# Review of Interconnection Assistance Reliability Benefits

May 12, 1999

NPCC CP-5
Working Group

# NORTHEAST POWER COORDINATING COUNCIL

## WORKING GROUP CP-5

# REVIEW OF INTERCONNECTION ASSISTANCE RELIABILITY BENEFITS

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# EXECUTIVE SUMMARY

NPCC's CP-5 Working Group, under the auspices of the Task Force on Coordination of Planning was charged to:

1. On a consistent basis, estimate the amount of interconnection assistance available to the NPCC Areas for the near term (five-year period).
2. Review each NPCC Area's current estimates of interconnection benefits used to meet the NPCC Resource Reliability Criterion.
3. Verify that the current levels of interconnection benefits are reasonable and do not result in overstating any NPCC Area's reliability.

Several multi-area reliability scenarios were modeled to examine interconnection benefits for each of the NPCC Areas. These scenarios range from examining the reliability of each Area on an isolated basis to examining Area reliability when all NPCC Areas were interconnected. Included was a benefit to Ontario Hydro from ECAR and New York's use of PJM's transmission system.

## Study Conclusions

1. The amount of interconnection assistance available to each of the NPCC Areas was estimated using a consistent methodology and assumptions, with the same multi-area model.
2. Recent NPCC Area estimates of interconnection benefits used to meet the NPCC Resource Reliability Criterion were reviewed on a consistent basis.
3. The study showed that the methodology and assumptions used by all NPCC Areas for evaluating interconnections in their reliability studies appear to be reasonable and do not overstate interconnection benefits.
4. Overall, NPCC reserves were sufficient to meet each Area's criterion.

## Study Recommendations

1. Examine the impact that changes to the transfer limits assumed on the transmission interfaces between Areas of NPCC have on tie benefits (e.g. between NE and NY).
2. Reevaluate this analysis if an Area recognizes Sub-Area transmission constraints in their interconnection assistance reliability studies. At present only the New York Area models Sub-Area transmission constraints.
3. Continue to keep the CP-5 Working Group's database up to date in order to facilitate NPCC or Areas' future studies.
4. Develop a more detailed reliability representation of regions bordering NPCC (i.e. PJM, ECAR).
5. Examine the impact that the Areas' evolving market rules may have on overall NPCC interconnection assistance.

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The members of the CP-5 Working Group wish to acknowledge the contributions of Brian Jennings, John Lally, and Dr. Narayan Rau of ISO New England, as well as Frank Vitale formerly of the New York Power Pool.

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# 1.0 INTRODUCTION

The CP-5 Working Group, under the auspices of the NPCC's Task Force on Coordination of Planning (TFCP), was charged to:

1. On a consistent basis, estimate the amount of interconnection assistance available to the NPCC Areas for the near term (five-year period).
2. Review each NPCC Area's current estimates of interconnection benefits used to meet the NPCC Resource Reliability Criterion[1].
3. Verify that the current levels of interconnection benefits are reasonable and do not result in overstating any NPCC Area's reliability.

Each NPCC Area is responsible for installing sufficient resource capacity to meet its load and operating reserve in accordance with NPCC criteria, taking into consideration the potential benefit arising from reserve sharing through interconnections with neighboring Areas. Each NPCC Area is required to comply with the NPCC criterion, and reports to NPCC their findings in a "Triennial Review of Resource Adequacy."

This evaluation utilizes consistent assumptions and methodologies to evaluate an Area's interconnection benefits. This objective was accomplished by use of a multi-area reliability program with data modeled on a consistent basis. Area loads were correlated based on the 1995 historical load period. Area load forecast uncertainties and emergency operating procedures were modeled on a consistent basis. Special operating characteristics were also represented in the model for the Beauharnois, LaGrande 2A, and Millbank stations (as shown in Section 3.3.5). In addition, the study recognized that each of the Canadian utilities have dispatchable loads [interruptible loads] which are operating procedures restricted for use solely by that utility.

[1] NPCC Resource Reliability Criterion – "Each Area's resources will be planned in such a manner that, after due allowance for scheduled outages and deratings, forced outages and deratings, assistance over interconnections with neighboring Areas and regions, and capacity and/or load relief from available operating procedures, the probability of disconnecting non-interruptible customers due to resource deficiencies, on the average, will be no more than once in ten years."

# 2.0 AREA INTERCONNECTION ASSISTANCE METHODOLOGIES

NPCC Areas currently utilize either Loss of Load Expectation (LOLE) or Loss of Energy Expectation (LOEE) techniques in evaluating the resource adequacy of their systems. Table 1 provides a list of factors that affect interconnection assistance and how each Area has modeled them in their studies.

