Attached is a report conducted by Stone & Webster in 1996 that discusses a New York City capacity requirement. Stone & Webster prepared the report for Consolidated Edison Company of New York, Inc., and it was included as an exhibit (7) to Con Edison's filing with the NYS Public Service Commission, Docket No. 96-E-0897. This report is being provided at the request of stakeholders in relation to the on-going discussion of the proposed Alternative Methods for Determining LCRs.

(A)

In-City Capacity Requirements Study

Submitted to

Consolidated Edison Company of New York

November, 1996

Stone & Webster Management Consultants, Inc.

IN-CITY CAPACITY REQUIREMENTS STUDY

Introduction

The impending restructuring of the electric power industry in the State of New York has important implications regarding the reliability of electric supply to New York City due to the unique configuration of its power supply and delivery system.

Mandates set forth by the New York Public Service Commission (NYPSC) in its Competitive Opportunities Order underscore the need for a dependable and reliable power supply.[1] Traditionally, reliability of supply has been assured by the New York Power Pool (NYPP) through its requirement that each member utility maintain an installed reserve margin. Locational capacity specifications were not pursued because adequate local capacity had been built and maintained by the utilities responsible to serve the load centers. Changes in industry structure may result in the reduction of existing capacity reserves in critical load areas.

There is a critical need to define an appropriate level of in-City generation so that electricity supply to customers located in New York City is not jeopardized in the new competitive environment. The reliability of electricity supply to New York City - one of the most critical load centers in the United States - is paramount. An inadequate level of generation directly connected electrically to the in-City system would result in degraded reliability which would have far-reaching social and economic consequences to the City. The criticality of a high degree of reliability for New York City load is highlighted by characteristics that include,

- Extremely high load density,
- Vertical construction; among the tallest buildings in the world,
- A complex and expansive mass transit system,
- The finance capital of the world, and
- Extremely sensitive electrical loads in the form of computers.

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[1] Opinion and Order Regarding Competitive Opportunities for Electric Service, Opinion No. 96-12 (May 20, 1996)

Stone & Webster Management Consultants, Inc. (Stone & Webster) and Power Technologies, Inc. (PTI) were retained by Con Edison to conduct a comprehensive study relating to the appropriate level of in-City generating capacity to ensure the reliability of electric supply to New York City.

System Configuration

New York City relies on underground transmission cables to meet its electricity needs. The in-City system peak currently is approximately 9,600 MW; it is projected to increase to about 10,000 MW by 2000. Transmission capability into the City is about 5,000 MW. Therefore, it is clear that Con Edison must rely on in-City generation resources, including those owned by others, to meet in-City loads in addition to the transmission cables supplying the City.

Figure 1 is a simplified schematic of the in-City system, showing interconnections to other New York utilities and the PJM power pool. Figure 1 shows a composite maximum cable transfer capability of about 5,000 MW after considering the unbalanced loading of the cable system.[2] Transmission ties include 13 cables that interconnect Con Edison to the Long Island Lighting Company (LILCO), Public Service Electric & Gas (PSE&G), and to upstate New York through Westchester County. The 13 cables comprise 3 basic interconnections to the in-City system: 8 cables tie to the Con Edison system in Westchester County; 2 to LILCO; and 3 to PSE&G.

Reference Design Criterion

Con Edison is a member of NYPP and the Northeast Power Coordinating Council (NPCC), which includes Hydro-Quebec, Ontario Hydro, the Maritime Provinces, New England and New York power systems. The generation design adopted by NPCC states:

> "Each Area's resources will be planned in such a manner that, after due allowance for scheduled outages, 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.

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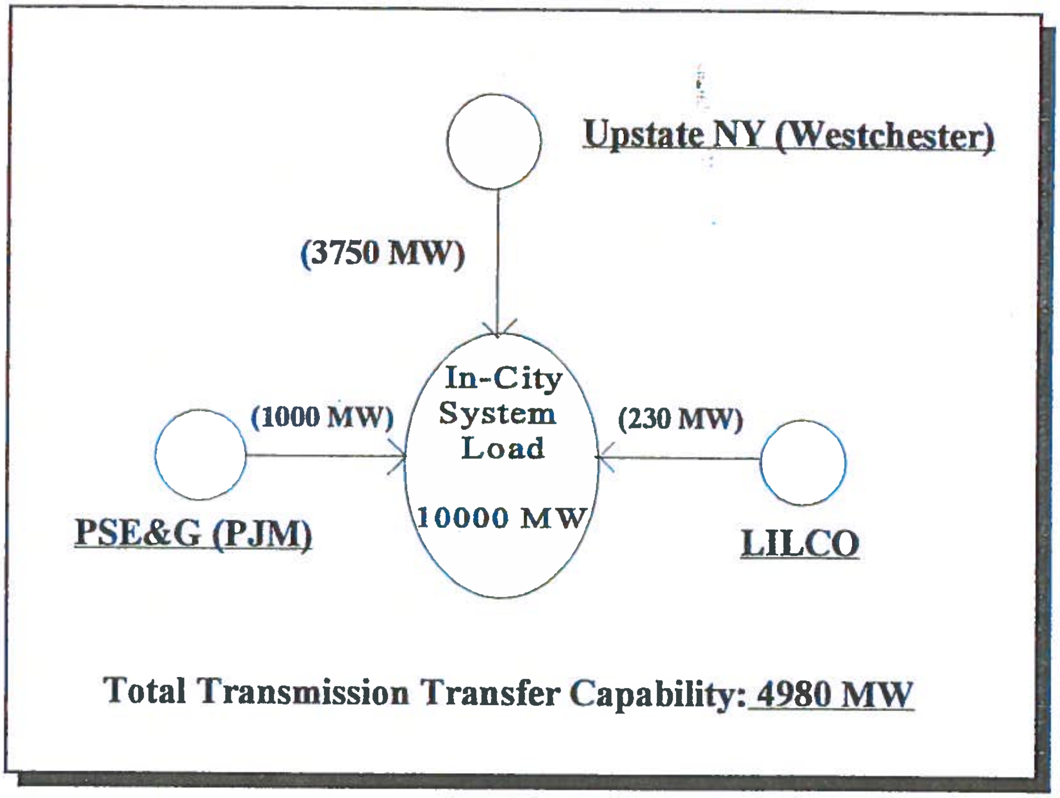
[2] Even though Con Edison has a large degree of control on the power flow over specific cables, not all cables load proportionally to their ratings.

