FIRST DRAFT 03/26/2019 EVALUATION OF EXTERNAL AREA MODELING IN NYCA IRM STUDIES

NEW YORK STATE

NYSRC

RELIABILITY COUNCIL

Contents

I) Background 2
II) Study Scope and Approach 4
III) Case Results 6
IV) Additional Scope Items or Next Steps 8
Case 4 Validation 8
Case with EOPs in External Areas 9
Review of Individual EA Limits 9
Explore simplified models of external Areas and topology 10
Timing of NYCA Isolated Case 10
V) Findings of Next Steps 11
Case 4 Validation 11
Case with EOPs in External Areas 11
Review of Individual EA Limits 11
Review of Individual EA Limits 11
Timing of NYCA Isolated Case 11
VI) Conclusion and Recommendations 11

I) Background

The inclusion of emergency assistance (EA) benefits from external areas in IRM studies has been standard practice since the very beginning of these studies[1]. The inclusion of EA in IRM studies results in a reduction in required resources below that which would otherwise have been required without EA to meet reliability requirements. EA is also referred to in the electric power industry as interconnection benefits, tie benefits and capacity benefit margin (CBM). The North American Electric Reliability Corporation (NERC) has developed reliability standard – MOD 004. The purpose of the standard is to "promote the consistent and reliable calculation, verification, preservation, and use of Capacity Benefit Margin (CBM) to support analysis and system operations." NERC defines CBM as follows:

> "**The amount of firm transmission transfer capability preserved by the transmission provider for Load-Serving Entities (LSEs), whose loads are located on that Transmission Service Provider's system, to enable access by the LSEs to generation from interconnected systems to meet generation reliability requirements. Preservation of CBM for an LSE allows that entity to reduce its installed generating capacity below that which may otherwise have been necessary without interconnections to meet its generation reliability requirements. The transmission transfer capability preserved as CBM is intended to be used by the LSE only in times of emergency generation deficiencies."**

The modeling of EA in IRM studies can be challenging because the models utilized to calculate an Areas IRM have limitations. For instance, the modeling of the transmission system is usually limited to a transportation like network model and not a power flow-based model. This makes it more difficult to capture transmission constraints that could negatively impact the delivery of EA or prevent loop flow. Other issues include a need to be careful not to model excess capacity that might exists in an external area. The "as-found-system" for most Areas will have excess capacity above that required to meet its reliability criteria. In NY, these concerns have led to a set of requirements in NYSRC's Policy 5-13 which are designed to avoid overdependence on the external Areas for emergency capacity support. These

[1] See "early evolution of LOLP *evaluating generating capacity requirements," Roy Billinton and Kelvin Chu, IEEE Power & Energy Magazine, July/August 2015, pages 88-98*

requirements can be found in Policy 5-13 in section 3.5.6 entitled: “External Control Area Load and Capacity Models” on pages 16-17.

Table I below the IRM base case for the last 10 years. It also presents the result for the isolated case – i.e., what the NYCA IRM would be without emergency assistance. The difference between the base and the isolated cases serve as proxy, albeit an imperfect one, for the level of EA that NYCA benefited from in establishing its IRM.

Table 1

Comparison of Emergency Assistance/Tie Benefits Impact on the IRM
As Measured by the Difference between the Isolated Case and the Base Case
2010 to 2019

Year	**2010**	**2011**	**2012**	**2013**	**2014**
Base Case IRM %	17.9	15.5	16.1	17.1	17.0
NY Isolated %	25.2	25.6	24.7	24.8	25.9
Difference	7.3	10.1	8.6	7.7	8.9
Peak Load MW	32,976	32,872	33,335	33,278	33,655
EA Equivalent in MW	2,407.2	3,320.1	2,866.8	2,562.4	2,995.3
Year	**2015**	**2016**	**2017**	**2018**	**2019**
Base Case IRM %	17.3	17.4	18.1	18.2	16.8
NY Isolated %	26.0	25.9	26.4	26.2	25.0
Difference	8.7	8.5	8.3	8.0	8.4
Peak Load MW	33,587	33,387	33,273	32,868	32,488
EA Equivalent in MW	2,922.1	2,838.0	2,761.7	2,629.4	2,729.0
Ten Year Average of the Differences & σ	8.5% +- 0.8%				

Table I implies that over the last 10 years[2] EA has on average reduced the required IRM by approximately 8.5%. For the 2019 IRM study, the updating of the external Areas resulted in an even larger EA benefit than presented here even after accounting for the required Policy 5 adjustments. The implied benefit would have been more than 1% greater than presented and could have been as high as 9.5%. A number that would be on the higher end of observed historical values.