**Table 1**

**INTERCONNECTION ASSISTANCE MODELING**

| FACTOR | | Hydro-Québec | Maritime Area | New England | New York | Ontario Hydro |
|---|---|---|---|---|---|---|
| 1. | Capacity support from interconnection modeled | Yes[1] | Yes | Yes | Yes | Yes |
| 2. | Reliability Index Calculated in Area Resource Adequacy Studies | LOLE | LOLE | LOLE | LOLE | LOEE |
| 3. | Number of Areas presently modeled | 4 | 1 | 4[2] | 5[3] | 2 |
| 4. | Interconnection explicitly modeled | Yes | No | Yes | Yes | Yes |
| 5. | Load forecast uncertainty represented | Yes | Yes | Yes[4] | Yes | Yes |
| 6. | Basis for installed reserve assumed for interconnected systems | Equal Risk | N.A. | Equal Risk | Equal Risk | Equal Risk |
| 7. | Internal Area transmission modeled in reliability studies | No | No | No[2] | Yes[5] | No |
| 8. | Interconnection outages modeled | Yes | No | Yes | No | No |
| 9. | Recently Approved Area Triennial Review | 5/99 | 12/98 | 6/97 | 6/99 | 4/97 |

[1] Since the Fall of 1998, Hydro-Québec does not consider capacity assistance from other Areas unless reservations and commitments are made for transmission and capacity on a commercial basis.

[2] New England is evaluating G.E's Multi-Area Reliability Simulation Program (MARS).

[3] The NYPP uses MARS to determine interconnection assistance and to determine whether LOLE is impacted by internal transmission constraints.

[4] Analysis based on a reference load forecast that has a 50% chance of occurring.

[5] The NYPP adheres to its Transmission Capability requirement that states "The NYPP bulk power system will be planned with sufficient emergency transmission capability to meet the NYPP resource adequacy criterion."

Table 2 shows the interconnected Areas that are considered when each Area performs its reliability studies. The following table is read from left to right (e.g. Hydro-Québec considers interconnections with the Maritime Area, New England, and New York).

## Table 2

### INTERCONNECTION CONSIDERED BY NPCC AREAS

| Area Doing Study | Interconnections Considered in Area Studies | | | | | | |
|---|---|---|---|---|---|---|---|
| | Hydro-Québec | Maritime Area | New England | New York | Ontario Hydro | ECAR | PJM |
| Hydro-Québec | - | X | X | X | - | - | - |
| Maritimes Area | X | - | X | - | - | - | - |
| New England | X | X | - | X | - | - | - |
| New York | X | - | X | - | X | - | X |
| Ontario Hydro[1] | X | - | X | X | - | X | - |

[1] Ontario Hydro combines the US Areas into a single equivalent area for its studies and also considers interconnections with Manitoba.

# 3.0 MULTI-AREA RELIABILITY ANALYSIS

## 3.1 MULTI AREA RELIABILITY MODEL

### *(1) MARS Program*

General Electric's (GE) Multi-Area Reliability Simulation Program (MARS) is a sequential Monte-Carlo simulator. It is capable of calculating on an Area and Sub-Area basis, the standard indices of daily Loss Of Load Expectation (LOLE in days/year), hourly LOLE (hours/year) and a Loss of Energy Expectation (LOEE in MWh/year). In the CP-5 study, the model was used to determine daily LOLE for each of the NPCC Areas and Sub-Areas at the time of each NPCC Area's daily peak load.

In MARS, chronological system events are developed by combining randomly generated operating histories of the generating resources with inter-Area and intra-Area transfer limits and chronological hourly loads. The capacity margin is determined for each isolated Area. If an isolated Area has a negative capacity margin, the model seeks to initiate transfers from Areas with a positive capacity margin. Available reserves are allocated among deficient Areas by a priority list and among Sub-Areas on a shared basis in proportion to Sub-Area shortfalls. This process is repeated for each load forecast uncertainty level. If a shortfall still exists after allocating the reserves that are available to flow across constrained interfaces, the model implements emergency operating procedures to avoid a loss of load to the extent possible at the time of the daily peak load.

### *(2) Program Enhancements*

The CP-5 Working Group commissioned GE to make the following program enhancements to MARS:

1. Specify load forecast uncertainty by Area and month.
2. Calculate each Area's daily LOLE based on its hour of daily peak.

The first program enhancement allowed each NPCC Area the flexibility to model their assumed forecast load uncertainty. The second enhancement allowed for the determination of LOLE on an individual Area basis rather than on an overall NPCC basis.

## 3.2 STUDY SCOPE

NPCC's CP-5 Working Group, under the auspices of the Task Force on Coordination of Planning was charged to:

1. On a consistent basis, estimate the amount of interconnection assistance available to the NPCC Areas for the near term (five-year period).
2. Review each NPCC Area's current estimates of interconnection benefits used to meet the NPCC Resource Reliability Criterion.
3. Verify that the current levels of interconnection benefits are reasonable and do not result in overstating any NPCC Area's reliability.

