

ERSWG Meeting Eastern Interconnection Frequency Response Assessment:

Changing Resource Mix Study

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RELIABILITY | ACCOUNTABILITY



Purpose:

- Understand the interconnection-wide reliability implications of the changing resource mix on frequency response
- Incorporate policy issues such as Clean Power Plan implementation with sensitivities such as changing resource mix, control strategies, and other assumptions
- Use the ERSTF Measure 4 metrics to assess frequency response performance

- **Phase I – 2016/17**
 - Focus on improving plant modeling and data quality
 - Base case development
 - Scenario analysis using various futures
- **Phase II – 2017/18**
 - Evaluate sensitivities using the ERSTF's Frequency Performance measures
 - Integrate complex load model
- **Phase III – 2018/19**
 - Evaluate other interconnections
 - Storage and distributed generation impacts

- **Cases**

- Business-As-Usual (BAU) Frequency Responsive Case
- CPP Base Case: BAU Case with 8500 MW of NTR additions
- High Nuclear Retirements Case: CPP Base Case with 10,000 MW of Additional NTRs

- **Deadband Modeling**

- Deadband = 0.00
- Deadband = +/- 0.017 Hz

- **New Technology Resources (NTRs) Dispatch**

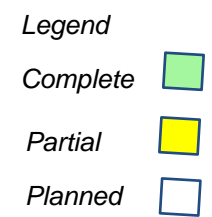
- Dispatch Pgen = PMAX
- Dispatch Pgen = 75% PMAX

Frequency Responsive Case Development

MMWG 2021 Light Load Base Case 2015 Series Case (0)

Business As Usual (BAU) Base Case
Modify 2021SLL_2015Series MMWG Case using Data from MMWG (from GOs and GOPs) to Create and Benchmark the Frequency Responsive Base Case (1)

Clean Power Plan (CPP) Base Case
- Modify BAU case by adding 8500 MW NTRs to Replace Retirements Identified in CPP.
- NTRs dispatched at 100% PMAX (no FR capability) Benchmark the Case to FNET Data.. (2)



Sensitivity to Nuclear Retirement
Potential Future State

High Nuclear Retirements Case #1.
Modify CPP Case to add 10,000 MW of FR NTRs (Pgen = 95% PMAX) to Replace 10,000 MW of Nuclear Retirements Beyond 2021 (3)

High Nuclear Retirements Case #2.
Modify CPP Case to add 10,000 MW of FR Combined Cycles to Replace 10,000 MW of Nuclear Retirements Beyond 2021 (4)

Frequency Response Impact Testing
Test CPP Case to quantify impact of 8500 MW NTRs with FR capability on the Eastern Interconnection IFR

CPP Frequency Responsive
Re-Dispatch 8500 MW NTRs w/ FR capability (Dispatched at Pgen = 75% PMAX) (5)

CPP Non-Frequency Responsive
Re-Dispatch 8500 MW NTRs w/o FR capability (Dispatched at Pgen = 75% PMAX) (6)

Bookend Testing
Evaluate Impact of High NTRs on Eastern Interconnection

Bookend Case #1.
Modify Case (3) to add 10,000 MW additional FR NTRs (Pgen = 95% PMAX) to Replace 10,000 MW of Available Generation (7)

Bookend Case #2.
Modify Case (7) to add 10,000 MW of additional FR NTRs (Pgen= 95% PMAX) to Replace 10,000 MW of Coal (8)