Figure 1



Customers in New York City demand superior reliability of electric supply. Stone & Webster did not attempt to establish a design criterion for New York City. Rather, we utilized the NPCC criterion as a basis for determining the in-City requirement. Characteristics of the bulk power supply to the City which uniquely distinguishes it from other areas in the region were explicitly considered in the assessment of the reliability of the in-City system. Due to the critical load composition in the City, a more stringent criterion may be warranted. Therefore, the in-City capacity requirement, defined herein, must be considered a minimum requirement.

The "1 day in 10 years" criterion is known as Loss-of-Load Expectation (LOLE) which is determined through probability analysis.[3] The in-City system comprising approximately one-third of the total NYPP load is sufficiently large to produce statistically valid LOLE results for reliability analyses employing probabilistic techniques.

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[3] The term "loss of load" does not mean a complete loss of load in the pool. Rather, it describes how many days some *portion* of load cannot be served due to insufficient generating capacity; for example, because of outages.

Summary of Findings and Conclusions

We conducted an assessment of the reliability of bulk power supply to New York City and have reached the following findings and conclusions.

- The appropriate method for determining the minimum level of in-City generating capacity is based on a loss of load expectation (LOLE) reliability analysis.

- The NPCC design criterion should be considered a minimum design criterion for New York City. Because of the importance of in-City load, it could be argued that a more stringent criterion is justifiable.

- The in-City capacity requirement is a function of transmission cable import capability into the City relative to in-City load.

- For the underground transmission system to the City, cable failure repairs last about one month based on actual experience. Therefore, it is appropriate to consider cable failure rates and repair times when determining capacity requirements in New York City.

- Reliability evaluations for the in-City system yield the following results:

  (1) Since the cable system can only satisfy at most 50% of the in-City peak, it is obvious that generation equal to at least 50% of the City's peak demand would need to be located in-City.

  (2) Reliability calculations, which recognize that in-City generating units are subject to random outages, increase the in-City requirement to at least 62% of the in-City peak demand.

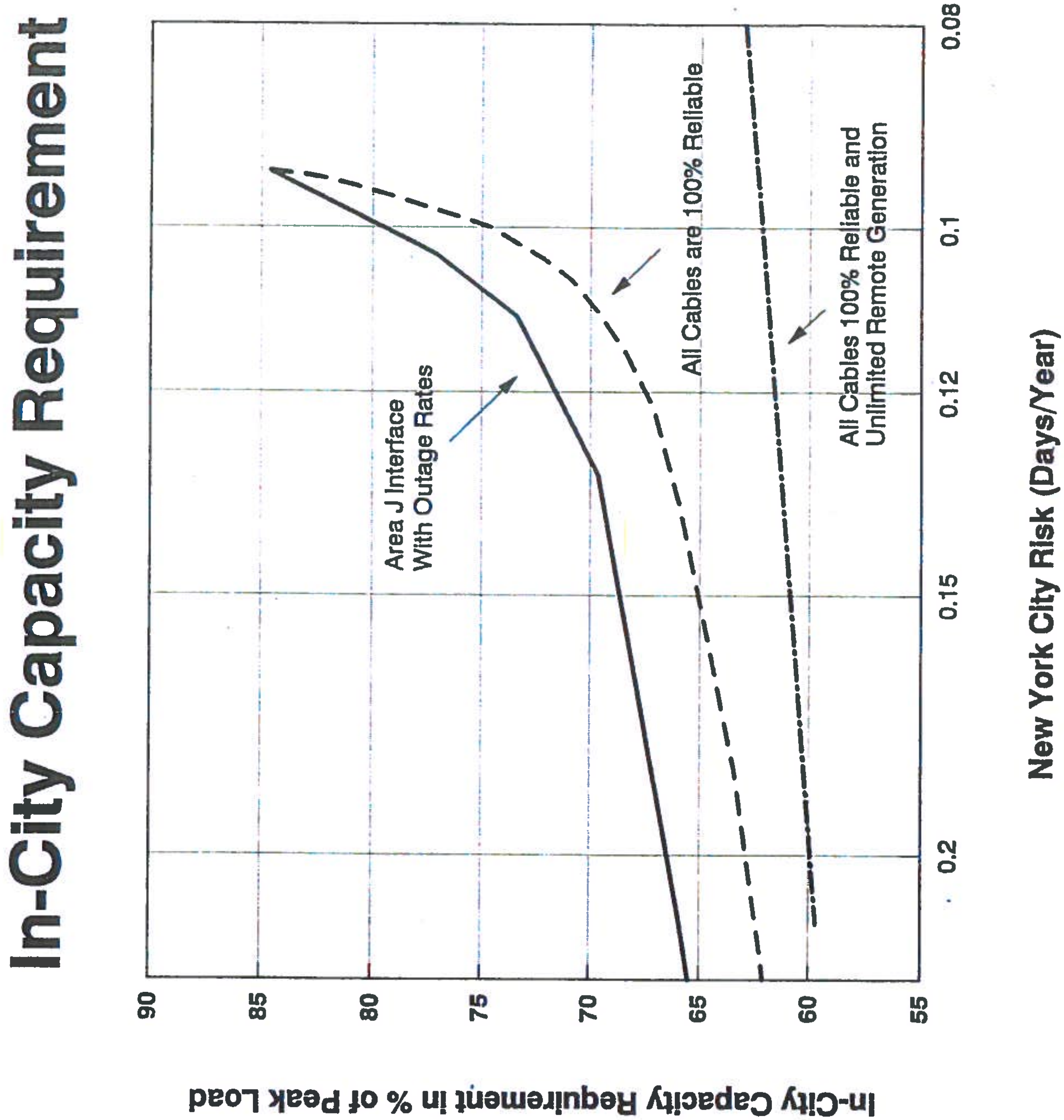
  (3) Generating capacity located beyond the transmission ties also is not perfectly reliable. Reflecting the likelihood of generation failures outside the City increases the in-City requirement to 75%.