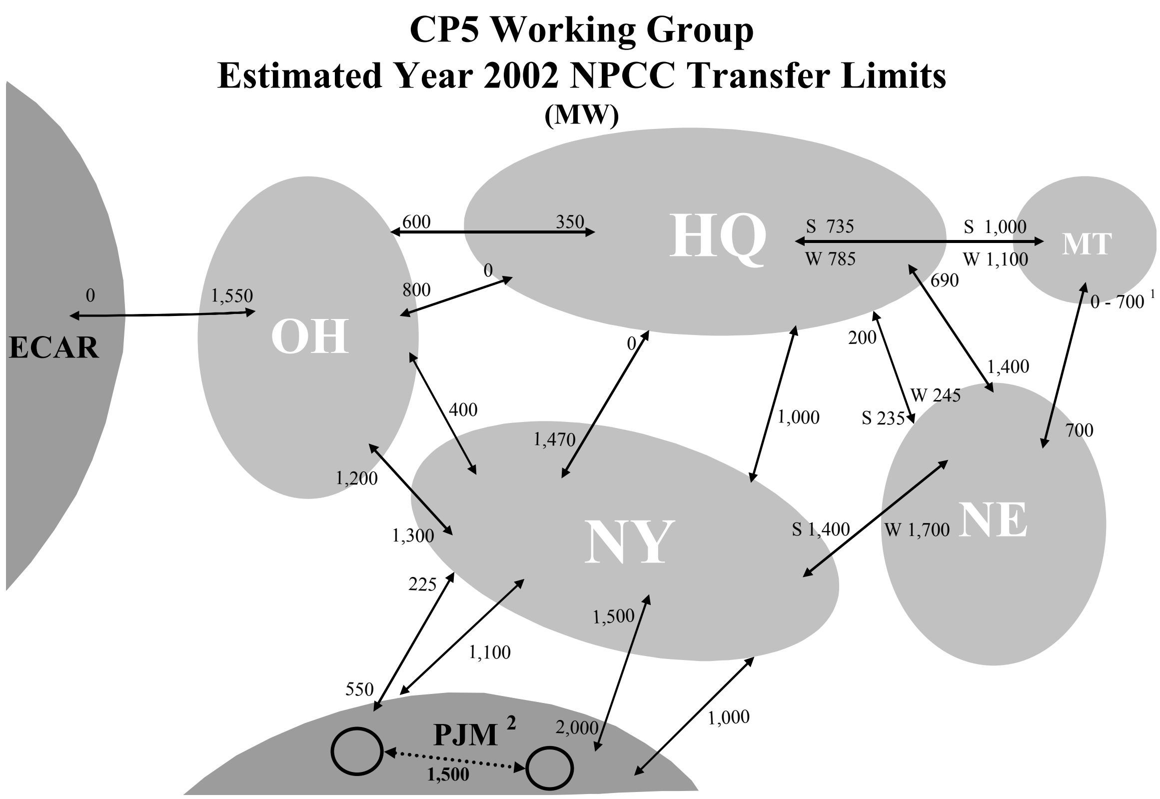
Several multi-area reliability scenarios were modeled to examine interconnection benefits for each of the NPCC Areas. These scenarios range from examining the reliability of each Area on an isolated basis to examining Area reliability when all NPCC Areas were interconnected. Included was a benefit to Ontario Hydro from ECAR and New York's use of PJM's transmission system.

## 3.3 MODELING ASSUMPTIONS

### *(1) Transfer Limits*

Figure 1 depicts the system that was represented in the CP-5 study, showing Areas and assumed transfer limits. Transmission limits shown for the year 2002 assumed existing transmission facilities will continue to be in-service, subject to existing constraints. Tie transfer limits between Areas are indicated with seasonal ratings where appropriate.

**Figure 1**




Transfer Limits have Annual Ratings unless noted:

S – Summer Rating
W – Winter Rating

The acronyms used in the diagram above are defined as follows:

| | |
|---|---|
| HQ | - Hydro-Québec |
| MT | - Maritime Area |
| NE | - New England |
| OH | - Ontario Hydro |
| NY | - New York |
| ECAR | - East Central Area Reliability Council |
| PJM | - Pennsylvania New Jersey Maryland Interconnection |

