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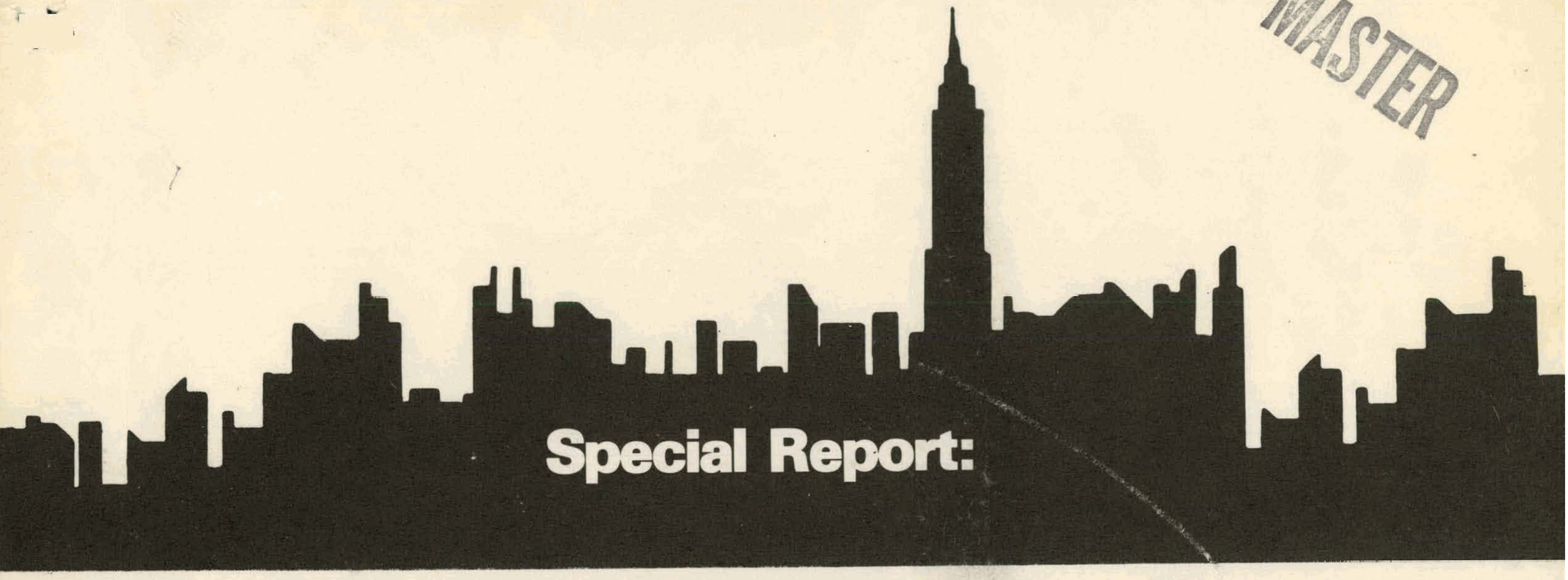

Impact Assessment Of The 1977 New York City Blackout

Final Report
July 1978

Prepared For

U.S. Department Of Energy

Assistant Secretary For Energy Technology
Division Of Electric Energy Systems

Under Contract No. EC-77-C-01-5103

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Impact Assessment Of The 1977 New York City Blackout

Final Report
July 1978

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Assistant Secretary For Energy Technology
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Washington, DC 20545

Under Contract No. EC-77-C-01-5103

Within the Division of Electric Energy Systems, the program SYSTEMS ENGINEERING FOR POWER has been developed to address systems theoretic oriented problems of emergent significance to the nation's electric energy systems. One of the constituent subprograms, Systems Effectiveness Analysis, is addressing the development of a conceptual framework within which rational tradeoffs between considerations of the availability, performance, cost, and worth of evolving systems could be evaluated.

One of the difficulties in such an area is the dearth of quantitative data relating to the worth of reliable electric service. The occurrence of the July 1977 New York City blackout provided a rare, hopefully not-to-be-repeated, opportunity for collecting extensive and valuable data directly relevant to this question of the worth of service continuity. The present study was commissioned as an attempt to determine the actual availability of such data and to evaluate its relevance, particularly with reference to our ongoing research in Systems Effectiveness Analysis. We believe however that this report is of considerable interest and value in its own right.

L. H. Fink
Division of Electric
Energy Systems
U.S. Department of Energy

Washington, D.C.
July 1978

TABLE OF CONTENTS:

LIST OF TABLES:

LIST OF FIGURES:

PREFACE

This report presents the final results of a study conducted by Systems Control, Inc. (SCI) for the Division of Electric Energy Systems, Department of Energy. The study entitled: "Impact Assessment of the 1977 New York City Blackout," has been performed under DOE contract EC-77-C-01-5103.

The principal SCI project staff included:

Dr. William T. Miles, Principal Investigator
Jane L. Corwin, Principal Investigator
Gary B. Ackerman
Ned L. Badertscher

In addition, SCI was assisted by consultants from the University of Pennsylvania:

Dr. Peter Blair, Assistant Professor, School of Public and Urban Policy
Dr. Samuel Klausner, Director, Center for Research on the Acts of Man

We also wish to thank the following organizations[1] for providing information and data on the impacts of the blackout. In particular we would like to express our appreciation to the Consolidated Edison Company for assisting us during the course of the study in numerous ways.

[1]This acknowledgement does not imply that the above organizations have reviewed or concurred with this report.

American Economic Foundation
American Insurance Association
American Red Cross
Bureau of Labor Statistics
California State Energy Commission
Citizens Committee for New York City, Inc.
Civil Defense Preparedness Agency, U.S. Department of Defense
Congressional Research Service
Consolidated Edison
Corporation Council for New York City
Defense Communications Agency, U.S. Department of Defense
E. F. Hutton Corporation
Edison Electric Institute
Electric Power Research Institute
Federal Aviation Administration, Eastern Region
Federal Communications Commission
Federal Disaster Agency
Federal Energy Regulatory Commission
Federal Insurance Administration
Ford Foundation
Greater New York Hospital Association
Human Resources Administration Insurance Information Institute
National Association of Electric Companies
New York Board of Fire Underwriters
New York City Commerce and Industry Association
New York City Criminal Justice Agency
New York City Department of Health
New York City Fire Department
New York City Health and Hospitals Corporation
New York City Mayor's Office
New York City Metropolitan Transportation Authority
New York City Office of Economic Development
New York City Planning Commission
New York City Police Department

New York City Real Property Assessment Bureau
New York City Regional Plan Association
New York City Small Business Administration
New York Power Pool
New York Property Insurance Underwriting Association
New York State Department of Commerce
New York State Department of Taxation and Finance
New York State Division of Criminal Justice Services
New York State Office of Court Administration
New York State Public Service Commission
New York University
Port Authority of New York and New Jersey
Power Authority State of New York
United States Bureau of Labor Statistics
United States Department of Commerce
United States Department of Health, Education and Welfare
United States Department of Housing and Urban Development
United States Department of Justice
University of Florida
University of Illinois
Vera Institute of Justice
Westchester County Office of Disaster and Emergency Services

Finally, the authors express their appreciation to Mr. Lester H. Fink, Assistant Director, Systems Management and Structuring, for his valuable direction, insights, and judgment during the course of the study.

Jane L. Corwin
William T. Miles

July, 1978

1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

This study was commisssioned by the Division of Electric Energy Systems (EES), Department of Energy (DOE) shortly after the July 13, 1977 New York City Blackout. The principal objectives of the project as originally conceived were two-fold:

- To assess the availability and collect, where practical, data pertaining to a wide variety of impacts occurring as a result of the blackout;
- To broadly define a framework to assess the value of electric power reliability from consideration of the blackout and its effects on individuals, businesses, and institutions.

This work was not intended to be a definitive and detailed assessment of the blackout and its impacts. Rather, the emphasis has been primarily on characterizing a broad spectrum of impacts relating to the blackout including economic impacts, social costs, disruption of important social activities, and other impacts whose important components may be long term rather than short term.

Given the unique nature of a blackout and the objectives of the project, the following methodology for studying the blackout was developed:

- A literature review was undertaken to review previous blackout literature, and to review relevant research on similar types of disasters (e.g., floods, earthquakes) to determine whether any of the theoretical impact constructs developed for these areas might be applicable to considerations of a blackout.
- The study team personally interviewed and met with a large number of key agencies and public and commercial organizations in NYC which had responsibility for maintaining a data base on blackout-related information and impacts.
- Impact Classification Schemes (ICS) were developed to characterize the kind of impacts (economic and social) that might be associated with a loss of electric power. The purpose of the ICS was to provide guidance for later data collection strategies and efforts.

- Several case studies were chosen to characterize the availability and quality of data for carrying out such analyses.
- The focus throughout the entire study has been on the usefulness of the data in supporting the eventual development of a generalized methodology for examining the value of electric power reliability to the end-user.

1.2 MAJOR IMPACTS

The blackout affected businesses, individuals, government agencies and Consolidated Edison itself. The impacts were complex and included both economic and social costs. In order to systematically classify the most significant of these impacts and provide guidance for data collection, impact classification schemes were developed. Major economic impact categories included:

- Business
- Government
- Utilities (Consolidated Edison)
- Insurance Industry
- Public Health Services
- Other Public Services

Impacts were classified as either direct or indirect depending upon whether the impact was due to a cessation of electricity or a response to that cessation. The principal economic costs of the blackout, developed during the course of this study are shown in Table 1-1. These data are neither comprehensive nor exhaustive and, for the most part, are based on secondary data provided by various government agencies and other organizations.