  (4) Recognizing cable failures in the calculation increases the in-City capacity requirement to about 80%. Figure 2 depicts these results.

  (5) Based on the analysis conducted, we conclude:

  In order to reliably serve in-City load, in-City generating capacity must equal 80% of the in-City peak load, based on application of the NPCC design criterion.

Figure 2



In-City Capacity Requirement
In-City Capacity Requirement in % of Peak Load
90
85
80
75
70
65
60
55
0.08
0.1
0.12
0.15
0.2
New York City Risk (Days/Year)
Area J Interface With Outage Rates
All Cables are 100% Reliable
All Cables 100% Reliable and Unlimited Remote Generation

NYPP Reliability Model

The NYPP developed a reliability data base for the year 2000 for use in the General Electric Multi-Area Reliability Simulation (MARS) computer model to calculate LOLE. Since the data base was developed over a period of time, adjustments to the load forecast to represent current projections would need to be considered.[4] MARS is a state-of-the-art tool designed to simulate power systems that have internal interconnections among several member systems, as well as ties to other power pools.

Figure 3 illustrates the interconnected New York grid by subregion, including key interconnections to neighboring pools and in-City (Area J) ties. Internal ties and outside interconnections to neighboring pools help reduce NYPP and member system capacity requirements.

The NYPP data used emergency transfer limits, except for Con Edison's cable system interface for which normal limits are more controlling.[5] Except for postulating a contingency in the determination of transfer limits, 100% availability was assumed on all its transmission ties between regions and within each subregion. While this may be reasonable for overhead lines that experience outages of relatively short duration, it is not so for underground cables or encapsulated equipment (i.e., transformers and phase angle regulators) which take far longer to repair.

Such factors are critical for studies of in-City capacity requirements since virtually *all* transmission ties to New York City are underground cables. This led to a conclusion that the NYPP data should be enhanced to properly represent cable outages.

A comprehensive analysis was conducted to determine cable failure and repair rates of the 13 underground ties to New York City. The analysis was based on recorded failures since 1988. This analysis yielded a composite failure rate of less than 0.01 cable failures per mile per year. Con

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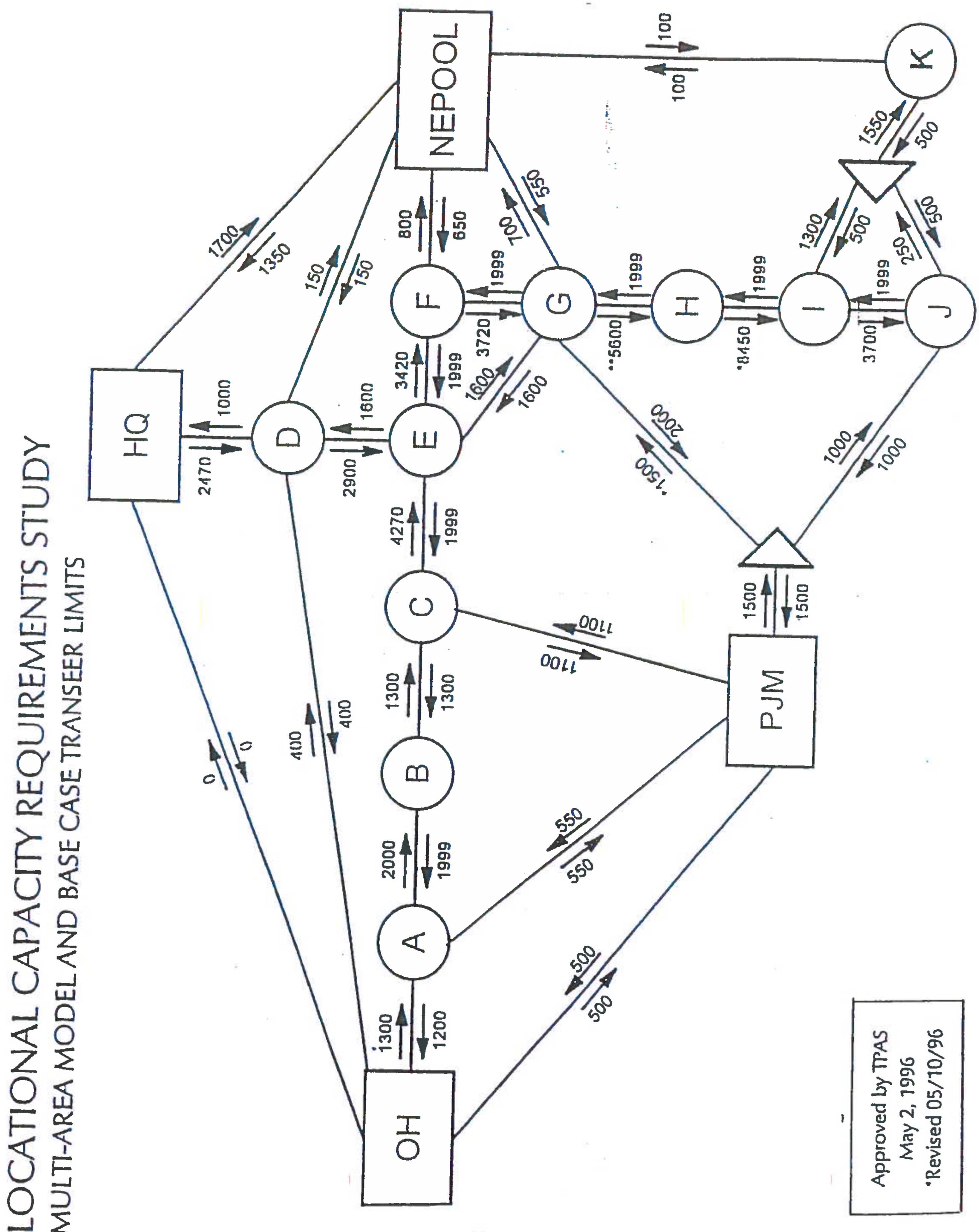
[4] The forecasted in-City peak load in the NYPP data base is approximately 350 MW lower than that forecasted by Con Edison.