Concerned about a significant increase in EA that wasn’t fully understood, NYISO staff brought its concern to ICS. After further review conducted by NYISO staff and NYSRC consultant Adams, it was decided not to update the external Areas from the

[2] In the five years prior to 2010 the average difference 5.2%.

2018 IRM model and study the issue further for the 2020 IRM study. This was consistent with prior changes to the external Areas that have been deferred to allow for more time to study the issue further.

II) Study Scope and Approach

At its September 5^{th}, 2018, the ICS directed the NYISO to evaluate alternative adjustments to external control areas as a result of the EA concerns raised by NYISO staff regarding the observed increase in EA VS. the 2018 IRM study after the externals were updated. The alternative adjustments were developed in conjunction with NYSRC consultant Adams. The adjustments result from NYSRC Policy 5-13 requirements which are designed to avoid overdependence on the external Control Areas for emergency capacity support. These requirements are: 1) an external Control Area's LOLE assumed in the IRM study cannot be lower than its own LOLE criterion and 2) its reserve margin can be no higher than the external Control Area's minimum requirement. Also, Policy 5 states that emergency operating procedures (EOP) are not to be represented in external Areas.

To evaluate alternative adjustments approaches the following set of five study cases were developed by NYISO Staff and the NYSRC Consultant:

- Case 1 - Load scaled proportional to existing load to meet the LOLE criterion and adjust reserve margins if needed to be no higher than the published minimum requirement.
- Case 2 - Same approach as the above case. However, this analysis uses the mod-mdmw table to add loads. The mod-mdmw table is necessary to adjust multiple load shapes; which will be needed for the cases 3-5.
- Case 3 - Change the order of adjustment steps. Load scaled proportional to existing load to meet the LOLE criterion first, then remove EOPS, lastly adjust reserve margins if needed to be no higher than the published minimum requirement.
- Case 4 - Load scaled proportional to excess capacity in each zone to the meet the LOLE criterion and adjust reserve margins, if needed, to be no higher than the published minimum requirement.

- Case 5 - Change the order of adjustment steps and use excess capacity to scale. Load scaled proportional to excess capacity in each zone to meet the LOLE criterion first, then remove EOPs, lastly adjust reserve margins if needed to be no higher than the published minimum requirement.

Case 1 is the current process for adjusting or scaling load in external areas and is for comparison purposes with the other cases. Case 2 is the same as case one except in uses the mod-mdmw to adjust loads to facilitate the timely completion of cases 3-5. Case 3 an alternative way to remove EOPs from external Areas and uses the uses the existing scaling approach. Case 4 is the alternative scaling approach where load is scaled proportional to the capacity in a zone or locality to meet Policy 5 requirements. Case 5 is the same as Case 3 except it uses the alternative scaling approach.

After the initial set of Cases were completed and evaluated the scope was expanded to further explore Case 4 and address alternative ways to model external Areas such as individual EA limits for external Areas and explore whether it possible to develop a more simplified approach to modeling external Areas. These additional scope items or next steps were as follows:

- Validate Option/Case 4 by repeating prior 2 years IRM results using this scaling approach.
- Run most recent IRM study by not removing EOPs in neighboring Areas.
- Begin review of individual control Area EA limits.
- Explore development of a simplified models of external Areas and topology if feasible.
- Investigate running the isolated case for NYCA much earlier in the study process in order to get an indication of the direction of the EA benefit accruing to the NYCA much earlier in the study process.
- Make changes to Policy 5 as required.

III) Case Results

The tables 2&3 below present the results of Cases 1-5.