Social impacts, i.e., the changes in social activities and adaptations to these changes were particularly significant in New York due to its unique demographic and geographic characteristics. The looting and arson that accompanied the blackout set aside the NYC experience from other similar power failures. While the blackout-related crime wave may

TABLE 1-1

SUMMARY OF ECONOMIC IMPACTS[1]

Impact Areas	Direct ($M)		Indirect ($M)	
Businesses	Food Spoilage	$ 1.0	Small Businesses	$155.4
	Wages Lost	5.0	Emergency Aid (private sector)	5.0
	Securities Industry	15.0		
	Banking Industry	13.0		
Government (Non-public services)			Federal Assistance Programs	11.5
			New York State Assistance Program	1.0
Consolidated Edison	Restoration Costs	10.0	New Capital Equipment (program and installation)	65.0
	Overtime Payments	2.0		
Insurance[2]			Federal Crime Insurance	3.5
			Fire Insurance	19.5
			Private Property Insurance	10.5
Public Health Services			Public Hospitals--overtime, emergency room charges	1.5
Other Public Services	Metropolitan Transportation Authority (MTA) Revenue Losses	2.6	MTA Vandalism	.2
	MTA Overtime and Unearned Wages	6.5	MTA New Capital Equipment Required	11.0
			Red Cross	.01
			Fire Department overtime and damaged equipment	.5
			Police Department overtime	4.4
			State Courts overtime	.05
			Prosecution and Correction	1.1
Westchester County	Food Spoilage	0.25[3]		
	Public Services equipment damage, overtime payments	0.19		
TOTALS		$55.54		$290.16

[1]Estimate based on aggregate data collected as of May 1, 1978. See previous page for discussion of limitation of these costs.

[2]Overlap with business losses might occur since some are recovered by insurance.

[3]Looting was included in this estimate but reported to be minimal.

These data are derivative, and are neither comprehensive nor definitive.

have been a singular event, it nevertheless pointed out the delicate balance of our societal order, and the key role that electricity plays in maintaining that balance.

Perhaps the most significant effects of the blackout were those felt by public and private organizations with responsibility for the economic and social activities of New York City and its inhabitants. In many cases, these organizations were ill-prepared for the blackout and much of the chaos, economic loss and individual inconvenience resulted from this lack of preparedness. A number of organizations have now embarked upon substantive contingency planning programs including upgrading of backup emergency generation.

1.3 CONCLUSIONS

The major conclusions of the study are summarized below:

Regarding General Impact Characteristics:

- The impacts of a power failure are in large part determined by the size of the area's population, ethnic diversity, income, housing characteristics, density, economic activities, and employment statistics. New York City, which is unique in terms of both demographic features and its position as the financial capital of the world, experienced substantial costs that are not easily extrapolatable to other regions of the country. Nonetheless, our examination of the NYC power failure has revealed important elements central to any future analysis of the consequences of energy shortages.
- The costs associated with a blackout are also sensitive to the geographic characteristics of the affected area. Areas such as NYC which are characterized by extreme weather conditions (hot, humid summers and cold winters) will be heavily impacted by the loss of electricity for air conditioners and heating systems.
- In high-density areas, like New York City, most travel per capita is done via the public transportation system. A high level of dependence on electrified transport systems results in greater economic and social costs during an extended power failure. Most people during the blackout were unable to report to work and perform productive activities because of the lack of an adequate transportation mode.

Regarding the Impact Classification Scheme:

- The development of an impact classification scheme highlighted an important distinction with respect to impacts resulting from a blackout. Direct impacts, i.e., those impacts resulting from the cessation of electricity such as refrigeration and transportation, are often accompanied by another class of potential costs referred to as indirect. These indirect impacts are unpredictable and reflect adaptations or responses to blackout conditions. The looting and arson is an example of an indirect impact. This distinction is useful because it provides further insight into the determination of the most cost-effective strategy for dealing with electricity shortages and interruptions in the future. It is possible that indirect impacts can be mitigated through improved communications and contingency plans while direct impacts can only be avoided through improvements in reliability standards.

Regarding Economic Impacts:

- Our survey indicated that economic costs attributable to the the blackout either directly or indirectly were in excess of $350 million. This figure, however, is based on a selective and stratified impact assessment and should be regarded as no more than a reasonable lower bound to total costs. The actual cost of the blackout taking into account both short and long term impacts might substantially exceed our estimate.
- The looting and arson (defined as an indirect impact) accounted for almost one-half of the total economic costs associated with the blackout. This fact supports a basic premise of this report, that the indirect impacts as well as the direct impacts must be considered if a realistic economic and social cost estimate of power outages is to be measured.
- The costs to Consolidated Edison were significant, both in terms of lost revenue, restoration costs and, most importantly, new capital investment programs to upgrade system security. What has not been ascertained is whether other utilities in the country, either voluntarily or involuntarily, are initiating or plan to initiate similar programs.

Regarding Social Impacts:

- The social costs of the blackout, as defined in this study, are difficult to measure. Adaptations to the blackout by people and organizations were significant, particularly in light of the extended duration of the power failure. Levels of inconvenience to individuals as evidenced by changes in macro-indicators of social activities appeared to be substantial. A structured survey of affected individuals will be necessary to accurately document these impacts in any detail.

Regarding Organizational Impacts:

- A number of organizations in New York City have implemented (or are in the process of implementing) new contingency plans and procedures as a result of the blackout. In some cases, new back-up generation systems have been added to facilities. Hospitals, in particular, had difficulty in starting and operating emergency back-up systems and have implemented new testing and maintenance schedules.
- In many cases, of equal or even greater importance than actual economic losses was the loss of credibility suffered by major industrial firms in NYC such as the banking and securities industries. (As an example of this concern, the NYC banking community is now planning to relocate certain computer facilities in New Jersey outside the Con Edison service territory.)

Regarding the Value of Reliability:

- Characterizing the New York City blackout has helped to identify important components, both quantifiable and non-quantifiable, that determine the value of electrical reliability. In previous studies which have attempted to assess the cost of power outages to customers, key factors (e.g., duration of blackout, indirect impacts and time of day) which were significant determinants in the New York City experience, were not taken into account.
- A lower bound on the value of reliability for end-users can be established by estimating the :

  --net-value of all equipment and materials for emergency back-up systems
  --value of time used to develop emergency procedures
  --value of insurance policies purchased to cover damage incurred (directly or indirectly) by power failures.
- A comprehensive methodology for determining the value of reliability is not presently available because of the difficulties in representing the complex losses that result from an extended power failure. A conceptual framework for characterizing these losses has been presented in this study (see Chapter 6). No attempt has been made to estimate the value of reliability using this framework. One approach for demonstrating its appropriateness and validity might be through the use of a survey designed to estimate what different classes of customers would be willing to pay for uninterrupted service.

2. INTRODUCTION

2.1 STUDY OBJECTIVES AND SCOPE

This study was commissioned by the Division of Electric Energy Systems (EES), Department of Energy (DOE) shortly after the July 13, 1977 New York City Blackout. The principal objectives of the project as originally conceived were two-fold:

- To assess the availability and collect, where practical, data pertaining to a wide variety of impacts occurring as a result of the blackout;
- To broadly define a framework to assess the value of electric power reliability from consideration of the blackout and its effects on individuals, businesses, and institutions.

The study was implemented to complement methodological work underway in the Systems Management and Structuring Program[1] of the Electric Energy Systems Division of DOE concerned with developing new procedures and techniques for enhancing the reliability of large-scale electric power systems.

This work was not intended to be a definitive and detailed assessment of the blackout and its impacts. Rather, the emphasis has been primarily on characterizing a broad spectrum of impacts relating to the blackout including economic impacts, social costs, disruption of important social activities, and other impacts whose important components may be long term rather than short term.

Examination of an unanticipated blackout in a large metropolitan area has few analogous events for comparison. A blackout usually strikes without warning, the duration is normally unknown to the customers affected, little advance planning (except for large critical services such as hospitals) is available to mitigate adverse effects, and the very nature of the

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1 See for example: "Systems Engineering for Power", U.S. Department of Energy, Program Report, (March, 1978).

blackout tends to exacerbate the difficulties in communications. While there are some corollaries in a related discipline referred to as disaster research[2], there are few physical events which are comparable to a large blackout.

The difficulties in studying the impacts of a major blackout also arise from the following: the (often) unique physical and social characteristics of the impacted area, the wide variety of impacts, the secondary, and other responses to the primary event (e.g., complex impacts to NYC financial processes), and the time delays in measuring many of the effects of the event. Finally, sufficiently disaggregate data to accurately reconstruct the economic and social activities of the affected region if no blackout had occurred, and data to accurately capture the significant costs incurred due to the power failure were in many instances not always available.

Given the unique nature of a blackout and the objectives of the project, the following methodology for studying the blackout was developed:

- A literature review was undertaken to review previous blackout literature, and to review relevant research on similar types of disasters (e.g., floods, earthquakes) to determine whether any of the theoretical impact constructs developed for these areas might be applicable to considerations of a blackout.
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[2] See for example: "Communities in Disaster: A Sociological Analysis of Collective Stress Situations", Barton, Alan (1969).

The data base developed for this report has been drawn from a wide variety of sources in both the public and private sectors. In some cases, the data has been gathered from "primary sources", i.e., individuals and/or organizations that were directly affected by the power shortage; in other cases the data represents extrapolations and averages over samples of varying sizes. In general, the data has not been verified for accuracy except for the test of "reasonableness." It is urged, therefore, that the data in this report be used with caution by other investigators and analysts.

2.2 RELATED STUDIES

Several studies were undertaken immediately after the blackout by various institutions at the request of the responsible federal, state and city officials. These studies deal principally with the technical event, and were undertaken to examine the causes of the power failure and the actions taken to deal with its consequences. In this section we list and summarize these various studies. Studies that were undertaken by both public and private organizations to assess a particular class of impacts to determine whether contingency plans were adequate and what new procedures might be required are discussed in Section 4.5.