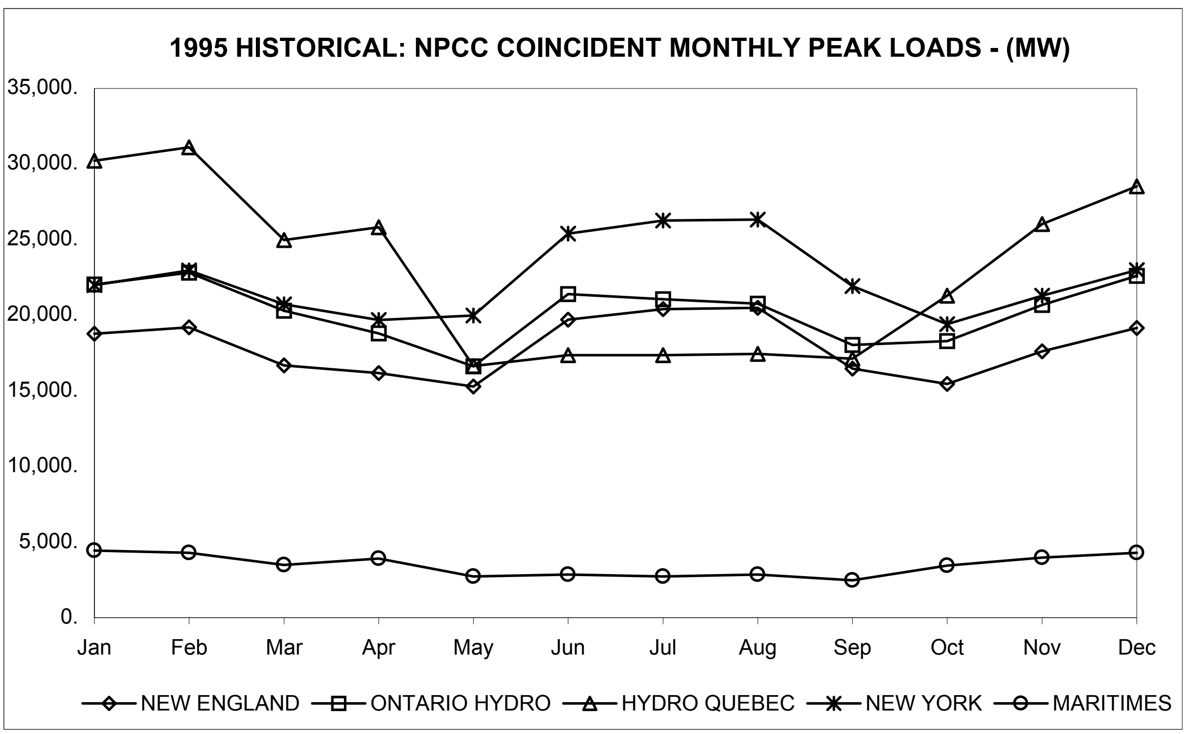
[1] See Section 4.2.
[2] New York assumed 1,500 MW use of PJM's transmission system.

### *(2) Load Model*

After reviewing the weather characteristics of the years from 1988 through 1997, the CP-5 Working Group agreed to use 1995 as the model for the load shape and used the growth rate in each month's peak to escalate their Area's loads to match their year 2002 forecasts. The impacts of Demand Side Management programs were included in each Areas load forecast. Load forecast uncertainty was included in the study by modeling each Area's forecasted load distributions due to weather and economic uncertainties, as supplied by the CP-5 Working Group members.

Figure 2 shows the diversity in load shapes between the NPCC Areas in 1995. It can be observed that the Canadian Areas are winter peaking while the U.S. Areas are summer peaking. This seasonal difference in the annual peak load contributes to the interconnection assistance available to each Area.

**Figure 2**




### *(3) Generation Resources*

Each Area provided its projections of available resources consistent with their forecasts for the year 2002 as of March, 1998. Firm purchases and sales were modeled as a shift in resources from the selling Area to the buying Area.

### *(4) Transition Rates*

The MARS program uses transition rates to represent the random forced outages of thermal units. Most of the unit data was represented with two-state transition rates, where units are represented as being fully available or as a full forced outage. The Maritimes and New York also modeled some units with partial outage states. Partial outage rates represent a unit as fully available, as a full forced outage, and with partially available state(s).

### *(5) Emergency Assistance Priority (EOP)*

Table 3 indicates the priority order followed when allocating reserves and emergency assistance to Areas with a deficiency. In this study, each EOP step was initiated simultaneously in all NPCC Areas and Sub-Areas.

**Table 3**

**PRIORITY ORDER MODELED[1]**

| Area Providing Assistance | Priority of Assistance | | | |
|---|---|---|---|---|
| | First | Second | Third | Fourth |
| **Hydro-Québec** | Maritime Area | Ontario Hydro | New England | New York |
| **Maritime Area** | Hydro-Québec | Ontario Hydro | New England | New York |
| **New England** | New York | Maritime Area | Hydro-Québec | Ontario Hydro |
| **New York** | New England | Hydro-Québec | Ontario Hydro | Maritime Area |
| **Ontario Hydro** | Hydro-Québec | Maritime Area | New York | New England |

1 Emergency assistance to neighboring NPCC Areas was not modeled and may affect results.

In addition, Beauharnois and La Grande 2A have special operating characteristics that allow for the direct connection of these resources to Areas adjacent to the Area in which they are located. The Millbank Station, although located within the Maritime Area, has three of its units contracted to Hydro-Québec. These units are modeled as a resource for Hydro-Québec first. These resources were modeled to reflect their priority order of assistance:

- Beauharnois Station: Hydro-Québec 1st priority, Ontario Hydro 2nd priority, New York 3rd priority.
- LaGrande 2A Station: Hydro-Québec 1st priority, New England 2nd priority.
- Millbank Station: Hydro-Québec 1st priority, Maritime Area 2nd priority

During the course of the study, contracts for units at the Millbank Station begin to expire and these units revert to the Maritime Area’s control. These changes were modeled in the analysis.