- ***Analysis and Benchmarking Events***

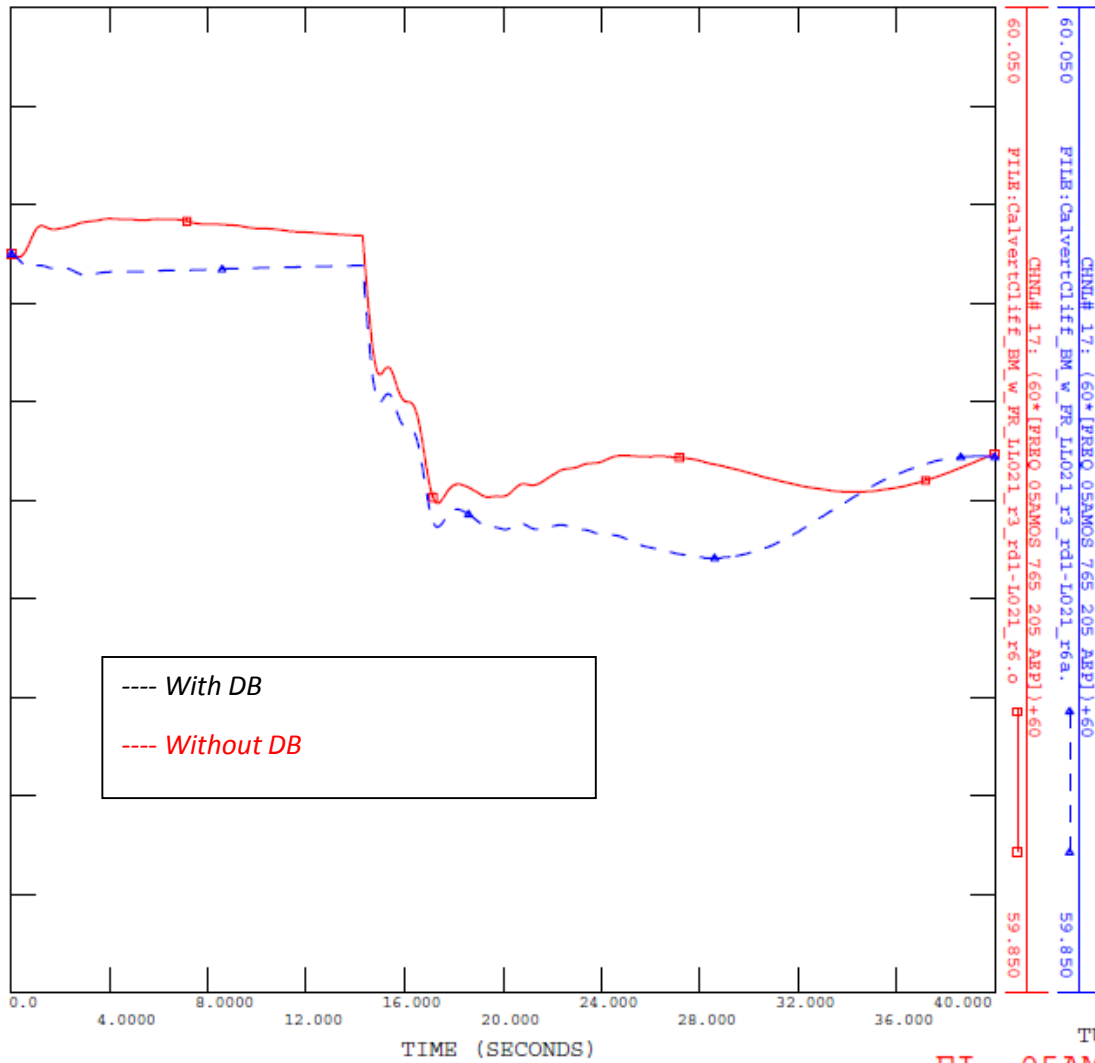
- EI 2015-04-07 Washington, D.C., (1981 MW) (Calvert Cliffs 1 & 2 tripped at 1779 MW net)
- May 25, 2014 at 07:01 Trip Millstone 2 (870 MW) and Millstone 3 (1,233 MW)
- Add Loss of Limerick (1100 MW) Generation to Evaluate More Severe Contingency.