2.2.1 "Electric System Disturbance on the Consolidated Edison System", Federal Power Commission, Staff Report, (August 4, 1977)

In a memorandum dated July 4, 1977 from President Jimmy Carter to Richard L. Dunham, Chairman of the Federal Power Commission (now the Federal Energy Regulatory Commission), a directive was issued which ordered the immediate investigation of the power failure "to ascertain the reasons why it occurred and to recommend specific actions to be taken to prevent a recurrence." Approximately two weeks later a staff report was submitted to the White House accompanied by a letter from Dunham. The report began with a caveat which stated that "the Federal Power Commission's staff has not sought to assess any legal cause and effect relationships between the social losses and the power supply interruptions." The study identified the various causes of bulk power supply interruptions and operating procedures that have been adopted by Consolidated Edison to mitigate the effects of those shortages. The next section of the study was devoted to an analysis of the Consolidated Edison generation, transmission and distribution system, service area and load characteristics, and special system characteristics. A description of the system before, during, and after the power outage was also presented. The final chapter cited preliminary recommendations and actions which Consolidated Edison should immediately act upon. The following proposals were made: acceleration of construction of new interconnections, automation of combustion turbine units by remote control, reassessment of all emergency procedures for system load shedding, provision of standby power sources to maintain oil pressure in underground cables, testing of equipment protecting major facilities, and reassessment of plans to locate generation facilities closer to load centers. These tentative recommendations, which address the issue of improving bulk power supply system reliability, were subject to revision and qualification during the second phase of the investigation. This final report[1] is expected to be released in the near future.

2.2.2 "The Special Commission of Inquiry Into Energy Failures", Report to the Mayor's Task Force, (December 1, 1977)

Immediately following the power outage, the Mayor of New York City formally established a special task force to conduct an inquiry on the power failure. This Commission was specifically mandated to "determine the cause or causes of, and remedies for, energy failures affecting the city and its people, and to make such reports, recommendations and proposals in regard thereto as the Commission deems proper." The primary objective of this study was to thoroughly examine the legal and regulatory issues and responsibilities surrounding the event and to provide recommendations to the appropriate organizations (including the Federal Power Commission, New York State Public Service Commission, and Consolidated Edison) responsible for improved system reliability. The investigative process included an inquiry into the activities of Consolidated Edison, a survey of system

[1]The report, "Con Edison Power Failure of July 13-14, 1977," Federal Energy Regulatory Commission was released in July 1978.

reliability, and an examination of the laws governing the regulatory agencies and the exercise of their legal authority. The Commissioners responsible for the inquiry concurred in the overall findings that "The Management of Consolidated Edison Company of New York, bears responsibility for the July 13-14, 1977 Power Failure; and the New York State Public Service Commission and the Federal Power Commission failed to take actions within their respective jurisdiction and authority to insure that Consolidated Edison provide adequate, safe and reliable service to its customers."

2.2.3 "State of New York Investigation of the New York City Blackout, July 13, 1977", Report by Norman H. Clapp, (January, 1978)

In response to the Blackout, the Governor of New York State requested the Public Service Commission, which is legally responsible for the regulation of the rates and services of private electric utilities in the State, "to investigate the causes of the power failure and make recommendations to prevent a recurrence." The study was to be conducted in three phases; the events leading up to the power failure, analysis of the 25-hour restoration process, and detailed review of the feasibility of specific recommendations made to the utility. The investigation was intended to aid the Public Service Commission in making decisions regarding system reliability and its relative merits and costs. The third and final report released in December, 1977, began with an introduction which stated the following: "...the economic losses alone from the blackout are incalculable. There is no way of even estimating the magnitude of the personal and social costs suffered by the people and communities affected." Hence, the report concentrated upon reviewing the operations of Consolidated Edison, the New York Power Pool and member utilities during the power failures including an identification of steps necessary to avoid future blackouts (with special emphasis on improving system reliability planning procedures).

One of the principal recommendations made in the report was to replace the New York Power Pool with "a single entity responsible for the planning, design, maintenance and operation of the statewide bulk power transmission system." The institutional inadequacies within the Power Pool and inability to be responsive to public interests, in addition to the individual self-interests of its member utilities, were cited as major problem areas.

The following statement contained in the Commission's study is of particular interest: "The tragic consequences of the July blackout underscore the special vulnerability of the New York City community to the effects of major power failures. This extreme vulnerability necessitates a higher level of reliability than may be required--and costs greater than may be tolerated--in other service areas."

2.2.4 "The Electric System Disturbance of July 13, 1977", New York Power Pool, Published--April, 1978

The New York Power Pool (NYPP) is an association comprised of eight power utility systems. Consolidated Edison is a member of the NYPP. The purpose of the NYPP is to obtain mutual benefits for all members by coordinated operation of their systems. The Chairman of the NYPP Operating Committee named a task force to undertake a review of the events of July 13-14, 1977, as they relate to the operations and procedures of the Power Pool. The Planning Committee organized a separate "Ad Hoc Task Force" to analyze the adequacy of the bulk power system before, during and after the power system disturbance. This task force was assigned to specifically respond to recommendations made by the New York State Investigation and Federal Energy Regulatory Commission.

The "Task Force to Review System Disturbance of July 13-14, 1977", reviewed the following topics: actions of the New York Power Pool Dispatchers during the emergency; methods of communication between the NYPP member systems and NYPP control center; adequacy of the electric system information presented to the NYPP System Dispatcher, NYPP member systems and adjacent pools; training procedures and policies of the NYPP Dispatchers; and, NYPP voltage control actions and restoration procedures. This internal assessment study also contained numerous recommendations for operating procedures.

2.2.5 "System Blackout and System Restoration, July 13-14, 1977", Consolidated Edison Board of Review, Phases I, II, III

Consolidated Edison undertook an internal review effort of the technical events leading up to the blackout. A formal Board of Review was established on July 14, 1977. This Committee was charged with the following three tasks: identify the causes of the power failure; recommend new policies and procedures which will enhance system reliability; and, establish new restoration procedures in the event of future emergencies. These assignments were performed in three phases which lasted a total of 5 months. The first phase report which was issued on July 26, 1977 contained a brief description of the events which took place between the first lightning stroke and complete shutdown of the system. An outline of the restoration process was also included. The second phase report contained an analysis of the operation of automatic protective equipment, actions taken to maintain system integrity, and performance of in-city generation. The third phase review summarized the results of the five-month investigation and identified the status of each of the 68 recommendations made to the utility.

2.3 THE BLACKOUT

2.3.1 The Technical Event

The sequence of events which began with a lightning stroke at 8:37 p.m. on July 13, 1977 and ended with the complete shutdown of the Consolidated Edison system some 59 minutes later would probably have been described as "impossible" had they been presented as a credible scenario prior to the actual occurrence. A combination of natural phenomena, improperly operating protective devices, inadequate presentation of data to the system dispatcher, and communication difficulties all combined to create conditions which cascaded to the ultimate point of total collapse of the Consolidated Edison system. A full description of the technical events leading up to the blackout is outside the scope of the present report; however, a complete description can be found in the three reports by Consolidated Edison (1) and a recent summary article (2).

2.3.2 A Descriptive Account of the City During the Blackout[1]

At approximately 9:36 p.m., on July 13th, 1977, New York City was plunged into darkness as a result of a complete electrical power failure which was to last a total of 25 hours and affect 9 million people. The City was already suffering from a sweltering heat wave when the first lightning strokes commenced, initiating the resultant power failure. During the subsequent 25-hour period as Consolidated Edison attempted to restore service, the activities of the City and its inhabitants were severely disrupted. The consequences ot these disruptions, both social and economic, is the principal emphasis of this report. To put these impacts into perspective, we first briefly describe the events that occurred during this 25-hour period.

As darkness fell and the blackout continued, large-scale civil disorders erupted and thousands of youths and adults engaged themselves in heavy looting and arson. A total of 1,037 fires were started in sections of Queens, Brooklyn, Manhattan and The Bronx, of which 60 were major. Arsonists were responsible for the fires started in commercial establishments supermarkets, appliance and clothing stores. Between the hours of 9:35 p.m., July 13th to midnight July 14th, 1977, there were a total of 1809 incidents of property damage as a result of looting and vandalism, two civilian deaths, and injuries sustained by 436 policemen, 204 civilians and 80 firemen. There were close to 3000 arrests made which swamped the City's already overcrowded and overburdened judicial system. Table 2-1 shows a comparison of relevant statistics comparing the 1965 and 1977 blackouts.

Thousands of protective service personnel were required to report to duty and many of them were forced to work several shifts. Decentralized command was organized in each borough to cope with the many problems associated with the coordination and operation of the protective service agencies during the emergency.

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[1]Much of this material is taken from a variety of media sources reporting on the events during and after the blackout.

TABLE 2-1

SOME RELEVANT STATISTICS
OF THE 1965 AND 1977 BLACKOUTS

	1965 (November 9/10)	1977 (July 13/14)	Normal 24-Hour Period (1977)
Duration of Blackout	12 hours	26 hours	NA
Location	9 Northeastern States 2 Provinces of Canada	5 Boroughs of NYC Westchester County	NA
Arson and Looting	Negligible	1,809 Incidents	*
Arrests	*	2,931	647
Deaths (blackout related)			
- Civilian	None Reported	2	NA
Injuries			
- Civilian	*	204	*
- Police Force	*	436	*
- Fire Fighters	*	80	5
Fires (reported)	241	1,037	350
Alarms			
- Single Alarms	662	2,724	1,262
- Multiple Alarms City Wide	6	54	12
Personnel			
- Civilian Volunteers	*	*	NA
- Red Cross Volunteers	*	120	NA
- Police Force/Officers	*	17,411	4,715
- Firemen/Officers	4,773	7,427	5,034
"911" Emergency Calls	*	70,680	18,500

* - Data not readily available
NA - Not Applicable

Sources: New York City Fire Department, New York City Police Department (Reports, Informal Interviews)

Grand Central Terminal was forced to close and even after power was returned, no electrically powered trains made it into the station during the morning rush hour on July 15th because of converters that flooded, delaying almost 75,000 daily commuters.

The New York airports were ordered closed at 9:57 p.m., only minutes after the power failure. Auxiliary generators did supply the terminals with emergency power in which over 15,000 passengers remained through the night. At Kennedy International Airport, some power was returned at 3:30 a.m. on July 14th but the first authorized takeoff was not until 5:34 a.m.

Fortunately, dispatchers running the subway system noticed power surges on the line before the power outage and instructed motormen to go to the nearest stations and remain there. Only two trains in the entire system were in transit when the power completely failed, thus rendering unnecessary any emergency relief effort since evacuation of trapped people through emergency exits was not necessary. During the 1965 Northeast Power failure, thousands of persons were trapped in train tunnels, and most of the rescue operations were directed toward that very time-consuming effort.