[5] Emergency limits were used for the ties to LILCO.

Figure 3


LOCATIONAL CAPACITY REQUIREMENTS STUDY
MULTI-AREA MODEL AND BASE CASE TRANSFER LIMITS
HQ
NEPOOL
OH
PJM
A
B
C
D
E
F
G
H
I
J
K
Approved by TPAS
May 2, 1996
*Revised 05/10/96

Edison's actual average repair time for 345 kV cable is about 34 days. Repairs times for 138 kV cables are somewhat less. NYPP's MARS data base was adjusted to include these cable outage and duration rates.

Technical Analysis

A detailed discussion of Stone & Webster's and PTI's analysis is included in the attached appendices.

Parameters that Influence In-City Capacity Requirement

Key input parameters in MARS include NYPP and member loads, generation forced outages, tie limits, and transmission outage (transition) rates. Accordingly, we conducted studies to determine how in-City capacity requirements are influenced by variations in respective input parameters.

a) Generating Unit Forced Outages - In-City LOLE can be expected to be affected by forced outage rates of in-City generation. Increasing or decreasing forced outage rates for units located outside the in-City system has a lesser impact on LOLE.

   Table 1 compares the historical outage rates of in-City generation to similarly sized units located throughout the United States as reported in the North American Electric Reliability Council Generating Availability Data System (NERC-GADS). This data base is a compiled average of generating units of similar size and fuel type.

   Table 1 shows that the data used for in-City generating units reflects overall better performance than recent industry averages reported in GADS. Thus, we do not believe it is reasonable or realistic to expect in-City unit performance to improve even further. Accordingly, this obviates the need for further study of unit forced outages.

b) Cable Failure and Repair Rates - We found that decreasing cable failure rates 50% below the historical average results in a 3% decrease in the in-City capacity requirement. About a 2% decrease is achieved if repair times are reduced by 50%. However, we consider such decreases to be well beyond the expected reduction that could realistically be achieved by Con Edison. There is no reason to believe the frequency of cable failures will decline. Existing cable failure rates appear reasonable and are based on historical records of equipment performance. Further, the Company has made a concerted effort to keep cable failure rates low and is expected to continue to do so in the future.

Table 1

Comparison of In-City and United States Generating Unit Statistics

Unit Name	Unit Rating	EFOR	U.S. Unit EFOR	Range in MW
		(%)	(%)	
AK2	335	6.14	11.73	300-399
AK3	491	5.29	7.31	400-499
AST3	353	5.03	11.73	300-399
AST4	361	13.89	11.73	300-399
AST5	361	7.56	11.73	300-399
ER6	130	6.65	14.87	100-199
ER7	170	9.97	14.87	100-199
RAV1	385	8.99	11.73	300-399
RAV2	385	7.31	11.73	300-399
RAV3	972	14.25	10.64	800-999
POLETTI	825	15.46	10.64	800-899
Total	4768	10.41	11.06	
		(Weighted Ave.)	(Weighted Ave.)	

Notes:

(1) In-City unit data based on NYPP outage report derived from 1982 - 1991 NERC-GADS data

(2) U. S. comparisons are from NERC-GADS data published in July 1996 for 1991 - 1995

Similarly, we expect Con Edison will be unable to compress the time required to complete cable repairs as there are a minimum number of days needed to repair high voltage transmission cables. When a cable fails, a series of sequential activities must take place: first, the failed section of cable must be located and unearthed (if underwater, this may take far longer); next, materials must be acquired and shipped to the site; the failed section then must be replaced and reconnected (spliced), a time-consuming and tedious process that requires extraordinary care and precision to avoid environmental impacts; the repaired cables then undergo a battery of tests to confirm the integrity of the repair; lastly, the support systems must be reconnected and tested (such as circulating oil pumps). The cable is then placed back into service.

We do not believe it is possible to achieve any meaningful reduction in the time required to accomplish any of these tasks. Indeed, to rush any of these steps could jeopardize cable integrity and possibly increase cable failure rates. Thus, we conclude the in-City capacity requirement of 80% is relatively robust with respect to changes in cable failure and repair rates.

c) Load Growth - The 80% base line capacity requirement is applicable to the year 2000 load projection of 10,000 MW for the in-City system. The actual studies conducted reflected a somewhat lower forecast of in-City peak load. A key relationship is in-City load relative to transmission transfer capability into the City. For peak loads above 10,000 MW, an increasingly larger proportion of in-City generating capacity would be required to reliably supply the in-City load.

d) Transmission Interconnections - Stone & Webster recognized if additional transmission to other NYPP utilities and adjacent power pools could be built, import capability would increase, potentially enabling additional remote generating reserves to be available to the City. This could result in lower in-City capacity requirements. Additional MARS studies were performed, assuming one new 345 kV cable is installed from upstate New York to an undefined location just south of the Dunwoodie-South interface. The new cable, nominally rated at 700 MW, would operate in parallel with the 8 existing underground cables. It was assumed that the cable interface transfer limit would also increase by 700 MW.