## 3.4 SCENARIOS

Table 4 summarizes the scenarios analyzed by the CP-5 Working Group. The As-Is cases refer to the modeling of systems with resources that are expected to be in-place for the year 2002, as supplied by the CP-5 Working Group members in 1998. The At-Criterion cases refer to modeling the adequacy condition of each of the NPCC Areas being at a criterion level of 0.1 days/year LOLE. This condition was achieved by adjusting load in each NPCC Area until each Area's interconnected reliability index simultaneously reached approximately 0.1 LOLE. New York has an Area reliability criterion but not a Sub-Area criterion. It was the only Area to model internal transmission constraints between its Sub-Areas. Scenarios B and C were modeled to reflect two possible methods of bringing the New York Area to criterion. In Scenario B, New York's Sub-Area load was increased equally until New York reached criterion. In Scenario C, load was increased only in New York's upstate Sub-Areas until criterion was achieved.

**Table 4**

**CP-5 STUDY SCENARIOS**

| Scenario | Description |
|---|---|
| A | Individual Areas Isolated As-Is |
| B | Interconnected At-Criterion<br>With equal load adjustments to each New York Sub-Area |
| C | Interconnected At-Criterion<br>With load adjustments to New York's upstate Sub-Areas |
| D | Interconnected As-Is |

## 3.5 RESULTS

### *(1) Scenario LOLE Results*

Tables 5 to 9 summarize the annual Loss Of Load Expectation (LOLE) results with Load Forecast Uncertainty for each of the scenarios described in Table 4. In the Tables Section of the report, Tables A-1 to A-4 summarize the annual and monthly LOLE results.

**Table 5**

**HYDRO-QUÉBEC**

| | Scenario | LOLE (Days/Yr.) |
|---|---|---|
| **Isolated As-Is** | A | 0.010 |
| **Interconnected At-Criterion** | B & C | 0.100 |
| **Interconnected As-Is** | D | 0.000 |

**Table 6**

**MARITIME AREA**

| | Scenario | LOLE (Days/Yr.) |
|---|---|---|
| **Isolated As-Is** | A | 0.054 |
| **Interconnected At-Criterion** | B & C | 0.100 |
| **Interconnected As-Is** | D | 0.000 |

**Table 7**

**NEW ENGLAND**

| | Scenario | LOLE (Days/Yr.) |
|---|---|---|
| **Isolated As-Is** | A | 5.514 |
| **Interconnected At-Criterion** | B & C | 0.100 |
| **Interconnected As-Is** | D | 0.030 |

**Table 8**

**NEW YORK**

| | Scenario | LOLE (Days/Yr.) |
|---|---|---|
| **Isolated As-Is** | A | 0.759 |
| **Interconnected At-Criterion** | B & C | 0.100 |
| **Interconnected As-Is** | D | 0.058 |

**Table 9**

**ONTARIO HYDRO**

| | Scenario | LOLE (Days/Yr.) |
|---|---|---|
| **Isolated As-Is** | A | 0.983 |
| **Interconnected At-Criterion** | B & C | 0.100 |
| **Interconnected As-Is** | D | 0.000 |

### *(2) Load Forecast Uncertainty*

Table 10 shows the impact of load forecast uncertainty on the study results. The representation of load forecast uncertainties increases LOLE in all cases. The results are only shown to three significant places.

**Table 10**

**IMPACT OF LOAD FORECAST UNCERTAINTY (LFU)**
**LOLE (DAYS /YEAR)**

| Area | Isolated As-Is | | Interconnected As-Is | |
|---|---|---|---|---|
| | No LFU | With LFU | No LFU | With LFU |
| **Hydro-Québec** | 0.000 | 0.010 | 0.000 | 0.000 |
| **Maritime Area** | 0.000 | 0.054 | 0.000 | 0.000 |
| **New England** | 4.496 | 5.514 | 0.005 | 0.030 |
| **New York** | 0.661 | 0.759 | 0.038 | 0.058 |
| **Ontario Hydro** | 0.253 | 0.983 | 0.000 | 0.000 |

## 3.6 DERIVATION OF INTERCONNECTION ASSISTANCE BENEFITS

Table 11 shows the interconnection assistance benefits available to each Area for Scenarios B and C. The benefits shown are in terms of equivalent "perfect" capacity (i.e. "perfect" capacity assumes 100% availability).

### Table 11

**ESTIMATED AVAILABLE ANNUAL INTERCONNECTION ASSISTANCE WITH LOAD FORECAST UNCERTAINTY (MW)**

| | Hydro-Québec | Maritime Area[1] | New England | New York[2] | Ontario Hydro |
|---|---|---|---|---|---|
| **NPCC Cases** | | | | | |
| **Interconnected At-Criterion (Scenario B)** With equal load adjustments to each New York Sub-Area | 1,125 | 1,175 – 1,875 | 2,900 | 950 – 3,500 | 2,925 |
| **Interconnected At-Criterion (Scenario C)** With load adjustments to New York's upstate Sub-Areas | 1,075 | 1,175 – 1,875 | 2,575 | 2,650- 3,325 | 2,550 |

[1] See Section 4.2.

[2] See Section 4.4.