No Disturbance FR CPP Case + 10,000 MW NTRs (100% PMAX) DB = +/- 0.017

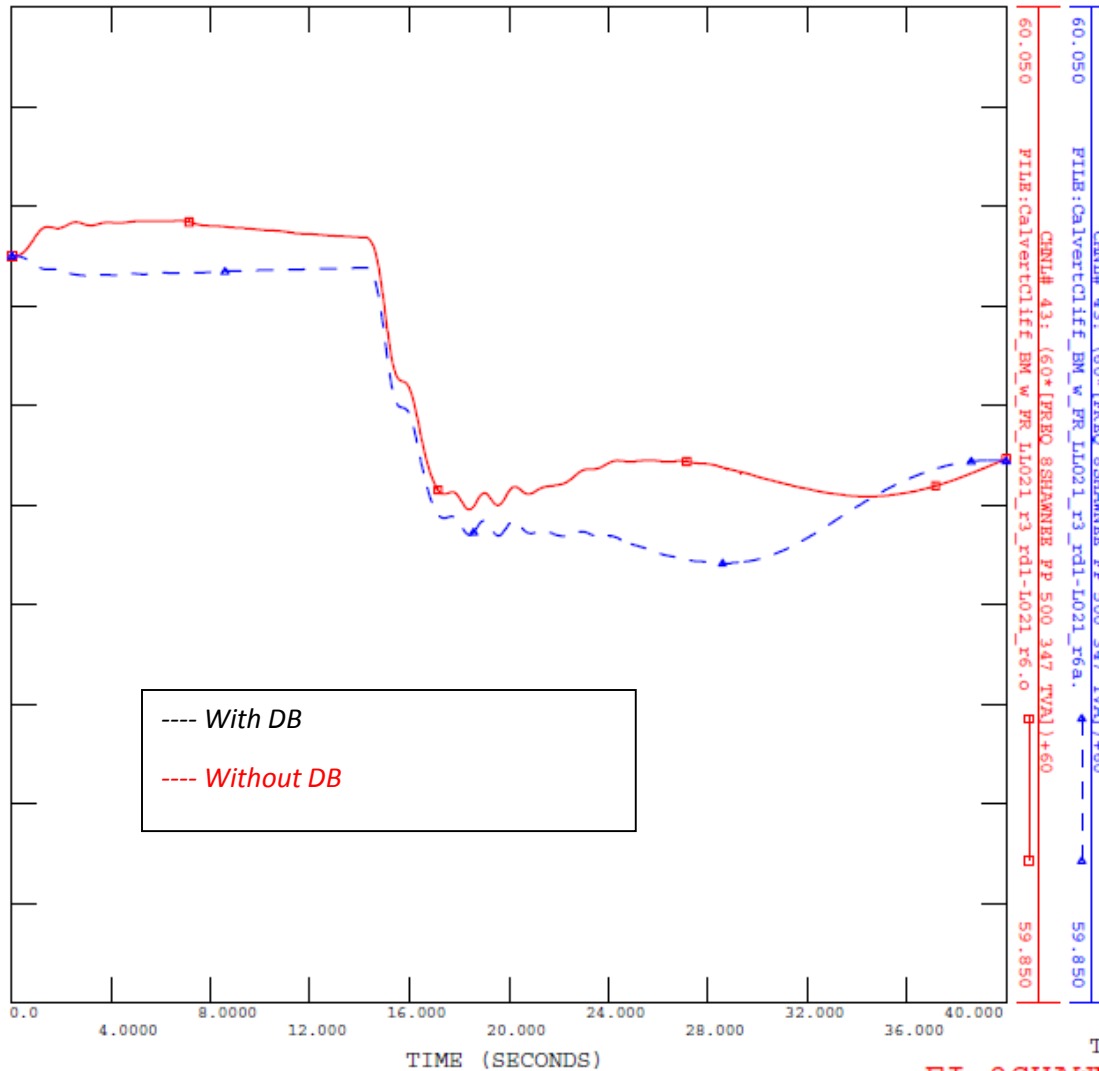
♀ PTI INTERACTIVE PLOTTING PROGRAM--PSSPLT SUN, FEB 12 2017 20:47
 2015 SERIES, 2021 SPRING LIGHT LOAD FR CASE
 2021 LL BASE_CASE DB+-0.017 CPP+10K N.R. (NTR=100% PMAX)FR; Deadband = +/- 0.017 Hz