There was a tremendous increase in telephone use during the 25-hour period. Approximately 80,000,000 calls were made by citizens and government agencies, which overloaded the telephone system and made communication very difficult. Although many of the demands for emergency aid came as a result of the looting, violence and arson, there were many individuals who had to be evacuated from stalled elevators and skyscrapers. Emergency portable generators had to be provided to those individuals with critical life-support equipment (respirators, iron lungs, kidney machines) in their home and health-care institutions with no self-sustaining systems. Rescue units were hampered by the inability to obtain fuel dispensed by electrical pumps. Rescue operations were also hampered since food supply for rescues was drastically diminished by the lack of refrigeration and looting.

In the areas hit worst by the looting and vandalism, the vast amount of refuse, garbage, and spoiled food required the addition of 82 sanitation trucks and 4,000 workers to cope with the clean-up operation. Health officials were required to inspect supermarkets and food supply stores to make sure all perishables were adequately disposed of. Insurance company officials were required to survey the scorched and scattered remains of the blackout battle zones immediately following the event so that accurate appraisals could be made.

The power failure had a special effect on the World Trade Center which comprises an entire Consolidated Edison service classification. Energy consumption in 1977 totaled 207,500,000 kWh. There are a dozen restaurants in the World Trade Center which serve over 20,000 meals a day, approximately 200 automatic elevators, 35,000 employed persons and 80,000 visitors per day. The following account was recorded by the New York City Port Authority:

> "By 10:12 p.m. July 13th, the World Trade Center's emergency power system had activated preselected elevators, emergency lighting in public corridors and fire stairs, the security center and all essential services. Police assigned to each building searched for stranded visitors and tenants and led them to street level on emergency elevators. Patrons on the Observation Deck elevator were freed within the hour, but it was close to midnight before the Observation Deck itself could be evacuated. A "Windows on the World" elevator, in operation by 10:40 p.m. started to remove restaurant patrons in groups of 25 to 30. By 1:30 a.m. July 14th, the WTC had been completely evacuated. Despite the fact that the fire and sprinkler pumps were operable on auxiliary power, the World Trade Center remained closed July 15th due to the absence of water and ventilation."

Many other disruptions of "normal" activities took place during the 25-hour period too numerous to include in this description. An important conclusion to be drawn from even a superficial analysis of these events, however, is that no simple representation will suffice to describe the dependence of individuals and organizations on the availability of electricity. A continuous supply of electricity is not only taken for granted by most customers; electricity has also become a dominant factor in the smooth functioning of our society. Any changes to the availability of reliable electric supply are sure to have complicated and severe impacts on the nation's economic and social systems, not unlike the effects during and immediately following the OPEC oil embargo. In the chapters which follow, these impacts and adaptations are discussed in detail.

2.4 HISTORY OF BLACKOUTS IN THE UNITED STATES (1967-1977)

Until October 1977, the Federal Power Commission (FPC),[1] was responsible for submitting quarterly reports on power outages which have occurred throughout the United States. This function was initiated on December 20, 1966 with an order which stated that a power outage was to be recorded if it met the following criteria: loss of 100 MW load (25 MW from 1966-1970), or half the system load, for a duration of 15 minutes (or more), by a generating unit or electric facility operating at a voltage of 69 kV (or higher). The order required that these reports be made soon after the event and related to the Commission via telephone or telegram. The following items refer to the different categories of power failures which were most frequently reported (3):

- Natural Phenomena - icing, snow, sleet, lightning, wind tornado, hurricane, vibrating conductors, insulator contamination, flood and fire.
- Equipment Failures - line conductors, cable, ground wire, insulator, control device, generator, transformer, other generating station or substation equipment, etc.
- System Operation - overload, overvoltage, undervoltage, switching surge, instability, and misoperation of relays.
- Human Acts, Foreign Objects, and Unknown - aircraft impacts, automobile accidents, tree damage, animal and bird actions, personnel error, vandalism, sabotage and unknown cases.

Between the latter half of 1967 and December of 1969, a total of 223 outages were reported to the FPC which met the initial criteria. In Table 2-2 and Figures 2.1, 2.2, and 2.3, electric power disturbances reported to the FPC by utilities during the period of July 1970 through September 1977 are summarized, including the number of interruptions, customers affected and the load involved per interruptions.

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[1] The Federal Power Commission was incorporated into the reorganization of the Federal Department of Energy (DOE) and is now the Federal Energy Regulatory Commission (FERC). The Economic Regulatory Administration within DOE is now responsible for collecting the data and assembling the reports on power outages.

TABLE 2-2

ELECTRIC POWER DISTURBANCES
REPORTED BY UTILITIES REQUIRED TO RESPOND TO FPC ORDER NO. 331-1
FOR THE PERIOD JULY 1970-SEPTEBMER 1977

Quarter	Total Interruptions Reported (1) Number Of Interruptions	(2) Load Involved MW	(3) Load Involved Per Interruption Average MW	(4) Thousands of Customers Affected	(5) Thousands of Customers Affected Per Interruption (Avg.)	Total Load Reduction Incidents Reported (6) Voltage Reductions*	(7) Other Measures	Total Incidents of Hazards to the Bulk Power Supply (8)
3	9	2,454	273	628	70	60 (15)	17	11
4	6	849	142	231 2/	46	2	0	3
1970 Totals (One-half year)	15	3,303	220	859	61	62	17	14
1	5	3,045	609	1,400	280	22	0	4
2	6	1,095	182	210 2/	42	7	0	10
3 F.Y. 71	5	867	174	380	76	6	0	8
4 (typ.)	2	68	34	29	15	0	0	0
1971 Totals	18	5,075	282	2,019	119	35	0	22
1	8	758	95	157	20	2	2	5
2	13	1,505 1/	125	535	41	1	1	4
3	6	1,691	282	758 2/	152	11	2	3
4	1	254	254	Not Reported	-	3	6	3
1972 Totals	28	4,208	156	1,450	56	17	11	15
1	6	809	135	405 2/	81	4 (3)	4	4
2	15	11,410	761	8,136 4/	740	9 (6)	12	1
3	9	1,395	155	289 3/	41	17 (7)	11	2
4	7	937	134	584 2/	97	4 (1)	1	1
1973 Totals	37	14.551	393	9.417	325	34 (17)	28	8
1	7	928 1/	155	164 2/	27	3 (1)	1	3
2	11	5,414	492	1,807	201	6	0	4
3	9	2,016	224	517	74	16 (7)	8	5
4	5	1,097	219	406	81	0	3	4
1974 Totals	32	9,455	305	2,894	107	25 (8)	12	16
1	19	3,003 1/	167	1,510	101	0	2	6
2	7	610	87	213	30	0	3	6
3	15	1,606 1/	115	458	33	0	1	1
4	7	511	73	251	36	0	3	0
1975 Totals	48	5,730	126	2,432	57	0	9	13
1	10	1,344	134	872	87	0	0	2
2	9	1,433	159	240	27	1	2	2
3	9	6,326	703	2,330 2/	291	0	5	4
4	7	729	104	160	23	0	11	7
1976 Totals	35	9,832	281	3,602	103	1	18	10
1	16	2 087	130	343	21	39 (12)	58	6
2	8	5,7[illegible]	716	1,884	236	2	3	1
3	17	8,689	511	3,288 2/	206	6 (3)	4	4
F.Y. 1977 Totals	48	17,235	359	5,675	118	47 (15)	76	13

* In parentheses are the number of other load reduction measures (column 7) that were instituted concurrently with the voltage reduction measures.
1/ In one instance, the load was not reported.
2/ In one instance, the number of customers was not reported.
3/ In two instances, the number of customers was not reported
4/ In three instances, the number of customer was not reported.