Available annual interconnection assistance benefits for Scenarios B and C were estimated:

- All required data for the interconnected NPCC Areas were input into the MARS model and the interconnected reliability was calculated in terms of a Loss of Load Expectation (LOLE) in days per year for each of the Areas.
- The interconnected NPCC Areas were simultaneously brought to criteria (0.1 days per year) by increasing all daily peak loads for a given Area by the same percentage or by adding additional generation. Each Area's isolated and interconnected reliability was calculated.
- Each Area was then isolated and firm equivalent "perfect" capacity was added until its isolated reliability reached the 1 day in 10 years criterion. This added capacity is, by definition, the total reliability benefits each Area received from all its interconnections.

## 3.7 COMPARISON OF AREA INTERCONNECTION ASSISTANCE BENEFITS

Table 12 compares the interconnection assistance benefits from the CP-5 study with recent Area studies. When interpreting these results, there are two important points that are critical to recognize; first, the data used in recent Area studies may have been considerably different from that used in the CP-5 study, and second, the underlying methodology varies somewhat for each NPCC Area.

**Table 12**

**ANNUAL INTERCONNECTION ASSISTANCE BENEFITS ESTIMATED TO MEET CRITERION FOR THE YEAR 2002 (MW)**

| NPCC Area | Assumed Benefits Recent Area Studies[1] | Available Benefits Range CP-5 Study Results[2] |
|---|---|---|
| Hydro-Québec | 0 | 1,075 – 1,125 |
| Maritime Area | 0 | 1,175 – 1,875 |
| New England | 2,800 | 2,575 – 2,900 |
| New York | 1,000 | 950 – 3,500 |
| Ontario Hydro | 0 – 700 | 2,550 – 2,925 |

[1] Recent Area studies are from NPCC Triennial Reviews of Resource Adequacy: Hydro-Québec– 5/99, Maritime Area – 12/98, New England – 6/97, New York – 6/99, and Ontario Hydro – 4/97.

[2] This represents the range of equivalent assisting capacities from Table 11 for the scenarios examined.

When evaluating the range of CP-5 study results, it is also important to understand that these results are not intended to be interpreted as minimum and/or maximum interconnection assistance benefits. Changes to the input data could easily change the range of results. Furthermore, additional cases using other priority orders may result in wider or narrower ranges than those presented.

With this said, the above comparison indicates that the interconnection assistance benefits used in each Area's current studies are not greater than the range of benefits available as indicated by the CP-5 study results. Therefore, it can be concluded that no NPCC Area presently overstates interconnection assistance benefits in its own reliability studies.

# 4.0 AREA COMMENTARIES ON CP-5 STUDY RESULTS

This section provides commentaries on study results prepared by the respective NPCC Areas.

## 4.1 HYDRO-QUÉBEC

The results are consistent with Hydro-Québec's past studies using a multi-area reliability program. But it is Hydro-Québec's position that, with the new open market approach, generation and transmission must be secured on a commercial basis to ensure their future availability. So the present study just shows that the overall reserve in NPCC is sufficient to meet the reliability criteria of the council. It should not be interpreted as a support to accept a Capacity Benefit Margin or other similar margin to reduce the availability of transmission on a non-commercial basis.

It should be noted that usually the Hydro-Québec system has a larger LOLE in January than in February. So the choice of the year 1995 as a reference for load, where Hydro-Québec peaked in February, slightly impacts on the result. However this should not change the overall conclusions.

## 4.2 MARITIME AREA

The interconnection assistance to the Maritime Area is available through interconnections with both the Hydro-Québec and New England Areas of NPCC.

The interconnection between the Maritime Area and Hydro-Québec consists of two HVDC stations and three Maritime Area system load blocks which can be switched to a radial supply from Hydro-Québec. Further, there is a combustion turbine plant (Millbank) located in the Maritime Area which has a portion of its output contracted to Hydro-Québec. Because this output is modeled as a resource of Hydro-Québec and because it is physically located within the Maritime Area, it has the effect of increasing the size of the interconnection between Hydro-Québec and the Maritime Area (for Maritime Area import) by the amount of the contract.

The ability of the New England Area to provide assistance to the Maritime Area is currently impacted by the ability of the interconnecting transmission system to withstand the sudden loss of the largest unit in the Maritime Area. Depending upon system load levels, the amount of new generation installed in Maine in and around the weak area, and also on the amount of transmission reinforcement installed between now and 2002, the transfer capability from New England to the Maritime Area could vary from 0 MW to 700 MW. This required that the simulation be performed at both levels. The maximum interconnection tie benefit available to the Maritime Area lies between the two results.

The method used to determine the value of interconnection assistance, by its nature, results in a value that is biased towards the peak load (winter) period when the interconnection ratings are higher. Further, a portion of the combustion turbine contract expires October 31, 2002. For this reason the range of values determined using the MARS program (1,375-2,075) was adjusted to reflect the lower summer ratings and to reflect the change in the combustion turbine contract. The amount of the adjustment is 200 MW resulting in a maximum interconnection tie benefit between 1,175 and 1,875 MW.