LIST OF 50 CHANNELS WITH MAXIMUM DEVIATION FROM INITIAL TIME= -0.0083
 FROM TIME 0.0000 TO TIME 60.0000

| CHANEL | IDENTIFIER | INITIAL VALUE | DEVIATION | TIME (SECONDS) |
|--------|--------------------------------|---------------|------------|----------------|
| 21 | FREQ 08EBEND 345 212 DEO&K | 0.000 | 0.5933E-06 | 34.2235 |
| 22 | FREQ 09BATH 345 209 DAY | 0.000 | 0.5695E-06 | 34.1944 |
| 40 | FREQ 7W GARRARDEK 345 320 EKPC | 0.000 | 0.5039E-06 | 34.2235 |
| 18 | FREQ 06CLIFTY 345 206 OVEC | 0.000 | 0.4719E-06 | 34.3193 |
| 20 | FREQ 08BEDFRD 345 208 DEI | 0.000 | 0.4460E-06 | 34.4360 |
| 23 | FREQ 10ABB345 345 210 SIGE | 0.000 | 0.4456E-06 | 34.4568 |
| 27 | FREQ 18CAMPBL 345 218 METC | 0.000 | 0.4393E-06 | 34.8025 |
| 25 | FREQ 16GUION 345 216 IPL | 0.000 | 0.4336E-06 | 34.4360 |
| 19 | FREQ 07WORTHN 345 207 HE | 0.000 | 0.4326E-06 | 34.4651 |
| 39 | FREQ 7REID 345 314 BREC | 0.000 | 0.4307E-06 | 34.4568 |
| 36 | FREQ 7SMITH 345 364 OMUA | 0.000 | 0.4271E-06 | 34.4360 |
| 45 | FREQ LEVEE 500 401 FPL | 0.000 | 0.4190E-06 | 35.8773 |
| 17 | FREQ 05AMOS 765 205 AEP | 0.000 | 0.4071E-06 | 34.4360 |
| 46 | FREQ LK TARPON 500 402 DEF | 0.000 | 0.4051E-06 | 35.8648 |
| 11 | FREQ SALBRY 345 105 NB | 0.000 | 0.3900E-06 | 36.4980 |
| 12 | FREQ 101S-WOODBIN 345 106 NS | 0.000 | 0.3860E-06 | 36.6229 |
| 141 | FREQ ELM ROAD 345 295 WEC | 0.000 | 0.3829E-06 | 34.9025 |
| 69 | FREQ ERG T11 345 295 WEC | 0.000 | 0.3826E-06 | -0.0083 |
| 26 | FREQ 17HIPLE 345 217 NIPS | 0.000 | 0.3824E-06 | 34.7151 |
| 29 | FREQ WILTON ; 765 222 CE | 0.000 | 0.3787E-06 | 34.7151 |
| 147 | FREQ RACINE1 345 295 WEC | 0.000 | 0.3781E-06 | 34.8984 |
| 127 | FREQ RACINE2 345 295 WEC | 0.000 | 0.3777E-06 | 34.9067 |
| 137 | FREQ ARCADN3 345 295 WEC | 0.000 | 0.3750E-06 | 34.9067 |
| 138 | FREQ ARCADN1 345 295 WEC | 0.000 | 0.3747E-06 | 34.9275 |
| 143 | FREQ BAIN 2 345 295 WEC | 0.000 | 0.3743E-06 | 34.8275 |