Source: Federal Power Commission

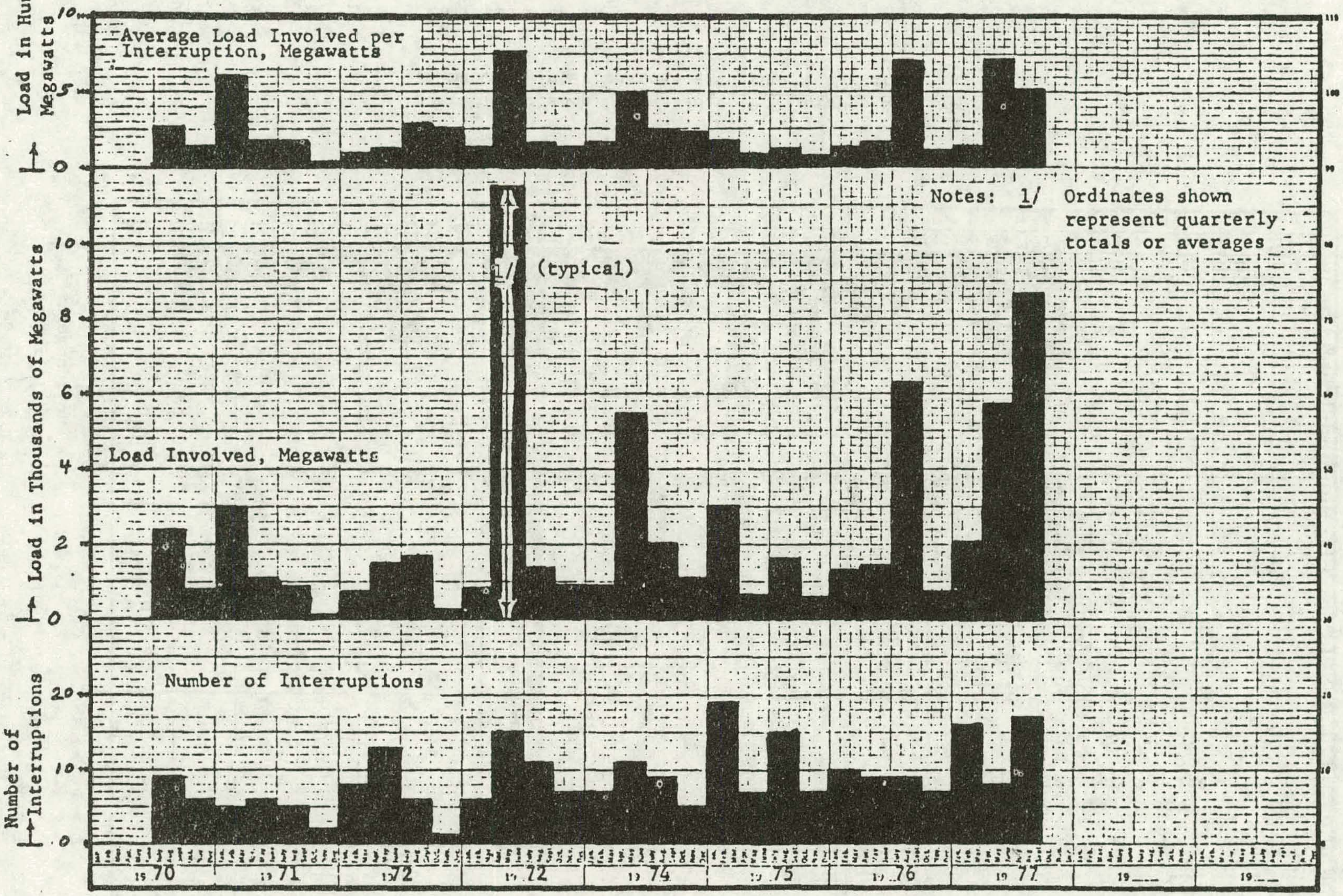

FIGURE 2.1

__Electric Power Disturbance Data - July 1970 Through September 1977__
(Number of Interruptions - Load Involved)

Source: Federal Power Commission

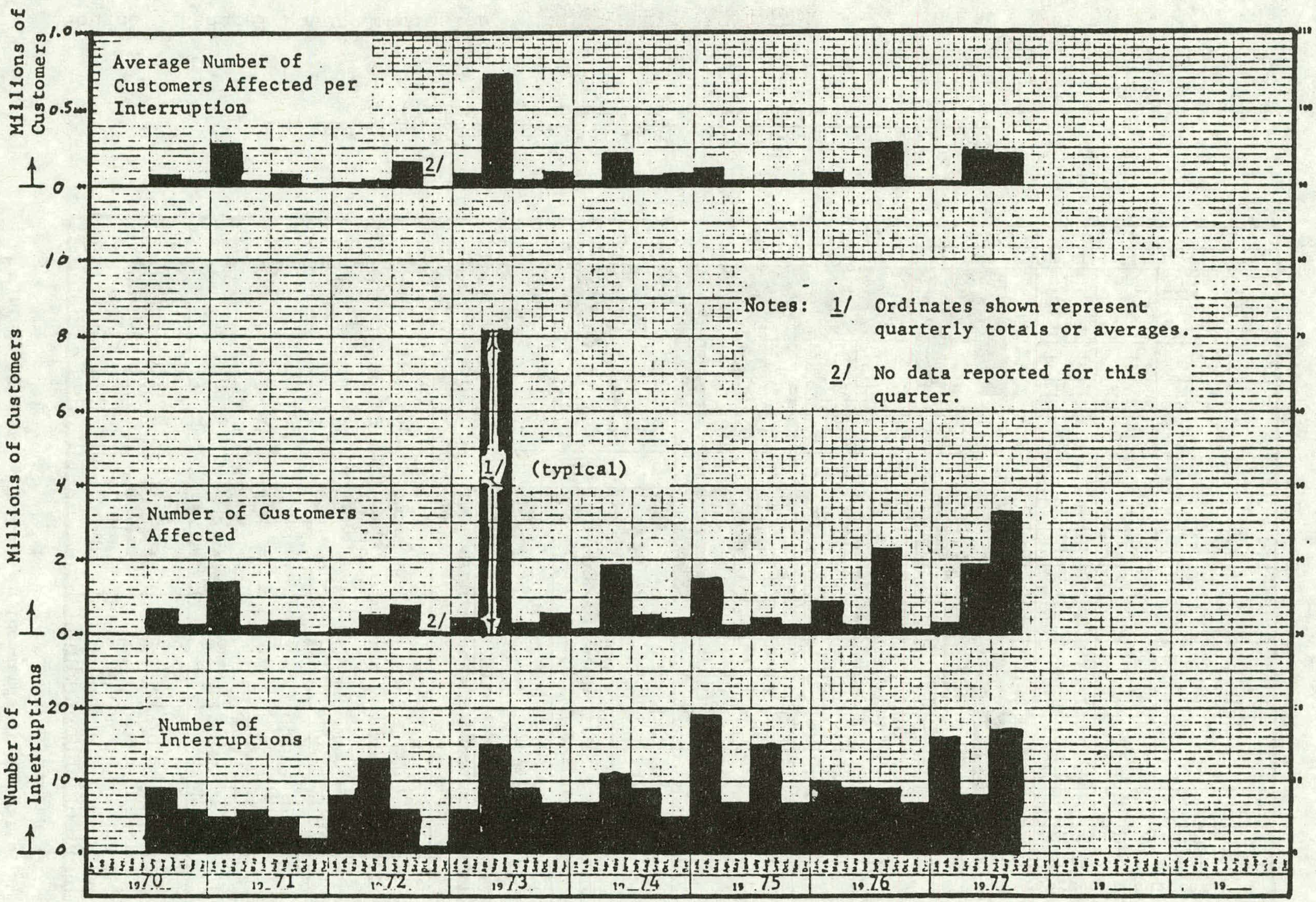

FIGURE 2.2

<u>**Electric Power Disturbance Data - July 1970 Through September 1977**</u>

(Number of Interruptions - Customers Affected)

Source: Federal Power Commission

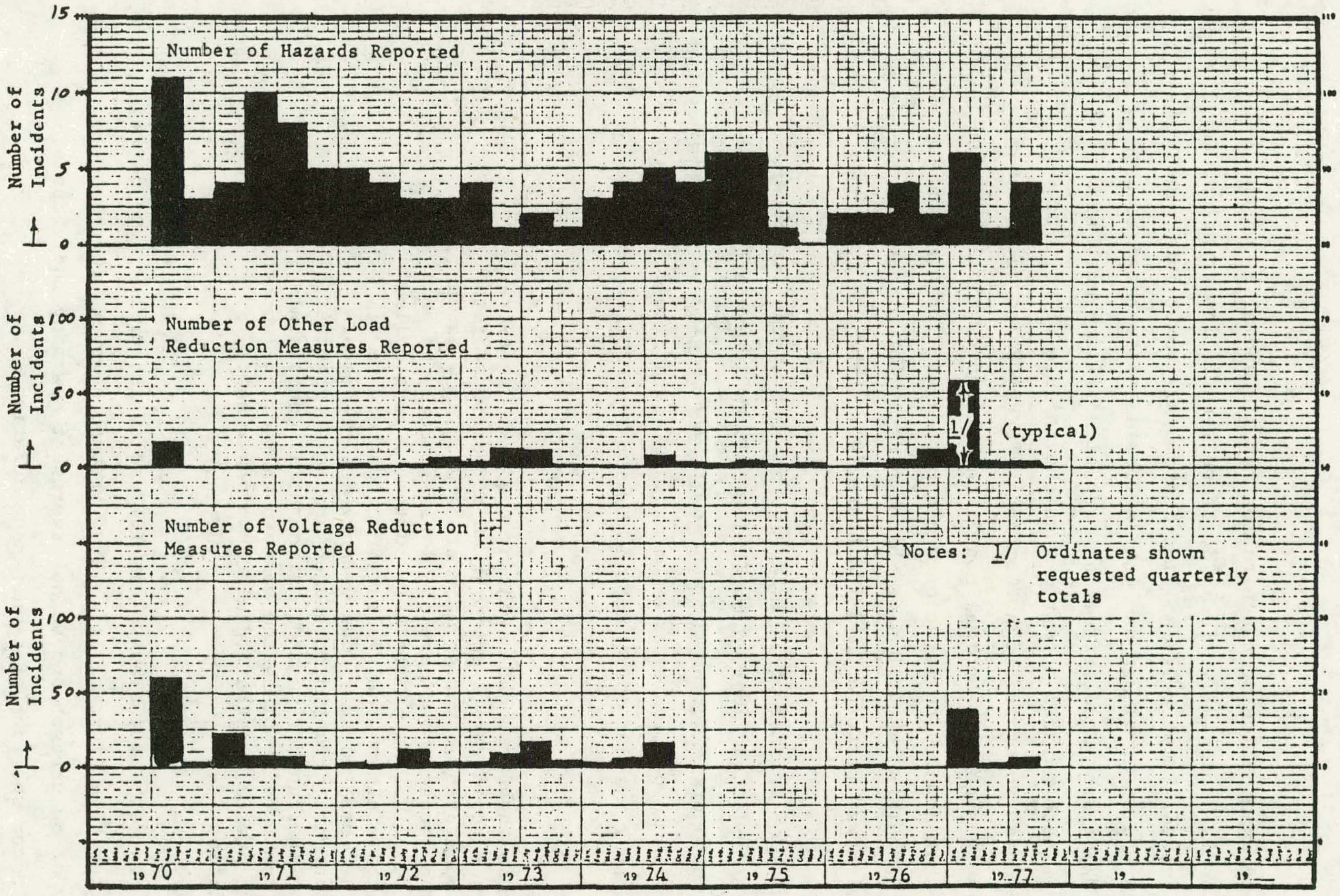

FIGURE 2.3

Electric Power Disturbance Data - July 1970 Through September 1977
(Load Reduction Measures and Hazards to Bulk Power Supply Reported)

Source: Federal Power Commission

A close examination of these tables reveals anomalies in the data reported for 1973 and 1977. In 1973, there were 37 interruptions reported which affected almost 9-1/2 million customers. Power interruptions which occurred on April 3rd and 4th in Florida contributed to a total of 5,350 MW of lost load, affecting over five million customers. According to FPC, both outages occurred when the failure of certain components at Florida Power and Light Company's Turkey Point No. 3 nuclear plant falsely signaled abnormal conditions and automatically caused the reactor to shut down. The first outage occurred at 9:37 a.m. and restoration was completed at 4:10 p.m. the same day. For the second outage all service was restored in 3-1/2 hours (4).