Table 2

External Control Area LOLEs and Margin Levels										
Year:	2018 FBC		2019 PBC							
Case:	**2018 FBC (18.2%)**		**Starting Case* (15.0%)**		**Finish Existing - Case 1 (15.6%)**		**Use Mod-MDMW - Case 2 (15.4%)**		**α to Excess Cap - Case 4 (16.4%)**	
Area	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level
_PJM_MA_	0.146	**116.0%**	0.017	**124.6%**	0.467	**115.9%**	0.398	**115.9%**	0.145	**115.2%**
ISONE	0.108	**113.8%**	0.000	**145.4%**	0.135	**117.6%**	0.108	**117.0%**	0.109	**116.5%**
IESO	0.104	**134.0%**	0.000	**143.5%**	0.639	**117.7%**	0.560	**117.7%**	0.551	**117.7%**
_HQ_	0.110	**144.1%**	0.000	**148.0%**	0.103	**138.3%**	0.103	**131.7%**	0.103	**131.7%**
_HQ_(winter)	-	**99.9%**	-	**107.9%**	-	**100.9%**	-	**100.5%**	-	**100.5%**

Table 3

External Control Area LOLEs and Margin Levels						
Year:	2019 PBC					
Case:	**Starting Case* (15.0%)**		**EOPs 2nd, α to load - Case 3 (19.5%)**		**EOPs 2nd, α to Excess Cap - Case 5 (21.7%)**	
Area	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level
_PJM_MA_	0.017	**124.6%**	1.712	**111.5%**	1.102	**109.6%**
ISONE	0.000	**145.4%**	0.260	**113.9%**	0.349	**110.7%**
IESO	0.000	**143.5%**	2.821	**110.5%**	1.111	**114.7%**
_HQ_	0.000	**148.0%**	1.118	**134.0%**	1.132	**125.0%**
_HQ_(winter)	-	**107.9%**	-	**97.7%**	-	**97.3%**

Cases 3, 4, & 5 are the cases of interest while Cases 1&2 are for comparison purposes. Cases 3 & 5 are the cases where the external Area are brought to its LOLE criterion as required by Policy 5 and then EOPs are removed. Case 3 utilizes scaling of load proportional to load by zone while Case 5 utilizes scaling of load proportional to zonal excess capacity. Policy 5 requires that EOPs not be modeled in external Areas. The concept behind this approach is to reflect the reduced external Area reliability that would result without the availability of their EOPS. As can be seen in Table 3, this approach has a significant impact on the resulting IRM when compared with Cases 1 or 2. Depending on the load scaling utilized, the IRM is increases by 4% to 6% compared to Cases 1 & 2. This significant impact and is the result of EOPs representing a significant amount of equivalent capacity.

Case 4 is the case where scaling of zonal load is done proportional to zonal excess capacity to accomplish the adjustment required by Policy 5. This approach results in an increase in the IRM of about 1%. The focus on zonal excess capacity to adjust load is more consistent with the objective to avoid overdependence on the external Areas for emergency capacity support. It reduces reserve margins or excess capacity proportionally more in the external Area zones with greater excess capacity. Therefore, depending on the juxtaposition of the zone relative to NYCA, reducing the excess reserves proportionally more in external areas zones closer to NYCA will result in less EA being available to NYCA. It also appears to result in the external Areas to meet their LOLE criterion with lower reserves.

IV) <u>Additional Scope Items or Next Steps</u>

Case 4 Validation

Case 4 is the approach where by adjustments to the external Areas to satisfy Policy 5 requirements which are designed to avoid NYCA over dependence on external capacity for EA are implemented proportional to the excess capacity in the external zone or locality. The purpose of this review is to validate the approach 4 by repeating prior 2 years of IRM results. This will demonstrate how this approach impacts year-to-year changes in IRM and whether there any issues which could produce adverse impacts.

Initial Case 4 analysis conducted by NYISO staff found the Case 4 approach eliminated the need to make additional reserve adjustments in two of the externals

Areas (ISO-NE and PJM) after LOLE Policy 5 criteria were satisfied and reduced the magnitude of IRM adjustments in the other external Areas. This suggest that scaling zonal load proportional to zonal excess capacity VS. scaling load proportional to existing load appears to offer the following advantages:

1. Given detailed topology models in external Areas, scaling load proportional to excess capacity to meet Policy 5 LOLE requirements, helps to avoid localized LOLE violations while reducing excess reserves in external Areas available to NYCA to provide EA.
2. Lower overall excess reserves in external Areas is more consistent with the Policy 5 objective of avoiding overdependence on the external Areas for emergency capacity support.

