Introduction to IDC Factors

- TDF – Transfer Distribution Factor
- GSF – Generation Shift Factor
- LSF – Load Shift Factor
- GLDF – Generation-to-Load Distribution Factor
- LODF – Line Outage Distribution Factor
- PTDF & OTDF Flowgates

Transfer Distribution Factors

- Transfer Distribution Factors (TDF's) represent the *impact* of an Interchange Transaction on a given flowgate.
- TDF is the measure of responsiveness or change in electrical loading on system facilities due to a change in electric power transfer from one area to another expressed in per cent (up to 100%) of the change in power transfer.
- TDFs address the question, "What portion of a power transfer shows up on flowgate X?"

How is TDF Used in the IDC?

- TDFs are used to determine which Interchange Transactions are eligible for TLR curtailment in the IDC.
- Only those Interchange Transactions with a TDF of 5% or greater are subject to TLR Curtailments.
- If a tag indicates a TDF of 8.3% on flowgate X, this means that 8.3% of the transfer amount on that tag flows on flowgate X.
- Use the following formula to calculate the MW impact on a flowgate for a particular Interchange Transaction:

MW impact = (Interchange transaction MW) x (TDF)

Generation Shift Factors

- Generation Shift Factors (GSF) describe a generator's impact on a flowgate
- The Generation Shift Factors (GSF) represent the change in flow on a flowgate due to an incremental injection at a generator bus, and a corresponding withdrawal at the swing bus
- IDC disregards losses $\Rightarrow$ the principles of superposition applies.
  - GSF between any two generators is the difference between the generators' GSF to the swing bus

$$GSF_{k \to m} = GSF_{k \to swing} - GSF_{m \to swing}$$

How is GSF Used in the IDC?

- GSFs are the most basic IDC calculation – used in TDF calculations (all TLR levels) and GLDF calculations (TLR level 5)
- GSFs on the ***Flowgate GSF*** display in the IDC indicate which generators contribute to or relieve congestion on a selected flowgate.
- If a generator indicates a GSF of 15.2% on flowgate X, this means that 15.2% of the generator's output flows on flowgate X, provided the injection is withdrawn at the swing bus
- Use the following formula to calculate the MW impact on a flowgate for a particular generator:

  MW impact = (Gen MW) x (GSF)

Load Shift Factors

- Load Shift Factors (LSF) describe how changes in system loading impacts a flowgate.

How is LSF Used in the IDC?

- LSFs are used to calculate GLDFs, which are used to determine NNL obligations under a TLR Level 5.
- LSFs are shown along with GSFs on the GLDF displays in the the IDC.
- The LSFs alone are not used by the IDC – the LSF is a component of the Generation-to-Load Distribution Factor (GLDF)

Generation-to-Load Distribution Factors

- Generation-to-Load Distribution Factors (GLDF) describe a generator's impact on a flowgate while serving load in that generator's Balancing Authority Area
- A GLDF is the difference between GSF and an LSF and determines the total impact of a generator serving its native Balancing Authority load on an identified transmission facility or monitored flowgate.

How is GLDF Used in the IDC?

- GLDFs are used to determine NNL obligations under a TLR Level 5.
- Only those generators with a GLDF of 5% or greater are subject to NNL redispatch obligations.
- GLDFs are shown in the ***Flowgate GLDF*** display and the ***CA GLDF*** display in the IDC.
- In the ***Flowgate GLDF*** display the user selects a flowgate and is shown a list of generators that contribute to flow as a byproduct of serving their own Balancing Authority Area load (i.e., the NNL impact).
- In the ***CA GLDF*** display, the user is shown a listing of flowgates that are impacted by generators serving their own Balancing Authority Area load. From this list, the user can drill down and view the generator contribution to flow.

How is GLDF Used in the IDC? (continued)

- Use the following formula to calculate the NNL MW impact on a flowgate for a particular generator:

NNL MW impact = (Scaled MW) x (GLDF) x (% ownership)

- Scaled MW is calculated according to the following formula:

Scaled MW = (Load / Available Assigned Generation) x (Pmax)

- If a generator indicates a GLDF of 9.7% on flowgate X, this means that 9.7% of the generator's output flows on flowgate X as a byproduct of serving Balancing Authority Area native load.
- The GLDF is calculated according to the following formula:

GLDF = GSF - LSF

Line Outage Distribution Factor (LODF)

- Line Outage Distribution Factor (LODF) represents the percentage of flow on a contingent facility that will flow on the monitored elements, if the contingent facility is outaged – Contingency Analysis
- Post-Contingency Flow on Monitored Element = Pre-Contingency Flow on Monitored Element + (Pre-Contingency Flow on Contingent Element)*LODF
- LODFs are not used in IDC TLR calculations – they are only used in assisting the RCs in filling the TLR NERC Report.