There were a total of 48 interruptions during the first three quarters of 1977 and load involved totaled 17,235 MW. This affected over 5-1/2 million customers. During the Winter of 1977, shortages of energy forms (natural gas in particular) due to extreme weather conditions contributed to utility systems operating problems. The FPC reported the following (5):

> "During the first two months of the year, an extraordinary cold wave swept over major portions of the United States, covering many areas with snow as far as the southernmost part of Florida. Early in this period, millions of electric customers were called upon to minimize their electric usage because of weather-related bulk power supply deficiencies. Frozen coal, plant maintenance problems, generation plant startup delays and environmental constraints all combined to place the eastern half of the country in an extremely strained electric power supply condition."

The New York City blackout in 1977 accounts for the jump during the third quarter (see Figure 2.1). These graphs, however, represent only frequency of occurrence and do not represent how many individuals experienced a power shortage of significant duration.

3. ELECTRICITY USAGE IN NEW YORK CITY

3.1 THE CONSOLIDATED EDISON SYSTEM

Consolidated Edison supplies electric service in the five boroughs of New York City--Manhattan, The Bronx, Brooklyn, Staten Island, most of Queens, and Westchester County--a service area covering about 660 square miles. Certain customers, primarily municipal corporations and governmental agencies, within the Company's service territory receive electric service from the Power Authority of the State of New York through transmission and distribution facilities of Consolidated Edison. The Company also supplies gas service to Manhattan, The Bronx, parts of Queens and the more populous parts of Westchester County. Steam service is supplied to parts of Manhattan.

In comparison with other electric utilities, Consolidated Edison is fairly large, providing 2.7 million customers a total of 28 million kilowatt hours in 1977 (6). Approximately 65% of Consolidated Edison's electric sales are to commercial and industrial customers, 28% to residential customers and the remaining 7% to railroads, railways and public authorities. Electricity consumption patterns in New York City are discussed in greater detail in Section 3.3.

The total operating revenues of the Consolidated Edison system were slightly in excess of $3 billion in 1977, of which $2.5 billion was for electric service, $0.3 billion for gas service and $0.2 billion for steam service.

The Consolidated Edison System has some noteworthy structual characteristics. Geography is one contributing factor as can be seen from Figure 3.1. The bulk of imported energy delivered to the system is supplied from the north through Westchester County. The wedge shape of the county and the limited availability of transmission rights-of-way results in closely spaced lines with individual towers carrying a multiplicity of overhead circuits. The system's other principal interconnection is located to the west via cable under the Hudson River to the Public Service

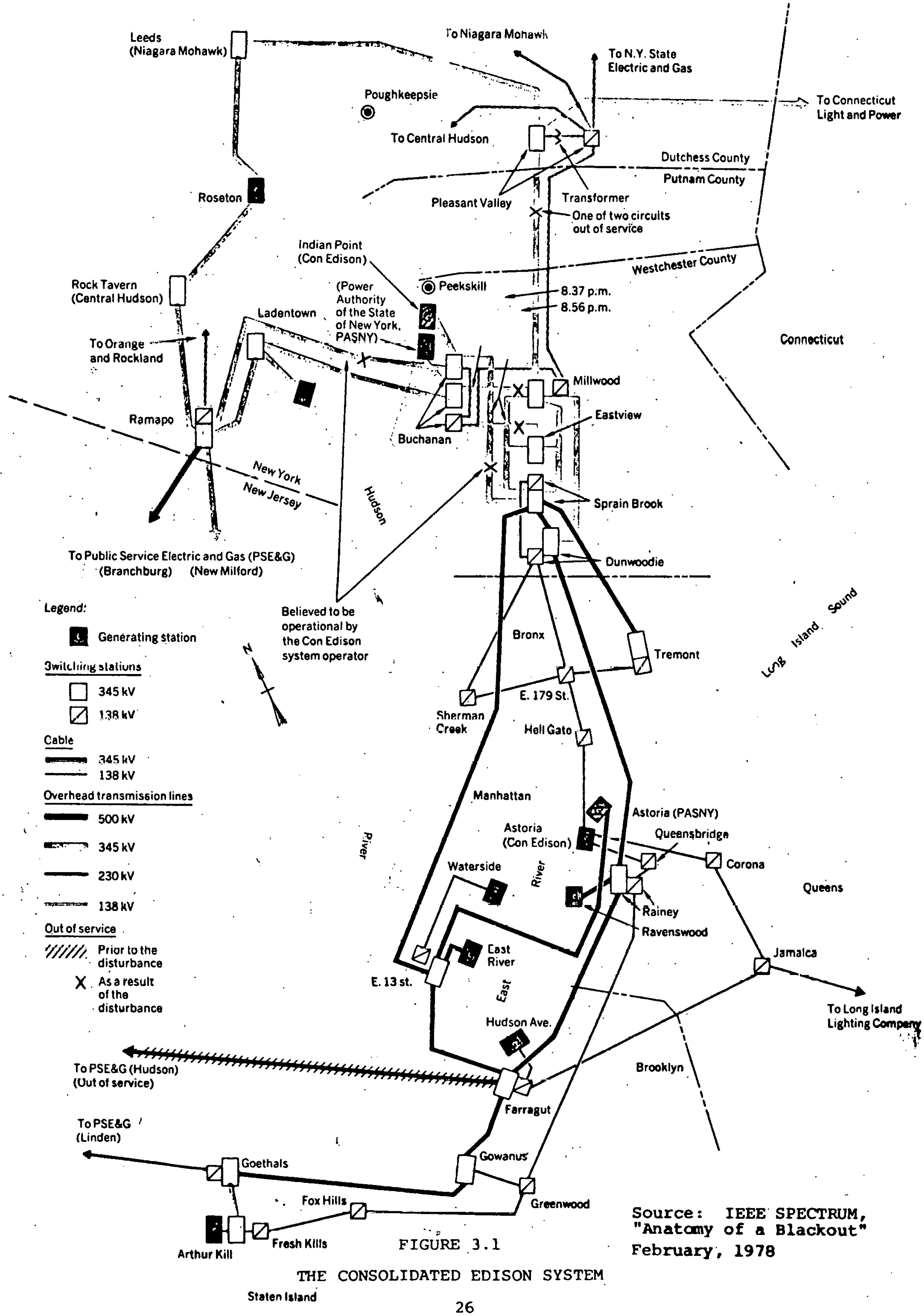

FIGURE 3.1

THE CONSOLIDATED EDISON SYSTEM

Source: IEEE SPECTRUM, "Anatomy of a Blackout" February, 1978

Electric and Gas Company (PSEG). It was in fact the northern ties, struck by lightning that contributed to ultimate system collapse. The western tie to PSEG was out of service the night of the event. Because of the population density in the area it serves, the Consolidated Edison system also has a larger number of underground cables than any other utility--approximately 77,000 miles in all. This fact also contributed to the collapse of the system because of voltage regulation and load shedding difficulties. Furthermore, the population density in New York City has severely constrained the ability of the utility to install additional in-city generation.

As an operating entity, Consolidated Edison is a member of the New York Power Pool (NYPP). That organization consists of seven investor-owned utilities in New York State whose purpose is to achieve coordinated planning and operation among the member systems. At the time of the black-out, Consolidated Edison was importing approximately 2860MW of its 5860MW requirements from other NYPP members, as well as from Canada (2).

Approximately 1200MW of the 2860MW being imported consisted of economy transactions with other companies. Such transactions are beneficial to Consolidated Edison and its customers because the majority of Consolidated Edison's generation is oil-fired and therefore more expensive than other forms of generation.

The remaining 1660MW of imports were from generating units owned or operated by or for Consolidated Edison, including Unit No. 3 at Indian Point, a nuclear unit purchased from Consolidated Edison by the Power Authority of the State of New York (PASNY).

The relationship with PASNY is another unique feature of the Consolidated Edison system. In 1976, the ownership of several Consolidated Edison generating plants and service agreements with certain customers (public/city facilities) were transferred to PASNY. In effect, Consolidated Edison merely provides the service of wheeling power from PASNY to these customers via its transmission and distribution facilities.

3.2 ELECTRICITY USAGE CHARACTERISTICS

Consolidated Edison Company's service territory covers over 600 square miles which consists of the five boroughs (counties) of New York City and the major portion of Westchester County. The population of the six county area is 8,332,000 people of which 98% is served by Consolidated Edison. The company supplies electricity to roughly 3 million households, 250 million square feet of rentable office space, 3700 public authority locations and 5 railroads (7). Comparing Consolidated Edison's share[1] of energy sales by class of customer to the U.S. for 1974, we find the following:

Class of Customers	Share of Energy Sales	
	Con Ed (8)	U.S. (9)
Residential	24.9%	33.9%
Commercial	49.3	22.4
Industrial	5.7	40.3
Other	20.1	3.4
TOTAL	100.0%	100.0%

where Other in the table refers to public authorities and transportation. The table points out that New York City is relatively more intensive in sales to commercial customers and transportation,[2] and relatively less intensive in sales to residential and industrial customers, as compared to national averages.

These phenomena are due not only to the mix of business enterprises and the large population, but are also due to the differences in per capita consumption among Consolidated Edison's residential and industrial customers relative to similar customers in the rest of the Nation. Per capita electricity use by residential customers in New York City is less than half that for all residential customers in the United States.

[1]We will use NYC and the Consolidated Edison franchise interchangeably in this section except where otherwise noted.

[2]Transportation accounted for 7.1% of Consolidated Edison's sales in 1974.

Industrial customers in the U.S., on average, use approximately four and one half times the electrical energy used by those customers in New York City (10). These differences stem principally from the high density of households and businesses in the Consolidated Edison service territory. The average population per square mile for New York City is 24,800; for Manhattan it is 61,600. This compares to a national average of about 60 people per square mile. The central business district is roughly nine square miles and accounts for 53% of the City's total employment. Finally, with regard to residential customers, the mix of apartments to single family houses in New York City is atypical of the Nation. As of 1975, there were almost 5 apartment households for each single family household in the Consolidated Edison service territory. It has been estimated by Consolidated Edison that apartments use half the kilowatt hours in a year relative to a single family home.