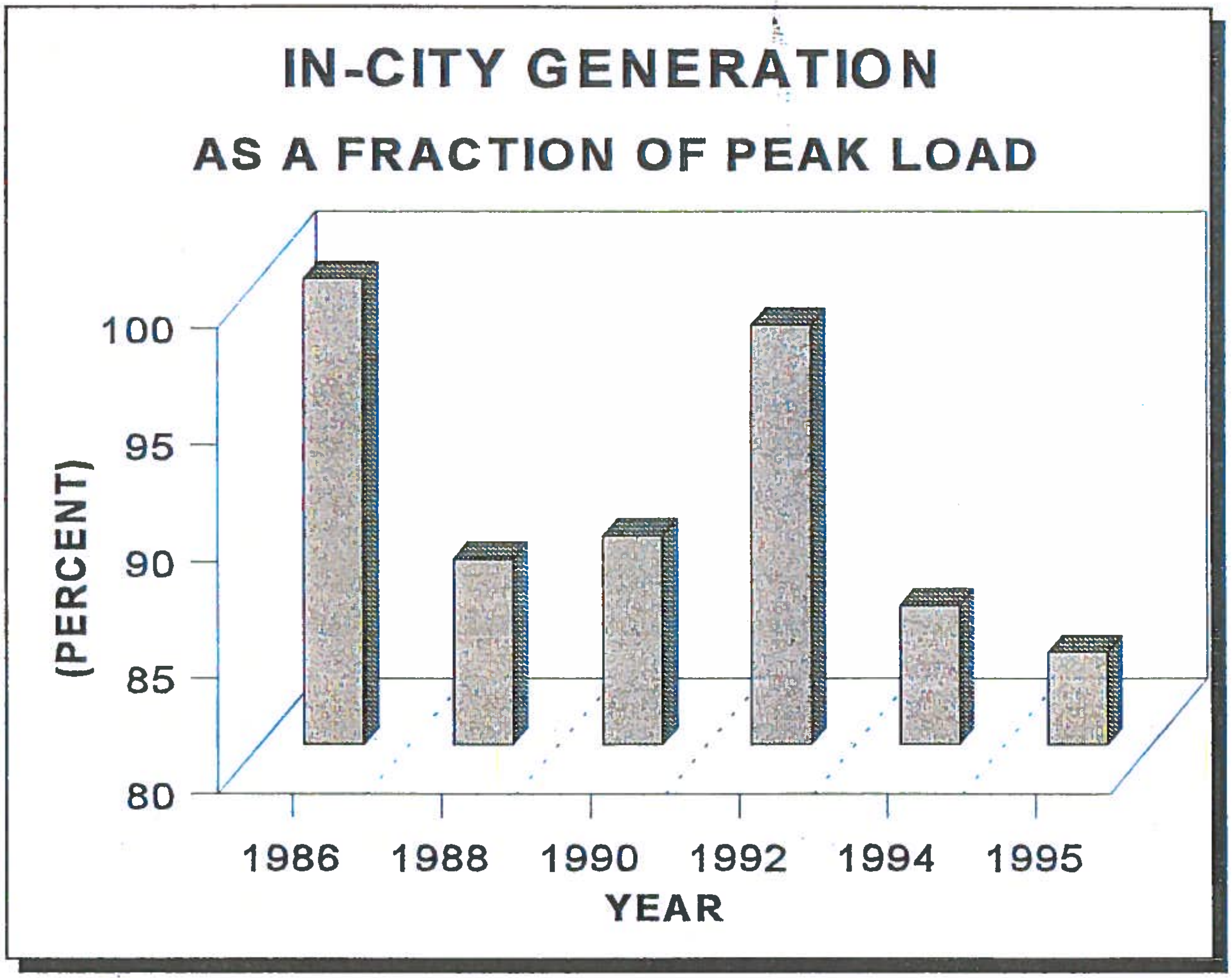
MARS analysis revealed the in-City capacity requirement would be reduced by 4% as a result of this increase in transfer limit. However, such a transmission reinforcement, even if feasible, would likely be very expensive (See Appendix B). In any event, the in-City requirement would continue to be 80% based on the "as found" system until such time as a transmission reinforcement was accomplished. The requirement would then be re-evaluated at that time.

Commentary

The 80% in-City requirement should be considered a threshhold level. As shown in Figure 4, in-City generating capacity as a percent of in-City peak load has historically been at levels above 80%. Such levels have contributed to the superior reliability of the electric supply to New York City. A deterioration of New York City electric supply is simply not acceptable.

Furthermore, while the MARS program is "state-of-the-art," it must be recognized that the model best represents the traditional operation of a regulated utility. Generating reserves relied heavily upon in the model to reduce the risk of loss of load are assumed to be available instantaneously without recognition of unit start-up times and ramp rates. Considerable uncertainty exists as to the manner in which the system will be operated in a deregulated competitive industry. To the extent the rules for reliable operation of the system established by the System Security Operator do not reflect the ideal operational assumptions in the MARS model, the actual loss of load expectation would be greater than that predicted by the model.

Figure 4


IN-CITY GENERATION
AS A FRACTION OF PEAK LOAD
100
95
90
85
80
(PERCENT)
1986
1988
1990
1992
1994
1995
YEAR

IN-CITY CAPACITY REQUIREMENTS STUDY

TECHNICAL ASSESSMENT

APPENDICES

Appendix A

STUDY ASSUMPTIONS AND METHODS

Multi-Area Reliability Simulation Methods

General Electric's Multi-Area Reliability Simulation (MARS) computer model was employed to conduct Loss of Load Expectation (LOLE) studies. MARS employs Monte Carlo statistical methods to calculate loss of load expectation. Other model attributes include:

- Representation of 11 distinct areas within NYPP, including transmission ties
- Representation of 4 neighboring power pools
- Load model based on 8760 hours
- Generation and transmission forced outage modeling based on frequency and duration method
- Maintenance scheduling
- Emergency Operating Procedures (EOPs) model, including frequency of implementation

MARS is a relatively new tool. As a condition of acceptance, the NYPP Planning Committee required General Electric to prove the model produced results consistent with those obtained via single and two-area models used in previous studies. To calibrate the model, NYPP compared 1994 results using a single-area model to those obtained via MARS. NYPP reported that MARS' results were consistent with those obtained in 1994 using the single area model and to an IEEE test system; subsequently, it was accepted by NYPP.[1]

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[1] To calibrate 1994 results to those obtained by MARS, NYPP applied equivalence techniques using a 2-area model. Results obtained for 2 separate areas were equivalenced to a single area. This process was sequentially repeated until each distinct region in the pool was modeled. Results of the final 2-area representation then were compared to results obtained using MARS.

Specific assumptions include those listed below. The NYPP data base was used as the starting point for our study.