PTDF & OTDF Flowgates

- PTDF – Power Transfer Distribution Factor. PTDF Flowgates are Flowgates that ***do not*** consider contingencies during curtailment evaluation. With PTDF Flowgates the monitored branches alone are considered during curtailment evaluation.
- OTDF – Outage Transfer Distribution Factor. OTDF Flowgates are Flowgates that take into account a predefined contingency during curtailment evaluation. With OTDF Flowgates the monitored branches are considered with a specific facility removed from service during curtailment evaluation.
- A Flowgate can exist as a PTDF Flowgate or an OTDF Flowgate.
- A Flowgate defaults to a PTDF Flowgate unless OTDF branch data is specified in the Flowgate creation process.

How are GSF, TDF, LSF and GLDF Calculated in the IDC?

- All factors (GSF, TDF, LSF) are calculated from a master shift factor matrix of each bus and each flowgate.
- This matrix is calculated by simulating an incremental injection in every bus (individually, one at a time) and a corresponding withdrawal at the swing bus. The term is loosely called GSF even though it is calculated for every bus, regardless of being attached to a generator.
- The Balancing Authority's TDFs are calculated as the weighted sum of the GSFs in a Balancing Authority Area for every in-service generator – the weighting factors are the generators' MBASE in the PSSE base case model, adjusted for de-ration as provided via the SDX

$$TDF = \Sigma(GSF \times MBASE \times DE\text{-}RATION) / \Sigma(MBASE \times DE\text{-}RATION)$$

- The Balancing Authority's LSFs are calculated as the weighted sum of the GSFs in a Balancing Authority Area for every connected load bus as defined in the PSSE base case – the weighting factors are the load MW amount on the buses.

$$LSF = SUM(GSF \times LOAD) / SUM(LOAD)$$

How are GSF, TDF, LSF and GLDF Calculated in the IDC?

- The TDF between two Balancing Authority Areas is the difference between the TDFs of the Balancing Authority Areas (principle of superposition):

$$TDF_{BA1-BA2} = TDF_{BA1} - TDF_{BA2}$$

- The TDF of a tag is the TDF between the source and sink Control Areas

$$TDF_{Tag} = TDF_{SourceBA-SinkBA} = TDF_{SourceBA} - TDF_{SinkBA}$$

- Tag path:
  - Every tag has a defined path:

    Source BA – TP*1* – TP*2* – … – TP*n* – Sink BA
  - The TDF of a tag is the sum of the TDFs of every segment on a tag – which is equivalent to the TDF between the source and sink BA:

    Segment 1: $TDF_{SourceBA-TP1} = TDF_{SourceBA} - TDF_{TP1}$

    Segment 2: $TDF_{TP1-TP2} = TDF_{TP1} - TDF_{TP2}$

    Last Segment: $TDF_{TPn-SinkBA} = TDF_{TPn} - TDF_{SinkBA}$

    $TDF_{Tag} = TDF_{SourceBA} - TDF_{TP1} + TDF_{TP1} - TDF_{TP2} + TDF_{TP2} - TDF_{TP3} + \ldots + TDF_{TPn} - TDF_{SinkBA}$