3.3 ESTIMATE OF CONSUMPTION OF ELECTRICITY FOR JULY 13-14, 1977

This section uses the available published data and research on Consolidated Edison's consumption patterns to estimate the electricity that would have been consumed had no blackout taken place. The estimated hourly loads are disaggregated by the following sectors:

- Residential
- Small commercial
- Large commercial
- Transportation
- Industrial and other.

3.3.1 Calculation of System Output and Consumption

It has been noted in Section 2.3 that the blackout commenced at approximately 9:30 p.m. on July 13, 1977 and terminated at 10:30 p.m. on July 14th. The weather conditions over that 25-hour time period were near design level for maximum sendout. Design weather conditions for July according to Consolidated Edison are a three-day sustained average maximum wet-dry bulb (AWD) temperature of 86.0°. On July 12th, one day before the blackout occurred, the AWD was 73.5°; on July 13th is was 84.0°; on July 14th it was 81.5°. The load characteristics for the blackout period were approximated using data from Consolidated Edison's Class Demand Study[1] for 1975. That study analyzed system loads by class of customer (residential, commercial and industrial and public authority), and the information therein is applicable to the type of loads demanded on the Consolidated Edison system over the duration of the blackout. A daily load curve exhibiting the hourly characteristics of the system for July 13-14 was established, and is shown in Figure 3.2.

According to a company spokesperson for Consolidated Edison, the maximum load that might have occurred on July 14th was 7300 MW (11). That load would have been slightly higher than the previous day's maximum load of 7264 MW, and well above the load on the 15th of 6942 MW. A load of 7300 is well within the upper 5% of the Company's annual load duration curve, thus strengthening the argument that the load shape during the blackout can be approximated from a system peak day load curve. Given a maximum of 7300 MW at 3-4 p.m. on July 14th, and given the load shape of Figure 3.2, it was estimated that 139,870 MWH of electricity would have been supplied during July 13th, 9:30 p.m.-July 14th, midnight. There were a total of 46,600 MWH actually distributed during that period, so that 93,270 MWH were lost. This amounts to approximately 84,000 MWH of sales assuming an average system line loss of 10%.

3.3.2 Consumption By Sector

Allentuck, Lee and Goldstein (12) investigated the contribution of several customer classes to the Consolidated Edison's system on summer and winter peak days, respectively. The following definitions of customer classes in terms of their respective Consolidated Edison Service Classification were used to analyze the system loads:

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[1] Consolidated Edison Class Study, Electric Department, 1975.

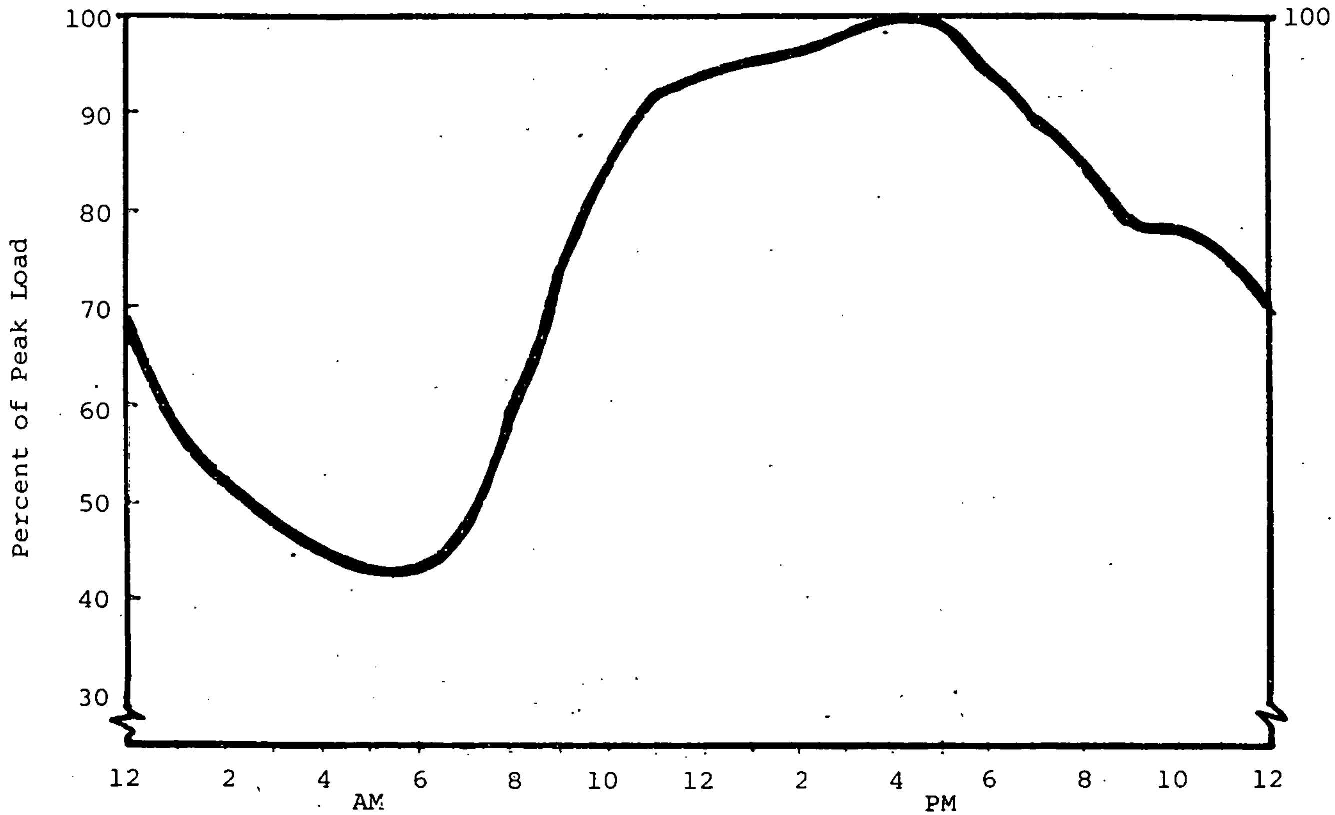


Figure 3.2

ESTIMATED CONSOLIDATED EDISON DAILY LOAD CURVE
FOR JUNE 13-14, 1977[1]

[1]Based on Consolidated Edison Class Demand Study, Electric Department, 1975.

Definition of Demand Sectors
Used in Allentuck, Lee and Goldstein (12)

Demand Sectors	Consolidated Edison Service Classification
Residential	SC1, SC7, SC8, SC12, SC13
Small Commercial	SC2
Large Commercial	Part of SC4 and SC9, SC11, SC14
Industrial and Misc.	Remains of SC4 and SC9, Company Use
Transportation	SC5, SC15

Their work made use of a computer model called the Brookhaven National Laboratory Electric System Model. They disaggregated each sector's demand into end use components and estimated the hourly contribution of each. The Allentuck study rather than the Consolidated Edison Class Demand Study was used to break down the system loads because of the former's greater level of disaggregation. Based on the predicted vaules for 1980 presented in Allentuck, percent contributions for each hourly load were assigned to residential, small commercial, large commercial, transportation, and industrial and other customers. The percent contributions were then applied to the estimated hourly system consumption based on the load curve in Figure 3.2 and a maximum sendout of 7300 MW. A summary of the estimated electrical energy that would have been sent out to Consolidated Edison customers during the balckout period can be found in Table 3-1.

In terms of relative impact, the residential customers consume the bulk of Consolidated Edison's load between 5 p.m. and 12 midnight. As a class, their load declines between midnight and 6 to 7 a.m., then gradually picks up throughout the rest of the day. According to Allentuck, food refrigeration and food freezers account for over half the load between midnight and 6 to 7 a.m. During that time period, the remaining load is due mostly to room air conditioners (central air conditioners under thermostatic control decrease in electricity consumption around 1 a.m. and surge up around 10 a.m.). After 7 a.m., lighting loads, water heating, small appliances, electric dryers, and all forms of air conditioning gradually increase throughout the day. Refrigerators also pick up in consumption as outside temperatures climb in the afternoon.

TABLE 3-1

ESTIMATED SEND OUT ON THE CONSOLIDATED EDISON SYSTEM[1] FOR JULY 13-14, 1977 (MWH)

Date	Hour	Residential	Small Commercial	Large Commercial	Industrial & Misc.	Transportation	Total
July 13	22	3128	176	340	1916	265	5825
	23	3005	158	171	1965	256	5555
	24	2538	149	---[2]	2102	256	5045
July 14	1	1861	126	---[2]	1918	240	4145
	2	1599	119	---[2]	1891	216	3825
	3	1384	118	---[2]	1929	184	3615
	4	1351	112	---[2]	1857	170	3490
	5	1316	108	---[2]	1838	173	3435
	6	1246	105	---[2]	1975	193	3520
	7	1347	112	127	2068	286	3940
	8	1440	178	326	2523	383	4850
	9	1600	244	854	2751	476	5925
	10	1820	327	1804	2174	420	6545
	11	1982	384	1908	2166	325	6765
	12	2179	397	1928	2135	301	6940
	13	2326	399	1872	2114	294	7005
	14	2419	396	1862	2145	293	7115
	15	2524	392	1836	2164	294	7210
	16	2672	377	1859	2015	377	7300
	17	3171	387	1233	1832	552	7175
	18	2951	298	1436	1593	522	6800
	19	3025	230	774	1879	407	6315
	20	2946	201	561	1908	299	5915
	21	3025	179	430	1941	262	5840
	22	3101	174	337	1900	263	5775

[1] Send Out is defined as total generation plus net energy imports. Table 3-1 allocates the hourly Send Out between the classes of customers used in reference (12) and discussed, above, on page

[2] Load for that customer class is negligible.

The small commercial customers use stems principally from air conditioning, food preparation, cold storage and security and lighting. The differential between daytime and nighttime loads is mostly due to air conditioning.

Large commercial customers have about 1500 MW demand for electricity between midnight and 6 a.m. on peak load days. Thereafter, electricity for elevators, escalators, automatic doors, and lighting reach full level by 10 a.m. and drop down by 7 p.m. Air conditioning and ventilation fans follow the activity of people in the buildings, with maximum loads for both end uses reached at noon.