Forced Outage Rates - Generation forced outage rates (FOR) used in MARS are those supplied by NYPP members to the North America Electric Reliability Council in its Generating Availability Data System (NERC-GADS). It includes 10 years of published data (1982-1991), covering a period which is thought to reasonably represent long-term unit performance. For its data base, NYPP adjusted member generation FOR's to exclude atypical outages (approximately 8-10 units are affected). Otherwise, 10-year historical average data applies.

Scheduled Maintenance - Generation maintenance intervals correspond to member-supplied schedules. The maintenance schedules provided by NYPP members used in MARS reflects historical experience.

Inter and Intrapool Ties - Figure 2 in the main report illustrates NYPP's internal and external ties modeled in MARS, including transfer limits. Interpool tie assistance is based on the "as is" system using data supplied by the other pools. The NYPP data base included adjustments to neighboring pool resources to account for uncertainty in the availability of these resources to assist NYPP in emergencies.

Load Model - The NYPP data base included a 1989 load model based on a full years' data of the member systems; which was considered representative of the expected load profile. Loads were adjusted upward to meet year 2000 projections. It should be noted, however, that these load projections are somewhat lower than those currently forecasted.

Loss of Load Criterion

LOLE criterion of 1 day in 10 years is based on the "classical" approach where the probability or expectation of loss of load is calculated for the peak hour of each day (i.e., 366 simulations for each year studied). Study results reflect 3000 iterations of the MARS model; which is a sufficient number of simulations to reach convergence.

Uncertainties

Standard industry practice recognizes that actual loads and forced outages will vary from the nominal forecast values. A study conducted by NYPP concluded that capacity requirements should be increased by 5% to reflect the impact of such variances. Accordingly, all results described in this report include this uncertainty adjustment.

Study Approach

The first step of the study was to benchmark the NYPP data base to the NPCC criterion. The NYPP data resulted in LOLE's of 0.079 and 0.062 days per year for the NYPP and Con Edison in-City system (Area J), respectively.[2]

The data base was then modified to include the following adjustments:

- Normalizing the NYPP LOLE to 0.10 days per year with no internal transfer limits. This was accomplished by shifting 770 MW of perfectly reliable capacity located outside the in-City system to outside the NYPP; for study purposes, from Area G to PJM.[3]
- With internal transfer limits applied to LILCO, NYPP LOLE exceeded 1 day in 10 years. Thus, it was necessary to shift 100 MW of perfectly reliable capacity from Area G to Area K for NYPP and LILCO to meet the 0.10 criterion.

The normalization of NYPP LOLE to 0.10 is appropriate and provides a consistent basis for comparing results based on NYPP's 0.10 design criterion.

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[2] The NPCC criterion is 1 day in 10 years or 0.10 days per year.

[3] Perfectly reliable capacity is defined as generation with 100% availability. The selection of the PJM system was random, as 0.1 LOLE could be achieved by shifting capacity to any one of the other 3 neighboring pools. The MARS program shifts generation by increasing load (or decreasing for lower LOLE) in the affected area, a program convention that provides the same result that would be obtained by actually transferring generation to other areas.

Normalization to a 0.10 design criterion prevents a "worsening" of in-City reliability relative to other NYPP areas that results from the *arbitrary* shifting of capacity among load centers. For example, use of a pool LOLE of 0.079 as a starting point creates a potential scenario whereby Con Edison's LOLE could increase to 0.10 while other areas correspondingly decrease (some to below already low LOLE levels).

The study then proceeded with the application of transfer limits into New York City. However, transfer limits within upstate New York were not represented - this assumes that generation upstate would be situated to avoid transmission bottlenecks. Various amounts of capacity were then shifted into and out of Area J and the resulting LOLE data was plotted. This step was repeated using transmission outage data for the New York City interfaces. Results are shown in Figure 2 of the main report.

APPENDIX B

TRANSFER LIMITS AND CABLE ANALYSIS

Transfer Limits

Imports into the in-City cable system can be achieved over 13 transmission interties to adjoining areas. These 13 ties can be grouped electrically and geographically to form three separate interfaces as shown in Figure B-1. These interface transfer limits were used in the MARS model.

Con Edison calculated transfer limits into the New York City underground cable system using PTI's PSS/E Load Flow and Contingency Analysis Simulation Models based on the following:

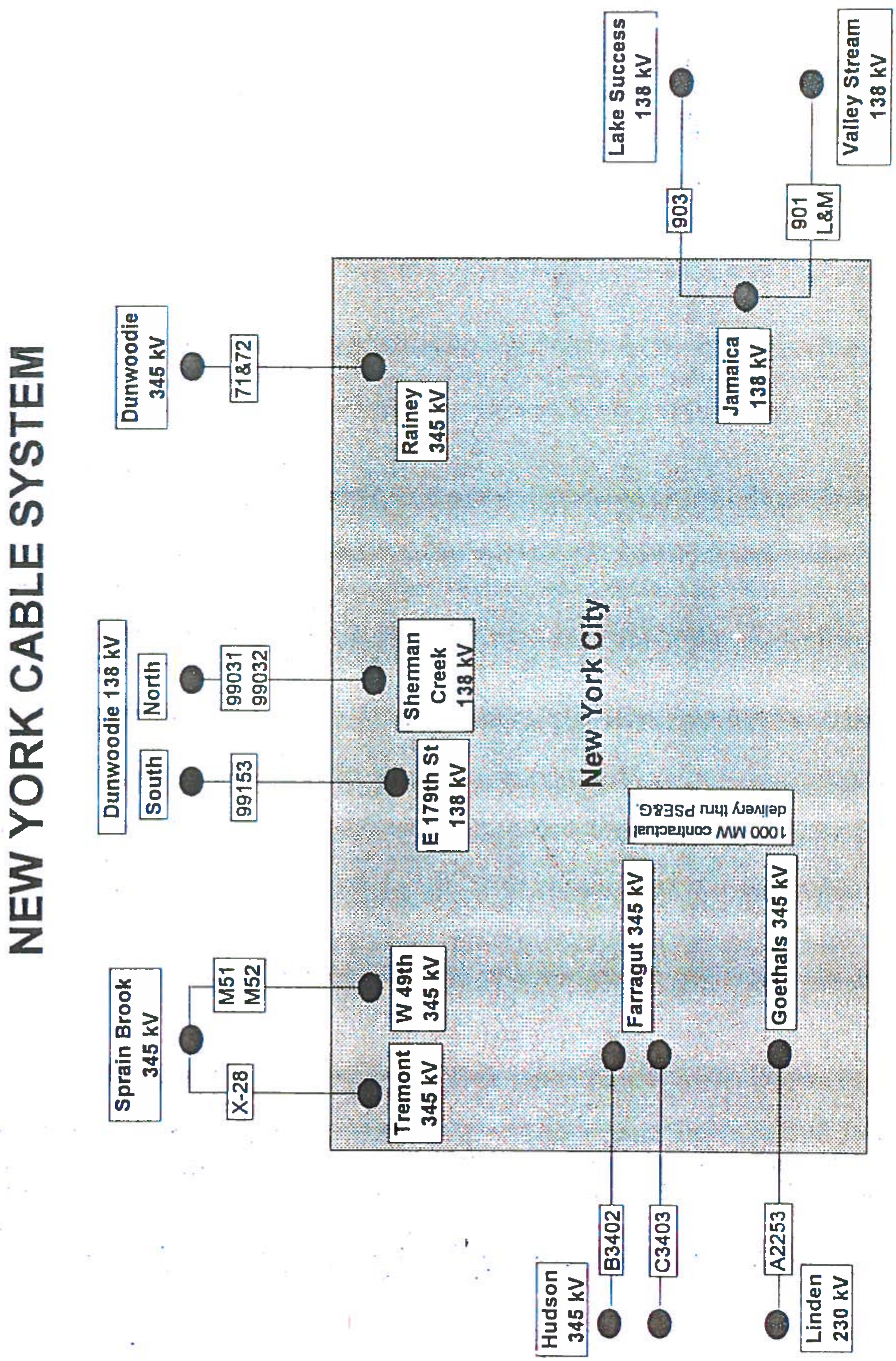
(1) Imports from the system north of the in-City interface were based on transfers from transmission ties to upstate New York. The five 345 kV and three 138 kV underground cables can be loaded to their normal ratings, less a minor reduction caused by imbalances, without exceeding the emergency rating of individual cables after a contingency.

(2) Imports from PSE&G from the west and LILCO on the east are controlled by phase angle regulators located on each of these ties. The total amount of flow from PSE&G to Con Edison's in-City system is limited to 1000 MW by contractual arrangement.

The summer normal ratings of ties from PSE&G's Hudson Substation to Con Edison's Farragut 345 kV and Linden 230 kV Substations are:

• Hudson to Farragut No. 1 (Feeder B3402)	503 MW
• Hudson to Farragut No. 2 (Feeder C3403)	497 MW
• Linden Goethals Tie (Feeder A2253)	511 MW
	1511 MW

Figure B-1


NEW YORK CABLE SYSTEM
Sprain Brook 345 kV
X-28
M51 M52
Tremont 345 kV
W 49th 345 kV
Dunwoodie 138 kV
South
North
99153
99031 99032
E 179th St 138 kV
Sherman Creek 138 kV
Dunwoodie 345 kV
71&72
Rainey 345 kV
New York City
1000 MW contractual delivery thru PSE&G.
Farragut 345 kV
Goethals 345 kV
Jamaica 138 kV
903
901 L&M
Lake Success 138 kV
Valley Stream 138 kV
Hudson 345 kV
B3402
C3403
A2253
Linden 230 kV

Although the total amount of transmission capacity with PSE&G is above 1,000 MW, these ties collectively cannot be loaded to their full rating during summer high load periods due to cable limits within Con Edison's system when both Cogen Technologies (an Independent Power Producer) and Arthur Kill generation are operating at full capacity.

Cable Transition Rates

Cable outage frequency and duration data is modelled in MARS under the term transition rates. Figure B-1 illustrates the interconnection arrangement for 13 cables that serve in-City load. Eight of the cables are rated 345kV; the other five, 138kV. Our reliability analysis used transition rates for modeling the probability of a transmission cable outage. Although the failure rate for transmission cable is relatively low, the longer repair times (compared to overhead lines) indicate it is appropriate to model these facilities probabilistically in MARS. Overhead line outages were not modelled.

Table B-1 presents the transition rates for each of the 13 cables modeled in MARS. Table B-1 includes repair rates based on an average restoration of about 34.5 days. For a land repair, this interval appears reasonable. However, several circuits cross bodies of water:

West: B3402 & C3403 (Hudson River)
East: M51, M52, 71 & 72

The duration of feeder outages to the west is not as important since imports from PSE&G are limited to 1000 MW (67% of normal rating) due to internal PSE&G transmission system requirements.

Underground and underwater cables, unlike overhead lines, require long repair times. Assuming availability of relatively short length spare underground cables, Con Edison estimated underground cable repair times of 34 to 35 days for 345 kV cables.

The approach used to develop cable failure rates and durations is based on established methodology. The use of historically based statistics is consistent with data developed for generation outages.