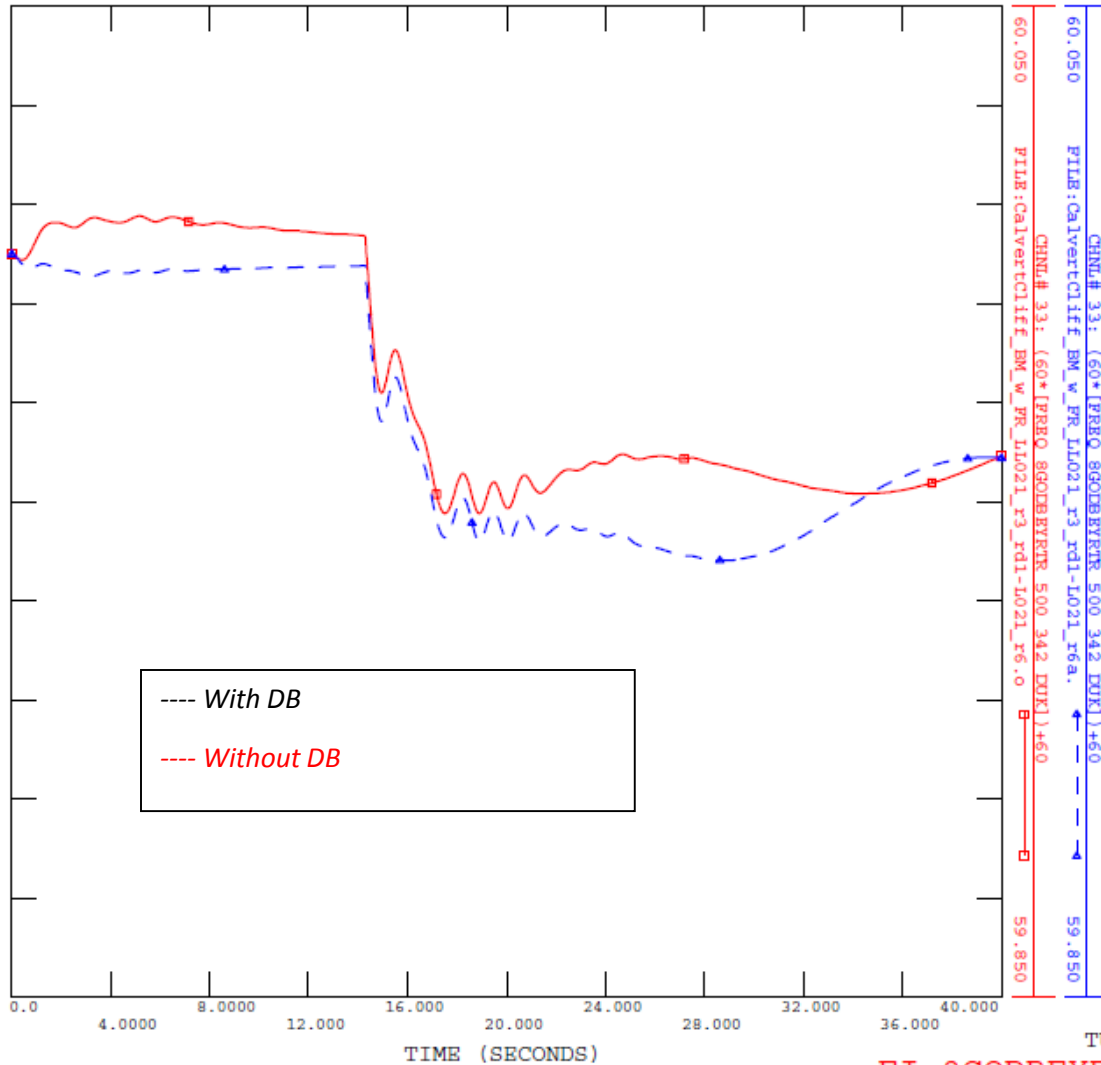


2015 SERIES, 2021 SPRING LIGHT LOAD FR CASE
2021 IL CALCLIFF HI CPP+10K NUC RBT. (NTR=75% PMAX) FR
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC)
CALCLIFF_BM_W_FR_IL021_R3_RD1-IL021_R6; DB=0.0 VS DB=0.017 HZ



2015 SERIES, 2021 SPRING LIGHT LOAD FR CASE
2021 IL CALCLIFF HI CPP+10K NUC RFT. (NTR=75% P_{MAX}) FR
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC)
CALCLIFF_BM_W_FR_IL021_R3_RD1-L021_R6;DB=0.00 VS DB=0.017 HZ