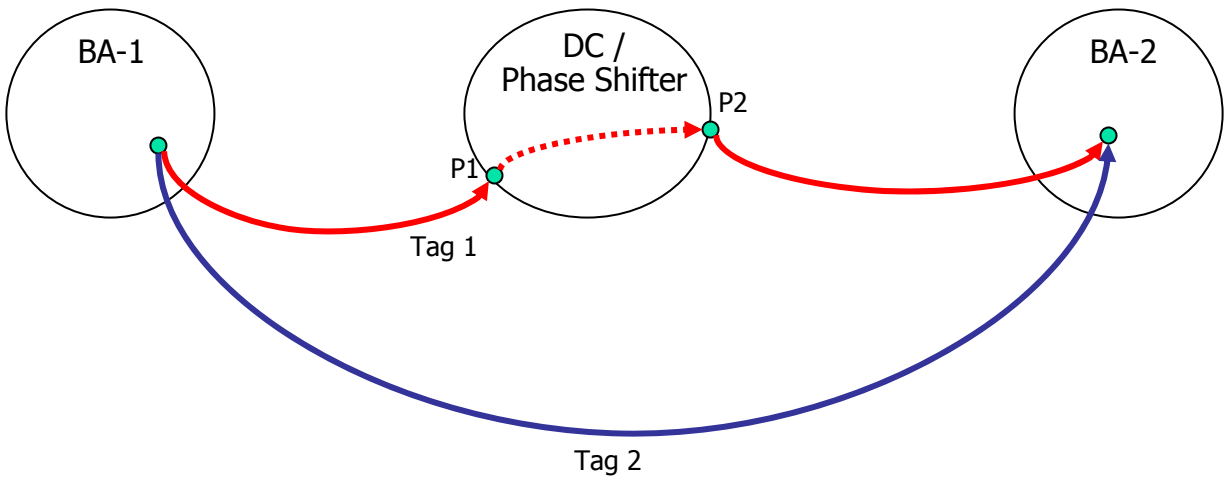
    $= TDF_{SourceBA} - TDF_{SinkBA}$

How are GSF, TDF, LSF and GLDF Calculated in the IDC?

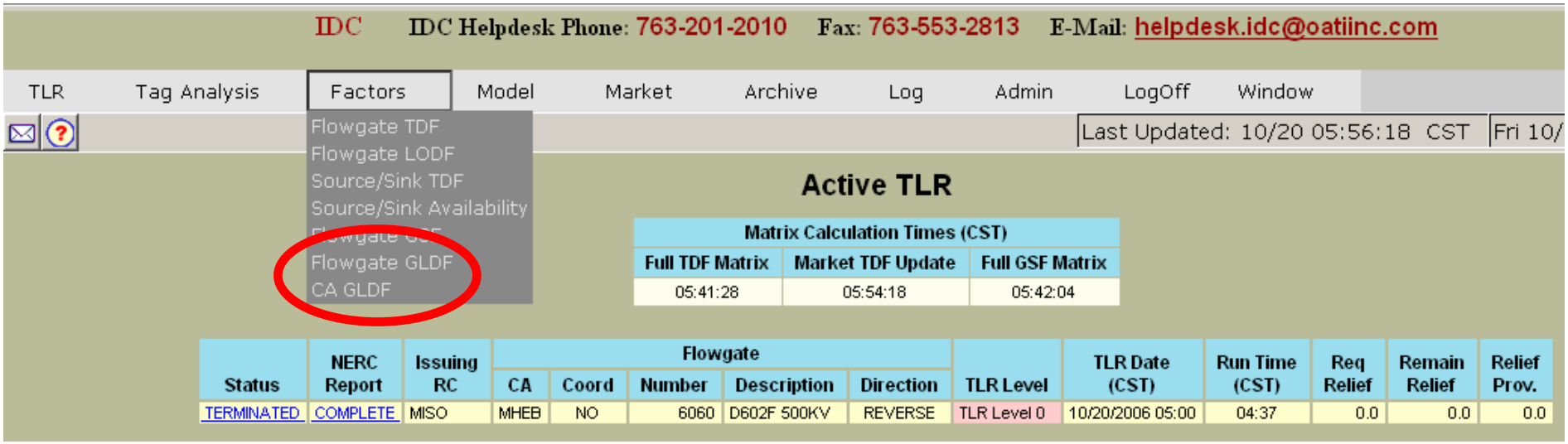
- Tag path (continued):
  - Special case – segmented tag, or tags through controlled devices (phase shifters and DC ties):
    - 100% of the tag scheduled MW flows through the controlled device
    - TDF of tag is the sum of the TDF between the Source BA and the entry point to the controlled device, and the TDF between the exit point of the controlled device and the sink BA.
    - Example:
      - Tag 1 – segmented through DC/phase shifter: $TDF_{Tag1} = TDF_{BA1-P1} + TDF_{P2} - TDF_{BA2}$
      - Tag 2 – AC tag between BA-1 and BA-2: $TDF_{Tag2} = TDF_{BA1} - TDF_{BA2}$
      - $TDF_{Tag1} \neq TDF_{Tag2}$
    - See diagram on the following slide

How are GSF, TDF, LSF and GLDF Calculated in the IDC?

- Special case diagram – segmented tag, or tags through controlled devices (phase shifters and DC ties):



GLDF in IDC



Two ways of using GLDF for analysis

- Flowgate GLDF
- CA GLDF

Flowgate GLDF

- Use the Flowgate GLDF tool if this is your question…
- "Which generators are contributing flow on flowgate X as a byproduct of serving that generator's native load?"
- "…and what level of MW impact do these generators contribute?"