Transmission Interface Transition Rates for Area J

New York City

Transmission Interface (1) (3)	Cable Location (kV)	Cable No.	Cable Symbol	Cable Capa. (MW)	Length (Miles)	MTTF (2) (Years)	MTTR (2) (Years)	Failure Rate (2) (per year)	Repair Rate (2) (per year)	Cable Availability (decimal)	Cable Un-Availb. (decimal)	Impact of Cable Loss (MW)
Interface 1	Ln. 230-Goeth.	A2253	A	511.00	0.380	175.458	0.120	0.0057	8.3333	0.999316539933	0.000683460067	-400
H.L. / G.F.	Hudson	B3402	B	503.00	3.400	19.610	0.120	0.0510	8.3333	0.993917891536	0.006082108464	-400
(1000 MW) (4)	(345)	C3403	C	497.00	3.400	19.610	0.120	0.0510	8.3333	0.993917891536	0.006082108464	-400
Interface 2	Lake Succ.	903	D	238.00	8.190	12.210	0.049	0.0819	20.2778	0.995977343400	0.004022656600	-250
C.E. / LILCO	V Stream/L Suc	901 L/M	E	272.00	8.190	12.210	0.049	0.0819	20.2778	0.995977343400	0.004022656600	-250
(500 MW)												
Interface 3	Sprainbrook	M51	F	774.00	17.410	11.490	0.096	0.0870	10.4167	0.991714137752	0.008285862248	-1200
Spr-Dun / So.	(345)	M52	G	774.00	17.410	11.490	0.096	0.0870	10.4167	0.991714137752	0.008285862248	-1200
(3700 MW)		X-28	H	432.00	9.260	21.090	0.094	0.0474	10.6383	0.995562688822	0.004437311178	-600
	Dunwoodie	99153	I	222.00	7.380	13.500	0.049	0.0741	20.4918	0.996398205007	0.003601794993	-230
	(138)	99031	J	142.00	7.800	5.780	0.031	0.1730	31.9489	0.994613941803	0.005386058197	-150
		99032	K	142.00	7.800	5.780	0.031	0.1730	31.9489	0.994613941803	0.005386058197	-150
	Dunwoodie	71	L	715.00	15.310	13.063	0.095	0.0766	10.5263	0.992780253799	0.007219746201	-750
	(345)	72	M	715.00	15.310	13.063	0.095	0.0766	10.5263	0.992780253799	0.007219746201	-750

Notes:

(1) Interface capability is from Area J (New York City) perspective in receiving assistance.

(2) Two parameters are needed to describe a cable outage: the frequency and the duration of the outage.
The failure rate is the reciprocal of the mean time to failure (MTTF) and the repair rate is the reciprocal of mean time to repair (MTTR).
In this reliability study the parameters were obtained from eight years of historical statistics.

(3) Each interface is represented by equivalent levels of transmission capacities and the equivalent transition rates among the different levels.
Calculation of the capacity levels and their transition rates is based on the frequency and duration theory developed by Billinton, Ringlee, Patton, Hall Wood, et al.

(4) The 1000 MW is by contract: Loss of any one cable reduces capacity to 600 MW. It is estimated that loss of any two would reduce capacity to 200 MW.

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Further, the modeling of statistical outage rates and repair durations for cable interfaces is consistent with the probabilistic modeling of unscheduled generation outages.

Transmission Reinforcements

(1) Additional Cable Ties to the North

The cost of a new underground cable tie includes both the cost for the cable reinforcement and the cost of reinforcing the northern transmission system to support additional generation imports. The cost of such upgrades is detailed in Table B-2. The additional cost of new generating capacity beyond the ties was not considered. Additional assistance from remote areas would be on an "as available basis." This would also be the case for reinforcements to PSE&G and LILCO.

Table B-2 includes a cost breakdown by major underground cable and overhead transmission components. Total costs in 1996 dollars are about $285 million, approximately $400/kW. We expect additional expenditures would be required for circuit breaker upgrades throughout the area for improved fault isolation; the interrupting capability of some breakers may not be adequate with the higher fault currents under the new system configuration.

Table B-2

Description	Total Cost
I. Underground Cable	
- Cable System	$140,000
- Substation Terminations (New/Upgrades)	$20,000
II. Overhead Transmission	
- Overhead Line	$120,000
- Substation Terminations (New/Upgrades)	$5,000
Total Cost	$285,000

Note: All costs in thousands of dollars

The reinforcement of the northern transmission system described above is a function of generating units north of the cable system interface. If these generating units are normally in service during periods of high demand, reinforcement may not be required.

(2) Increase Cable Tie Import Capability From PSE&G

The three Con Edison transmission ties to PSE&G have a combined thermal rating of about 1500 MW. However, in order to increase the transfer limit to 1500 MW, additional reinforcements are required on both PSE&G's and Con Edison's transmission systems.

Transfers of power from west to east are limited by 138kV and 230kV transmission facilities within PSE&G's system. Some of those facilities would need to upgraded to a higher voltage and new facilities added. In addition, replacement of associated circuit breakers, transformers and a phase angle regulator would be required. The total cost of these reinforcements is estimated at $130 million.

Transmission upgrades also would be required within Con Edison due to cable limits within Con Edison's system when both Cogen Technologies (an Independent Power Producer) and Arthur Kill generation station are operating at full capacity. These upgrades would include an additional cable from Staten Island to Brooklyn at a cost of about $120 million.

Table B-3 highlights the estimated cost of respective system reinforcements by major equipment category. Accomplishing these upgrades depends on cost, technical and institutional factors including whether it is feasible to install the equipment, and each company's ability to acquire requisite permits.

We found from previous NYPP MARS studies that PJM provides relatively minor reliability support during high load periods when the risk of loss of load is greatest Thus, the high cost of upgrades needed to increase import capability via west-to-east ties versus the potential reliability benefits likely do not justify the investment.

Table B-3

Description	Total Cost
I. PSE&G	
- Overhead Lines	$130,000
- Underground Cable System	Inc.'d
II. Con Edison	
- Underground Cable System	$120,000
Total Cost	$250,000

Note: All costs in thousands of dollars

(3) Increase Cable Tie Capacity to LILCO

We also evaluated whether increased imports from LILCO was a viable alternative to in-City generation. Currently, imports from LILCO are limited to about 500 MW on an emergency basis. Such was already modeled in the reliability studies. Several options exist for increasing import capability up to 500 MW based on normal transfer limits, including new and/or upgraded transmission lines and underground cables. Such arrangements could result in increased emergency transfer into Con Edison.

Increasing the import capability from LILCO at Jamaica up to the thermal rating of the interconnection requires reinforcement of the Con Edison system at a cost of about $20 million. Similarly, reinforcements would be required within LILCO at a cost of about $80 million.[4]

However, since studies show little or no excess capacity on Long Island, the reliability benefits to the in-City system are questionable if an increase in emergency transfer limits from LILCO into Con Edison is effected without a corresponding increase in generation on Long Island.

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[4] Based on the Company's current agreements with LILCO and the Municipal Electric Utilities Association in Long Island (MEUA), Con Edison receives approximately 225 MW at Jamaica from LILCO under normal conditions.