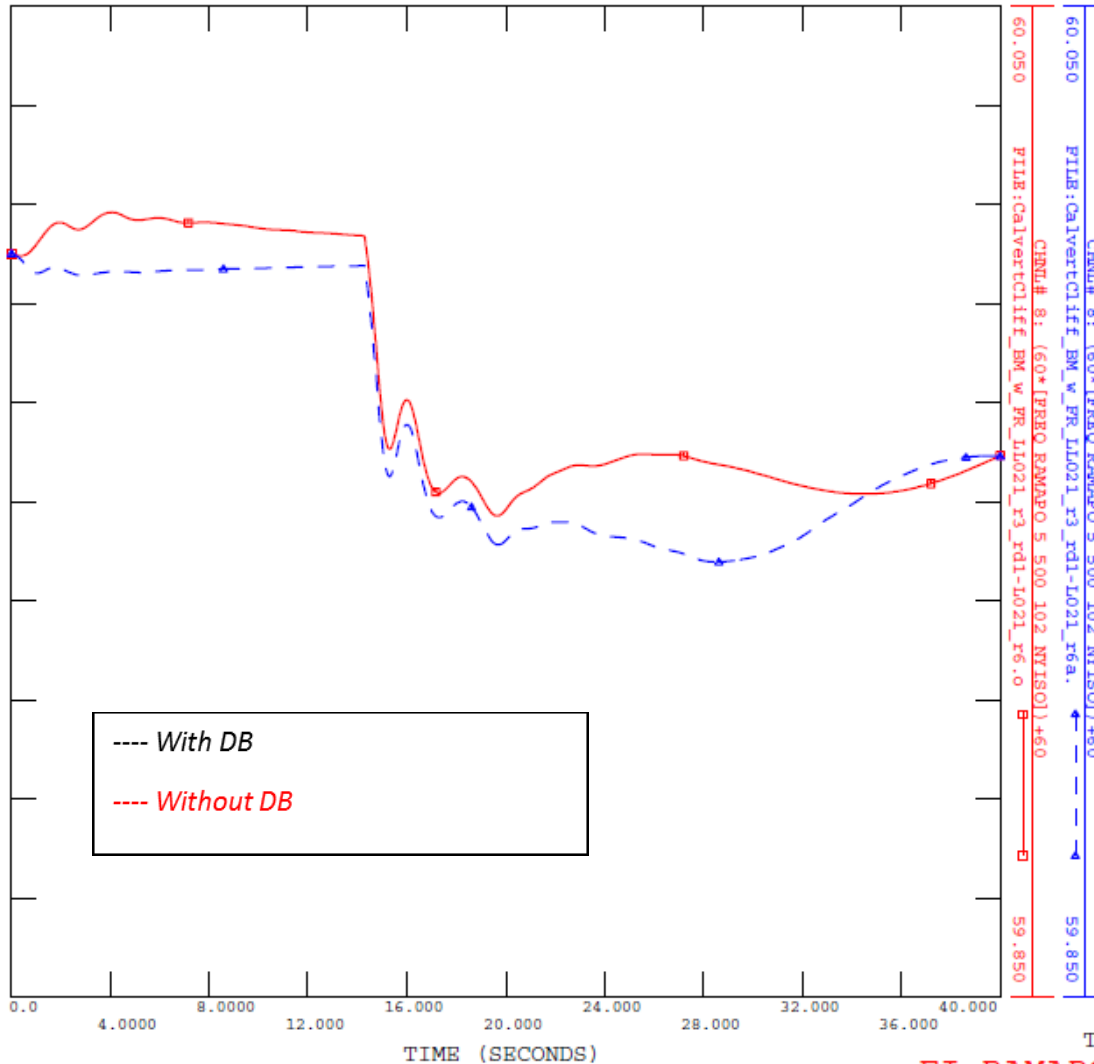
TUE, FEB 14 2017 17:28
EI 8SHAWNEE 500 347 TVA



2015 SERIES, 2021 SPRING LIGHT LOAD FR CASE
 2021 IL CALCLIFF HI CPP+10K NUC RET. (NTR=75% PMAX) FR
 NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC)
 CALCLIFF_BM_w_FR_LI021_R3_RD1-L021_R6; DB=0.00 VS DB=0.017 HZ