Case with EOPs in External Areas

Cases 3 & 5 clearly demonstrated that bringing the external Areas to their LOLE criterion and then removing the EOPs as required by has a significant impact on external Areas LOLE and the NYCA IRM. This is because Area EOP steps can account for a significant amount of equivalent capacity. Adopting this approach would represent a significant change and should not be pursued further.

Current practice is to remove the EOP steps in the external Ares and then bring the Area to its LOLE criterion. In NYSRC consultants view, this approach effectively replaces the EOP steps capacity equivalent with some of the excess capacity in the external Area. This raises the question as to why even go through the process of removing the EOP steps. The purpose of this next step was to explore the impact on the NYCA IRM if the EOP steps in the external Area were not removed to start with. If this approach were adopted it would require Policy 5 to be updated.

Review of Individual EA Limits

Currently, each MARS Monte Carlo draw limits the total amount of EA available to NYCA from the external Areas to 3500 MW. This limit was developed from the analysis of excess operating reserves that is available in the external Areas. The amount of EA that can come from any one external Area is subject to the transfer capability between the external Area and the NYCA. However, concerns were raised that the majority of the 3500 MW could come from a single external Control Area. Large injections of EA from a single Area may be unrealistic and could result in NYCA being over dependent on a single external Area for EA. As part of the evaluation of EA issue, examination of individual control area limits was included in the next steps.

Explore simplified models of external Areas and topology

During the review of EA, a suggestion was put forth by NYISO staff that alternative ways be explored to model the external Areas that would result in less complex models of those Areas. This would speed up both the updating process for the external Areas and the run time of the simulations. Three test cases or alternative approaches were proposed by NYISO staff. They are as follows:

1. Test #1: Using the individual Area EA limits developed above, model each external control area as a single Area with the tie capability entering New York set to the individual EA values and isolate the ties leaving New York in order to eliminate loop flow.
2. Test #2: Same as test #1 but with a single perfect generator modeled in each external Area equal to the individual Area EA limit.
3. Test #3: Same as Test #2 but remove the tie limits from the interfaces

Timing of NYCA Isolated Case

The isolated IRM case where NYCA is modeled without the availability EA from the external Areas is a proxy for how much benefit or reduction in the IRM that results from having access to EA. This result provides guidance as to how much the level of assistance has changed from the previous year’s study to the current year’s IRM study. Significant changes in level can indicate that a more in-depth review of the updates to the external Areas should be under taken. The isolated case is run as part of the sensitivity cases. These cases are run close to the end of the IRM study. This can result in limited time for review if an issue arises. NYISO staff has been asked if it would be possible to run the isolated case earlier in the process.

V) Findings of Next Steps

Case 4 Validation

Preliminary Results

	2017			2018			2019		
IRM	Before Pol 5	Final	New Final	Before Pol 5	Final	New Final	Before Pol 5	Final*	New Final
LOLE									
NYCA	0.0995	0.1000	0.0999	0.1000	0.0997				0.1002
PJM_MA	0.1285	0.1408	0.1401	0.0000	0.1462		0.0173	0.1477	0.1489
ISONE	0.1505	0.1344	0.1344	0.0916	0.1077		0.0000	0.1068	0.1191
IESO	0.1017	0.1093	0.1088	0.0404	0.1044		0.0001	0.1051	0.1043
Quebec	0.1048	0.1131	0.1131	0.0001	0.1103		0.0000	0.1063	0.1103
Load Added		Previous Method	New Method		Previous Method	New Method		Previous Method	New Method
PJM_MA		75	50		14014			11456	12500
ISONE					150			6032	6340
IESO		10	0		1390			4822	4822
Quebec					2550			1623	2865
Total		85	50		18104			23933	26527
IRM Sensitivity		18.10%	18.07%		18.20%		15.00%	15.60%	16.40%

* If the replacement of the externals had occurred and the old method retained.

Case with EOPs in External Areas

Review of Individual EA Limits

Review of Individual EA Limits

Timing of NYCA Isolated Case

VI) Conclusion and Recommendations