The LOLE results reported in Table 10 are consistent with the results reported in the most recent Maritime Area Triennial Review of Resource Adequacy (December, 1998).

Reliability reviews conducted by the Maritime Area do not determine the amount of interconnection support available. Rather, the reviews determine the amount of interconnection support required by the Maritime Area in order to comply with the NPCC resource adequacy criterion. This requirement is then evaluated against the available interconnection support as documented in the most recent NPCC CP-5 Working Group report "Review of Interconnection Assistance Reliability Benefits" or other sources as appropriate (i.e. "Review of NEPOOL's Reliance on Outside Assistance," etc.). The most recent Maritime Area Triennial Review of Resource Adequacy demonstrates that for the 10 year period 1998-2007, no interconnection support is required for the first nine years; only 55 MW is required in 2007.

The range of interconnection equivalent capacity reported in Table 11 is approximately equal to the installed capacity of the Maritime Area interconnections. The results indicate that the systems behind the interconnections are not the limiting factor in the determination of the amount of interconnection support available. This is due, in part, to the size and strength of the systems relative to the size of the interconnections and also due to the size of the interconnections relative to the load and resources of the Maritime Area.

## 4.3 NEW ENGLAND

The range in interconnection equivalent capacity (2,575 MW – 2,900 MW) for New England obtained from this study is consistent compared to results of previous New England analyses. The ”Review of NEPOOL’s Reliance on Outside Assistance” conducted by NEPOOL in 1994, using a multi-area reliability program, calculated average annual interconnection benefits in the 2,300 MW – 3,000 MW range.

## 4.4 NEW YORK

Table 12 shows that NYPP receives interconnection equivalent capacity of from 950 MW to 3,500 MW, depending on the assumptions made in the particular scenario. NYPP agrees with these results.

The lower of these numbers is the amount of capacity that has to be added to NYPP as an isolated system, when all of this capacity is added to NYPP’s most resource critical Sub-Areas, for the NPCC resource adequacy criterion to be met. This approach, and the result obtained, is consistent with that of the last CP5 study where NYPP was modeled without Sub-Areas.

The higher of these values is arrived at in the same way, only in this case, capacity is added to all Sub-Areas in NYPP, whether or not they are resource critical. Because capacity is also added to non-critical areas, it is not added as efficiently and, hence, more is needed.

The system representation on which this range is based was obtained by adding equal amounts of load to *each* Sub-Area of NYPP while NYPP was interconnected to the other Areas until NYPP LOLE was equal to the NPCC criterion.

The other range in Table 11, that of from 2,650 MW to 3,325 MW of equivalent capacity, was obtained in the same manner, except that the system representation of NYPP was obtained by adding load *only to the most reliable* Sub-Areas of NYPP until the NPCC criterion was met. Because more Sub-Areas in NYPP were made resource critical, a larger amount of capacity had to be added to return NYPP’s reliability to the NPCC criterion (when it was subsequently isolated from the other Areas) than when the added capacity could be targeted at a smaller number of Sub-Areas.

Adding load to only the most reliable Sub-Areas of NYPP also reduced the MW equivalent capacity of neighboring Areas because the Sub-Areas of NYPP they were directly connected to were now less reliable.

Given the evolution of the economy in New York State, NYPP feels that the scenarios employing equal load adjustment to each Sub-Area are the more realistic of the two, and may themselves be conservative in their implications for the MW equivalent tie capacity of neighboring Areas.

NYPP is currently engaged in a Locational Requirements study as part of starting the installed capacity market that will operate once the New York State Independent System Operator (NYISO) begins functioning. The database and much of the methodology created for the CP5 study will be employed in that effort.

## 4.5 ONTARIO HYDRO

The range 2,500 to 2,900 MW of interconnection equivalent capacity available to Ontario determined in this study is considerably above the 700 MW currently used by Ontario Hydro. Ontario Hydro must consider increasing the amount of interconnection assistance used in its reliability studies.

Several aspects not considered in this study which could have specific impacts on Ontario interconnection and would have to be considered before using the values for interconnection assistance calculated in this study. Ontario reliability was substantially impacted by generation maintenance schedules and hydro-electric seasonal use patterns--the impact of this on the amount interconnection assistance would need to be considered. Internal Ontario transmission limitations especially related to flow to ECAR could impact interconnection assistance but could not be studied with the NPCC-specific data available for this study.

# 5.0 CONCLUSIONS

1. The amount of interconnection assistance available to each of the NPCC Areas was estimated using a consistent methodology and assumptions, with the same multi-area model.
2. Recent NPCC Area estimates of interconnection benefits used to meet the NPCC Resource Reliability Criterion were reviewed on a consistent basis.
3. The study showed that the methodology and assumptions used by all NPCC Areas for evaluating interconnections in their reliability studies appear to be reasonable and do not overstate interconnection benefits.
4. Overall, NPCC reserves were sufficient to meet each Area's criterion.