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EI 8GODBEYRTR 500 342 DUK

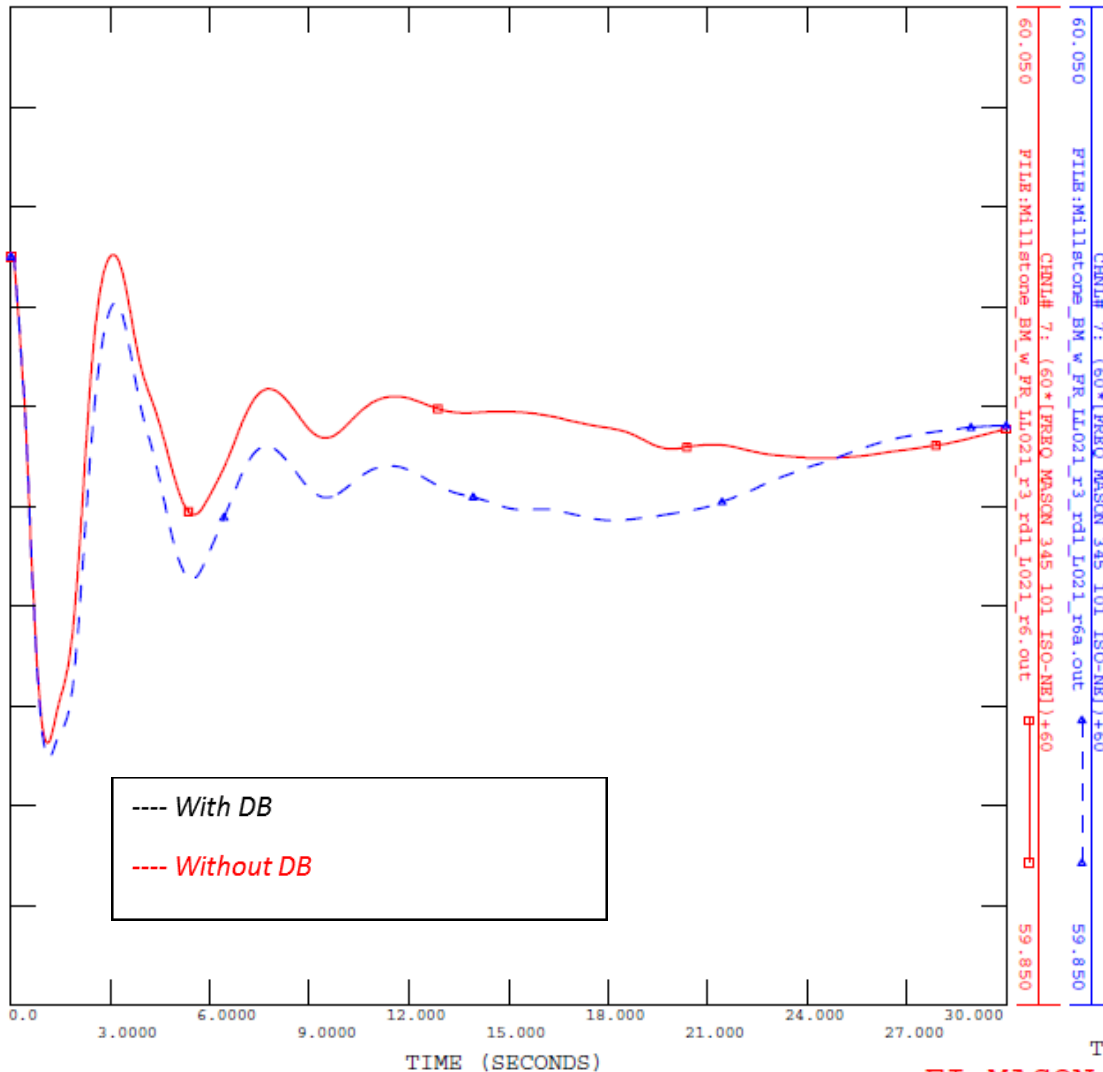


2015 SERIES, 2021 SPRING LIGHT LOAD FR CASE
 2021 LL CALCLIFF HI CPP+10K NUC RET. (NTR=75% P_{MAX}) FR
 NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC)
 CALCLIFF_BM_w_FR_LL021_R3_RD1-L021_R6; DB=0.00 VS DB=0.017 H

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EI RAMAPO 500 102 NYISO

Millstone (ISO-NE) CPP Case + 10,000 MW NTRs (75% PMAX) DB=0.00 vs DB=0.017 HZ



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2021 IL MILLSTN HI CPP+10K NUC RPT (NTR=75% PMAX) FR
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC)
MS_VER2_MLSTN_DB_BM_W_FR_LL021_R3_RD1-L021_R6:DB=0.00 VS DB=
    
