	8.5	32.1	-32.1
T19	T18	-1.5	203.2	-202.5	225.6	-224.8
T22	T25	-1.4	83.1	-83	103.2	-103.1
T21	T24	-1.4	78.4	-78.3	99.1	-99
LN50	T33	-1.4	-38.6	38.7	-18.2	18.3
T25	LN10	-1.3	35.7	-35.7	54.4	-54.4
LN12	LN57	-1.3	22.3	-22.3	41	-41
LN57	LN58	-1.3	12.4	-12.4	31.1	-31.1
LN58	LN17	-1.3	0.1	-0.1	18.8	-18.8
LN20	LN27	-1.3	0.1	-0.1	18.8	-18.8
LN27	LN33	-1.3	0.1	-0.1	18.8	-18.8
LN31	LN36	-1.3	-20.3	20.3	-1.6	1.6
LN50	T31	-1.3	-36.7	36.7	-16.7	16.8
T24	LN2	-1.2	80.3	-80.2	98.3	-98.2
T20	T23	-1.2	77.4	-77.2	95.8	-95.7

From Name	To Name	% LODF	MW From	MW To	CTG MW From	CTG MW To
LN3	LN5	-1.2	53.6	-53.5	71.6	-71.5
T16	T17	-1	449.4	-436.5	464.6	-451.7
Line LODF Records						
From Name	To Name	% LODF	MW From	MW To	CTG MW From	CTG MW To
LN9	LN7	-1	48.7	-48.6	63.3	-63.3
LN30	LN37	-1	-39.1	39.1	-24	24
LN37	T31	-1	-48.3	48.4	-33.2	33.3
LN45	LN44	-0.7	70.8	-70.8	81.3	-81.3
LN44	LN43	-0.7	67.7	-67.6	78.2	-78.1
LN53	LN54	-0.7	59.5	-59.5	69.6	-69.5
LN41	LN40	-0.7	53.2	-53.1	63.1	-63
LN46	LN42	-0.5	55.6	-55.6	63.5	-63.5
LN47	LN46	-0.5	55.8	-55.6	63.7	-63.5
LN13	LN21	-0.5	47.9	-47.9	55.7	-55.7
LN22	LN23	-0.5	24.6	-24.6	32.5	-32.5
LN25	LN24	-0.5	14.4	-14.4	22.2	-22.2
T6	T4	-0.4	38	-38	43.8	-43.8
T24	T23	-0.3	45.3	-45.3	49.4	-49.4
T19	T26	-0.3	-152.9	157.7	-148.1	153
T19	T26	-0.3	-152.9	157.7	-148.1	153
T19	T26	-0.3	-152.9	157.7	-148.1	153
T25	T24	-0.1	47.3	-47.3	48.7	-48.7
LN51	LN52	0	30.6	-30.5	30.6	-30.5
LN30	LN35	0	24.4	-24.4	24.4	-24.4
LN17	LN10	0	0	0	0	0
LN23	LN10	0	0	0	0	0
LN22	LN11	0	0	0	0	0
LN26	LN20	0	0	0	0	0
T25	LN23	0	0	0	0	0
LN24	LN27	0	0	0	0	0
LN35	LN34	0	0	0	0	0
LN38	LN34	0	0	0	0	0
T1	T2	0	0	0	0	0
LN38	LN37	0	-9.1	9.1	-9.1	9.1
LN26	LN25	0	-10.2	10.2	-10.2	10.2
LN14	LN15	0	-12.4	12.4	-12.4	12.4
T33	LN52	0	-22	22.1	-22.1	22.1
LN4	LN5	0	-22.4	22.4	-22.4	22.4
LN6	LN5	0	-33.9	33.9	-33.9	33.9
LN50	LN48	0.3	29.9	-29.9	25.4	-25.3
LN57	LN56	0.3	-17.2	17.3	-21.7	21.7
LN45	LN57	0.3	-37.6	37.6	-42	42
LN25	LN23	0.5	-24.6	24.6	-32.4	32.5
T42	T39	0.5	-28.5	30.5	-35.9	37.9
LN22	LN21	0.5	-38.1	38.1	-45.9	46
LN41	LN42	0.5	-48.9	48.9	-56.8	56.8
LN13	LN15	0.5	-51.6	51.6	-59.4	59.4
LN15	LN1	0.5	-64	64	-71.8	71.9

LN1	T23	0.5	-64	64	-71.9	71.9
LN47	T32	0.5	-66.5	66.6	-74.4	74.5
T33	T32	0.6	45.7	-45.7	36.4	-36.4
LN39	LN41	0.6	-46.7	46.8	-55.3	55.4

<div align="center">Line LODF Records</div>

From Name	To Name	% LODF	MW From	MW To	CTG MW From	CTG MW To
LN55	LN54	0.7	-50.6	50.7	-60.7	60.7
LN41	LN43	0.7	-58.7	58.8	-69.2	69.3
LN53	T33	0.7	-62.8	63	-72.9	73
T32	T31	0.8	65.9	-65.9	54.4	-54.4
T28	T31	0.9	125.9	-125.5	112.9	-112.5
LN50	LN49	0.9	61.9	-61.8	49.1	-49
T29	T32	1	136.8	-136.4	121.6	-121.1
LN30	LN29	1	-4.5	4.5	-19.7	19.7
LN5	LN7	1	-38.7	38.7	-53.4	53.4
LN9	T23	1	-58.4	58.5	-73	73.2
T29	T17	1	-436.1	436.5	-451.3	451.7
LN3	LN2	1.2	-61.9	62	-79.9	80
T30	T33	1.3	125.6	-125.3	105.9	-105.7
LN50	LN36	1.3	29.7	-29.7	11	-11
LN31	LN32	1.3	11.2	-11.2	-7.5	7.5
LN20	LN17	1.3	-0.1	0.1	-18.8	18.8
LN32	LN33	1.3	-0.1	0.1	-18.8	18.8
LN11	LN10	1.3	-35.7	35.7	-54.4	54.4
LN12	LN11	1.3	-35.6	35.7	-54.3	54.4
LN28	LN19	2.7	-2.1	2.1	-42.6	42.6
LN19	LN18	2.7	-12.6	12.6	-53.1	53.1
LN16	LN8	2.7	-21.7	21.8	-62.3	62.3
T37	T38	5.8	219.8	-219.8	133.7	-133.7
T40	T39	6.6	-221.1	222.8	-318.7	320.4
T41	T40	6.8	-308.2	309.9	-408.2	409.9
T34	T30	15.4	-138.7	138.7	-366.6	366.7
T34	T30	15.5	-139.7	139.7	-369.2	369.2
T22	T21	20.7	-70.2	70.2	-377.3	377.3
T19	T22	21.5	-90.4	90.7	-409.8	410
T19	T20	21.9	-91.6	91.9	-416.3	416.6
T12	T11	28.6	-392.2	392.2	-816.5	816.5
T36	T35	36.7	-58.2	58.2	-601.7	601.7
T11	T36	49.2	65.3	-64.8	-663.5	664
T5	T9	56.8	1709	-1701.6	866.6	-859.1
T10	T11	64.3	544.9	-544.9	-408.3	408.3