# 6.0 RECOMMENDATIONS

1. Examine the impact that changes to the transfer limits assumed on the transmission interfaces between Areas of NPCC have on tie benefits (e.g. between NE and NY).
2. Reevaluate this analysis if an Area recognizes Sub-Area transmission constraints in their interconnection assistance reliability studies. At present only the New York Area models Sub-Area transmission constraints.
3. Continue to keep the CP-5 Working Group's database up to date in order to facilitate NPCC or Areas' future studies.
4. Develop a more detailed reliability representation of regions bordering NPCC (i.e. PJM, ECAR).
5. Examine the impact that the Areas' evolving market rules may have on overall NPCC interconnection assistance.

# APPENDIX

**Table A-1**
**Scenario A - Isolated As-Is Loss of Load Expectation (LOLE)**
**Days per Period**

| | Hydro-Québec | Maritime Area | New England | New York | Ontario Hydro |
|---|---|---|---|---|---|
| Jan | - | 0.019 | 0.004 | - | 0.034 |
| Feb | 0.010 | 0.035 | 0.001 | - | 0.068 |
| Mar | - | - | - | - | 0.013 |
| Apr | - | - | - | - | 0.017 |
| May | - | - | 0.006 | - | 0.005 |
| Jun | - | - | 0.332 | 0.019 | 0.161 |
| Jul | - | - | 3.275 | 0.487 | 0.298 |
| Aug | - | - | 1.634 | 0.253 | 0.234 |
| Sep | - | - | 0.260 | - | 0.006 |
| Oct | - | - | - | - | 0.048 |
| Nov | - | - | - | - | 0.054 |
| Dec | - | 0.001 | 0.002 | - | 0.045 |
| Annual[1] | 0.010 | 0.054 | 5.514 | 0.759 | 0.983 |

**Table A-2**
**Scenario B - Interconnected At-Criterion Loss of Load Expectation (LOLE)**
**New York is brought to Criterion with equal load adjustments in each Sub-Area**
**Days per Period**

| | Hydro-Québec | Maritime Area | New England | New York | Ontario Hydro |
|---|---|---|---|---|---|
| Jan | 0.016 | 0.037 | - | - | 0.005 |
| Feb | 0.084 | 0.058 | - | - | 0.022 |
| Mar | - | - | - | - | - |
| Apr | - | - | - | - | - |
| May | - | - | - | - | - |
| Jun | - | - | 0.023 | 0.001 | 0.015 |
| Jul | - | - | 0.035 | 0.055 | 0.028 |
| Aug | - | - | 0.039 | 0.044 | 0.023 |
| Sep | - | - | 0.002 | - | - |
| Oct | - | - | - | - | 0.001 |
| Nov | - | - | - | - | 0.001 |
| Dec | - | 0.001 | - | - | 0.004 |
| Annual[1] | 0.100 | 0.098 | 0.099 | 0.099 | 0.100 |

[1] Monthly LOLE may not sum to Annual LOLE due to rounding.
Note: Dashed fields in the tables are zero LOLE values.

**Table A-3**
**Scenario C - Interconnected At-Criterion Loss of Load Expectation (LOLE)**
**New York is brought to Criterion with load in reliable Sub-Areas**
**Days per Period**

| | Hydro-Québec | Maritime Area | New England | New York | Ontario Hydro |
|---|---|---|---|---|---|
| Jan | 0.016 | 0.038 | - | - | 0.002 |
| Feb | 0.083 | 0.061 | - | - | 0.015 |
| Mar | - | - | - | - | - |
| Apr | - | - | - | - | - |
| May | - | - | - | - | - |
| Jun | - | - | 0.037 | 0.035 | 0.025 |
| Jul | - | - | 0.030 | 0.036 | 0.026 |
| Aug | - | - | 0.031 | 0.028 | 0.026 |
| Sep | - | - | 0.001 | - | - |
| Oct | - | - | - | - | 0.001 |
| Nov | - | - | - | - | - |
| Dec | - | 0.002 | - | - | 0.002 |
| Annual[1] | 0.099 | 0.102 | 0.100 | 0.098 | 0.099 |

**Table A-4**
**Scenario D - Interconnected As-Is Loss of Load Expectation (LOLE)**
**Days per Period**

| | Hydro-Québec | Maritime Area | New England | New York | Ontario Hydro |
|---|---|---|---|---|---|
| Jan | - | - | - | - | - |
| Feb | - | - | - | - | - |
| Mar | - | - | - | - | - |
| Apr | - | - | - | - | - |
| May | - | - | - | - | - |
| Jun | - | - | 0.008 | - | - |
| Jul | - | - | 0.010 | 0.032 | - |
| Aug | - | - | 0.011 | 0.025 | - |
| Sep | - | - | 0.001 | - | - |
| Oct | - | - | - | - | - |
| Nov | - | - | - | - | - |
| Dec | - | - | - | - | - |
| Annual[1] | 0.000 | 0.000 | 0.030 | 0.058 | 0.000 |

[1] Monthly LOLE may not sum to Annual LOLE due to rounding.
Note: Dashed fields in the tables are zero LOLE values.