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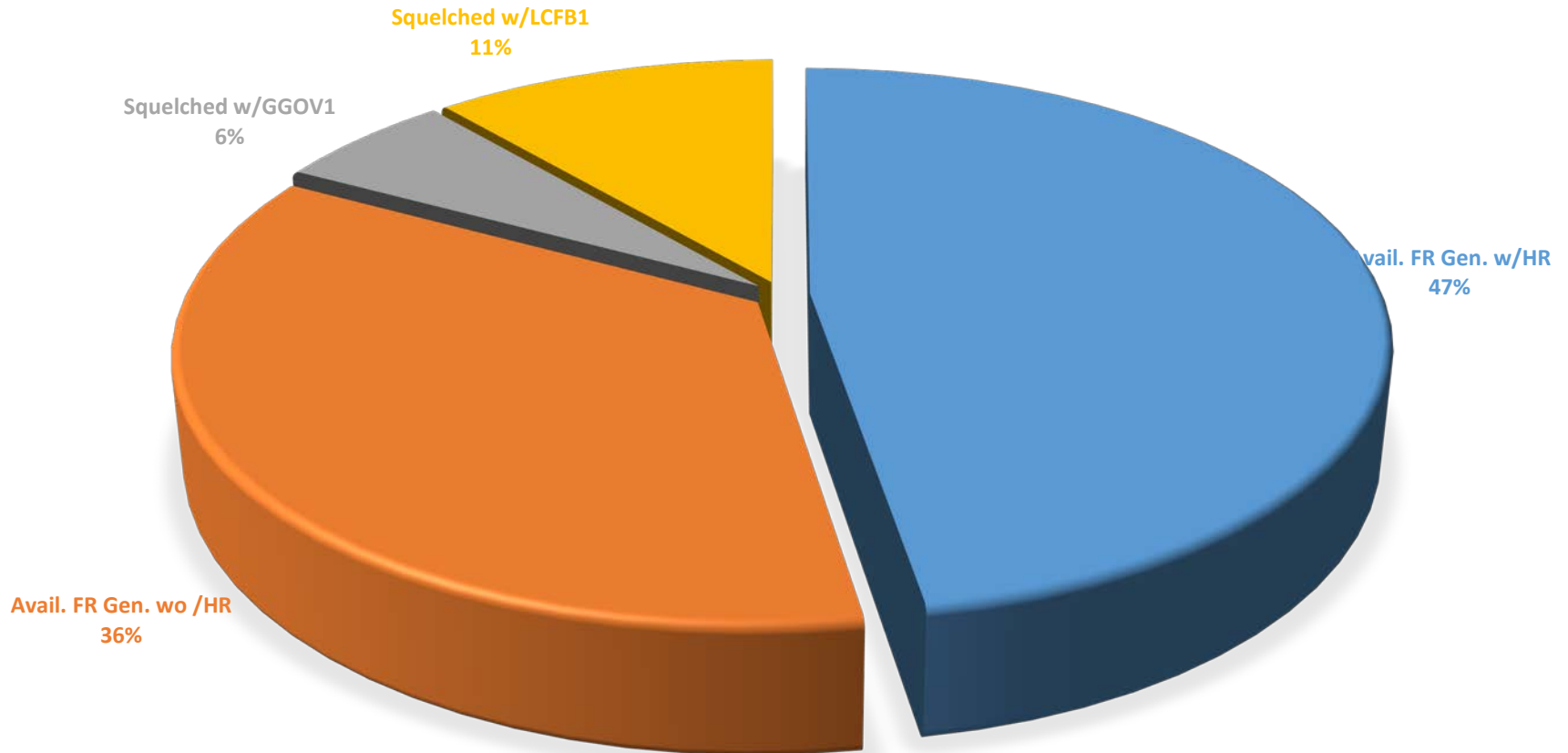
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EI MASON 345 101 ISO-NE

RELIABILITY | ACCOUNTABILITY

| Base Case Online Generation Summary | | |
|-------------------------------------|----------------|---------------|
| Avail. FR Gen. w/HR | 63,283 | 47.0% |
| Avail. FR Gen. wo /HR | 49,542 | 36.8% |
| Squelched w/GGOV1 | 7,634 | 5.7% |
| Squelched w/LCFB1 | 14,252 | 10.6% |
| Total Online Generation | 134,711 | 100.0% |

BASE CASE ONLINE GENERATION SUMMARY





Questions and Answers