Flowgate GLDF

Flowgate SC: VACS | Flowgate CA: DUK | Flowgate Number: | Enter

Flowgates: 1205 - 8OCONEE 500 8S HALL 500 (MKT COORD) | Direction: From->To

Control Area: ALL | GLDF Cutoff (%): 5

View GLDF | Switch Generator Status

Flowgate: 1205 - [OTDF] - [8OCONEE 500 8S HALL 500]
Direction: From->To
Market Coord.: MISO , PJM

Owner Name	Generator	Control Area	GLDF (%)	GSF (%)	LSF (%)	Generator MW	Scaled MW	Ownership %	Owner MW	Energy on Flowgate	Status	Base Case Status	Switch Status
DUK	OCONEE3 19.0 3	DUK	12.4	34.6	22.2	857.0	474.3	100.0	474.3	58.8	IN	OUT	☐
DUK	BADCRK1219.0 1	DUK	9.5	31.8	22.2	339.0	187.6	100.0	187.6	17.9	IN	IN	☐
DUK	BADCRK1219.0 2	DUK	9.5	31.8	22.2	339.0	187.6	100.0	187.6	17.9	IN	IN	☐
DUK	BADCRK3419.0 3	DUK	9.5	31.8	22.2	0.0	0.0	100.0	0.0	0.0	OUT	OUT	☐
DUK	BADCRK3419.0 4	DUK	9.5	31.8	22.2	0.0	0.0	100.0	0.0	0.0	OUT	IN	☐
DUK	KEOWEE 13.8 1	DUK	8.0	30.3	22.2	80.0	44.3	100.0	44.3	3.6	IN	OUT	☐
DUK	KEOWEE 13.8 2	DUK	8.0	30.3	22.2	80.0	44.3	100.0	44.3	3.6	IN	OUT	☐
DUK	OCONEE1 19.0 1	DUK	8.0	30.3	22.2	857.0	474.3	100.0	474.3	38.1	IN	IN	☐
DUK	OCONEE2 19.0 2	DUK	8.0	30.3	22.2	857.0	474.3	100.0	474.3	38.1	IN	IN	☐

CA GLDF

- Use the CA GLDF tool if this is your question…
- "Which flowgates are ***my*** generators impacting as a byproduct of serving native load?"
- "…and what level of MW impact do ***my*** generators contribute?"

Control Area NNL Impacting Flowgates for CA: DUK

SC: VACS CA: DUK

View

1 of 2 35 rows

Flowgate				Direction	
Type	Mkt Coord	No.	Description	Normal	Reverse
PTDF	NO	1201	VACAR-SOUTHERN	○	○
PTDF	NO	1203	8ANTIOCH 500 05J.FERR 500	○	○
PTDF	NO	1204	8NEWPORT 500 8RICHMON 500	○	○
OTDF	YES	1205	OCONEE 500 - S HALL 500 1 flo CONASAG 500 - BOWEN 500 1	○	○
PTDF	NO	1208	6ANTIOCH 230 6MITCH R 230		○
PTDF	NO	1210	8OCONEE 500 6OCONEE 230	○	○

IDC Basics

Control Area GLDF for CA: DUK

Details for Flowgate: 1222 - Riverview-Ripp 230 kV 1 flo 2 line (Normal)

Market Coordination: None

Close

1 of 2 35 rows

	Generator		
Impacting CA	Control Area	Name	GLDF %
DUK	DUK	BRECG5 18.0 5	62.6
DUK	DUK	BRECG2 18.0 2	62.6
DUK	DUK	BRECG3 18.0 3	62.6
DUK	DUK	BRECG4 18.0 4	62.6
DUK	DUK	BRECG1 18.0 1	62.6
DUK	DUK	LEE CT 13.8 6	8.7
DUK	DUK	LEE 3 18.0 3	8.7
DUK	DUK	LEE CT 13.8 4	8.7
DUK	DUK	LEE CT 13.8 5	8.7
DUK	DUK	LEE 1 13.8 1	8.7
DUK	DUK	LEE 2 13.8 2	8.7
DUK	DUK	OCONEE1 19.0 1	7.5
DUK	DUK	OCONEE2 19.0 2	7.5
DUK	DUK	KEOWEE 13.8 1	7.5
DUK	DUK	KEOWEE 13.8 2	7.5
DUK	DUK	JOCASSE114.4 1	7.2