The railroads and subway system are relatively stable in electricity demand throughout the day. Two surges take place during the commuter rush hours. Thus, the periods 8 a.m. to 11 a.m. and 5 p.m. to 6 p.m. have much higher consumption levels than at other times during the day.

Customers designated as Other include Consolidated Edison and other large facilities which are neither commercial nor industrial. Some examples of the latter would be hospitals, military posts, municipal offices, federal offices, parks and public sanitation sites. Consolidated Edison uses electricity to serve generating plants and offices. The hourly loads of these customers are roughly constant across a twenty-four hour period as seen in Table 3-1.

4. IMPACTS OF THE BLACKOUT

4.1 INTRODUCTION

The real costs of providing or not providing electric energy to customers is a subject of enormous contemporary interest to both electric utilities, customers, and energy analysts. The costs of energy shortages should be closely related to the determination of standards for reliability of service, i.e., the costs and benefits of providing (or not providing) some level of reliable electric service should be in reasonable balance. The determination of these costs and benefits is not a simple matter. Much theoretical work has been done in the recent past on marginal cost pricing, i.e., pricing electricity to each customer to reflect the cost of producing the next kilowatt-hour of energy. In principle, such a pricing scheme should allow the determination of the value of electricity to different end-users through some iterative process of adjusting rates and observing the resultant elasticities, i.e., customer responses. In fact, little is known about the customer response to different prices for electricity, hence the value of electricity to different classes of customers can, in many cases, only be guessed at. Furthermore, the value that a customer will place on reliable electric service will be a complicated function of economic considerations, levels of inconvenience and other intangible factors.

A number of studies have been undertaken to estimate the cost to the customer and the electric utility of unserved energy. The majority of these approaches focus on the relationship between reductions in electricity consumption and the proportionate drop in the value of the goods and services not produced. We will refer to these later as "direct impacts." The major failing of these models is that they do not account for "indirect impacts", i.e., costs incurred that are not directly related to electricity shortages but arise from social responses to the blackout conditions. The notion of indirect impacts (costs) is particularly important in the case of the New York City experience since the so-called indirect impacts accounted for a major portion of economic losses attributed to the blackout.

The approach taken in this study has been to collect data on a wide variety of impacts related to the power failure in a number of different sectors of society, e.g., business, government, health, transportation and the utility. Both economic and social costs are considered although no attempt is made to place an economic value on levels of inconvenience or disruptions of societal activities. The impacts derived in this section are based on a systematic but non-exhaustive data collection. In most cases, the data is aggregated and little or no attempt has been made to carry out primary data collection, i.e., to survey affected end-users directly.

4.2 IMPACT CLASSIFICATION SCHEMES

A general classification scheme was developed to efficiently characterize, a priori, potentially important impacts of the power shortage and to serve as a guide for subsequent data collection activities. In general, the classification approach has proved a useful prescriptive tool and can be disaggregated further to whatever level of detail is appropriate.

4.2.1 Definitions

Direct Impacts. These impacts relate to the interruption of an activity or service which requires direct input of electrical energy, and the immediate consequences of that interruption. Examples of this would include the following:

- Food spoilage
- Manufacturing plant shutdown
- Damage to electronic data and loss of computer services
- Loss of life support systems in hospitals, nursing homes and households
- Suspension of electrified transport
- Traffic congestion due to the failure of traffic control devices.

Indirect Impacts. These are effects which result from one or more direct impacts and reflect social responses made to blackout conditions. Virtually all previous studies have dealt only with direct impacts. They can be further disaggregated into short, medium and long-term impacts. Examples of each are as follows:

- Short term
  - property losses resulting from looting and arson
  - overtime payments to police and fire personnel
  - cancellation of social activities due to impaired transportation system
- Medium term
  - cost of recovery from looting
  - overtime wages for correctional institution personnel
  - lost tax revenues during recovery period
- Long term
  - potential increase in insurance rates
  - litigation costs
  - probability of disease and contamination increased due to sewage disposal problems
  - incarceration of looters.

The distinction between direct and indirect impacts is important because it provides input to the determination of the most cost-effective strategy for dealing with possible electricity shortages in the future. Direct impacts, by definition, can only be avoided through increase of end-user reliability (implemented either by the utility and/or customer). Indirect impacts, on the other hand, may be partially mitigated through contingency planning, improved communications, customer education and other planning approaches. This distinction is thus convenient for assessing the relative benefits of alternative strategies for dealing with electricity shortages, e.g., upgrading reliability versus planning for more frequent failures.

Local Impacts. Any impact which takes place within the affected area is considered to be a local impact. The Consolidated Edison service territory covers all of the five boroughs of New York City and the major portion of Westchester County. The local impacts for the New York City blackout, therefore, are all the indirect and direct impacts within the Consolidated Edison service territory.

Neighborhood Impacts. These are impacts which take place in areas outside the affected area. This includes neighboring counties, states and countries. For example, in the New York City 1977 blackout, the New York Stock Exchange was closed. This affected business transactions in the rest of the country and the world.

Economic Impacts. These are impacts which can be measured in terms of lost wages, production, profits, revenues and property and equipment damage. Any impact (direct or indirect) which can be assigned a dollar value is an economic impact.

Social Impacts. The cessation or interruption of a human activity whether it be conducted for leisure or occupational purposes is a social impact. The changes and adaptations made in response to these disruptions which are of a social and physical nature are also social impacts. It is difficult to assign, objectively, dollar values to these activities and adaptations.

Organizational Impacts. These refer to those procedural, organizational and other changes and recommendations made by organizations in response to blackout conditions. Examples might include new emergency plans adopted by the police and fire departments, and changes in a public health facility's back-up power system. Most organizational impacts are of an indirect nature and reflect social as well as economic costs.

4.2.2 Impact Categories

In dealing with economic impacts, the following major categories were identified as important:

- Business
- Government
- Utilities (Consolidated Edison)
- Insurance Industry
- Public Health Services
- Other Public Services

These categories include most of the major economic sectors of a metropolitan region and should capture the majority of economic impacts (both direct and indirect) although there may be problems of double counting. In nearly all cases, the categories also align fairly closely with available sources of data. Table 4-1 shows the type of costs postulated a priori which affects each category. This table was subsequently used to aid in data collection.

In examining the economic impacts of a blackout, one must also be concerned with the interdependence of economic activities. These linkages can become significant in the case of a prolonged power interruption.

The inclusion of social impacts into our framework is a much more complicated problem. There are difficulties in both defining and measuring a social cost. In general, a social impact associated with a power outage refers to the changes in social activities which are ordinarily facilitated by electricity-dependent technology, and the social adaptations, short and long term, which are made in response to these changes. Impacts may be classified according to the type of activity either directly or indirectly involved. The best way to document social impacts would be to monitor social behavior by individuals and groups of individuals during the event. Long-range impacts may be assessed by interviewing the population after the event.

The collection of such primary data was outside the scope of this study. Indicators of key activities, however, can offer an alternative method of observation. Here, too, time and budget constraints can become significant. The approach taken here was to limit ourselves to data that was aggregated by avrious administrative agencies involved in monitoring the flow of people, goods and services in and around New York City. It is recognized however, that this is only a rough approximation to the real social impacts that occurred. The remainder of this section deals with the economic, social and organizational impacts and adaptations that actually occurred during and after the blackout.

TABLE 4-1

ECONOMIC IMPACT CATEGORIES

Direct Impacts		Indirect impacts
1. Business Losses		
- production time loss (duration of blackout) - damages to plant equipment - inventory loss (food spoilage, etc.)		- production time loss (results of the looting, etc.) - damages to equipment - inventory loss - security equipment installation expense - backup power system costs
2. Government Losses		
- transit revenue loss - city tax revenue loss	City	- tax and transit revenues - emergency aid - overtime payments - investigation and research costs
- state tax revenue	State	- emergency aid - tax revenues - investigation and research costs
- state tax revenue loss	Federal	- emergency aid - investigation and research costs
3. Consolidated Edison		
- revenue loss - overtime costs (for recovery) - capital expenses for recovery		- capital expenses mandated - legal fees - investigation and research costs - potential effects on rates

TABLE 4-1 (Continued)

Direct Impacts		Indirect Impacts
4. Insurance		
		- unemployment - private property - business property and inventory - health
5. Public Health and Safety		
- food and medical specimen spoilage - hospital costs (supplies, operation of generators, etc.) - overtime costs - revenue costs		- increased patient load (results of the looting, etc.) - backup power system costs - new contingency plan costs
6. Public Services		
	Fire	- overtime costs
	Criminal Justice	- police overtime costs (state, local) - correction costs (short and long term) - court-related costs
- revenue loss - equipment damage	Transit	- revenue loss - new equipment - backup power system costs
- revenue loss	Utilities (non-electric)	- overtime (sanitation, water)

4.3 SUMMARY OF ECONOMIC IMPACTS: THE NEW YORK CITY EXPERIENCE

In this section we discuss the economic impacts of the New York City blackout. The economic costs documented here are neither comprehensive nor exhaustive. For the most part, these costs are based on secondary data sources, provided by numerous public and governmental agencies. Thus, the costs listed in each category in Table 4 2 should be regarded as a broad sampling of the total economic losses which are directly and inderectly associated with the power outage. Many of the potential costs identified in Table 4-1 have not been included in Table 4-2 because of our inability to determine them with any accuracy within the scope of this study. Examples of costs which fall in this category include the following:

- Losses in retail business
- City, State and Federal tax revenue losses
- Production time loss
- Computer industry losses
- Total loss interest for the banking industry

4.3.1 Impacts on Business

The direct costs due to a power interruption that may be incurred by businesses generally can be attributed to the following:

- Lost production time
- Damaged plant equipment
- "Spoiled" product
- Additional maintenance costs

The relative magnitudes of these costs vary according to the nature of the affected business activities (industrial processes, commercial activity, etc.).

TABLE 4-2

SUMMARY OF ECONOMIC IMPACTS[1]

Impact Areas	Direct ($M)		Indirect ($M)	
Businesses	Food Spoilage	$ 1.0	Small Businesses	$155.4
	Wages Lost	5.0	Emergency Aid (private sector)	5.0
	Securities Industry	15.0		
	Banking Industry	13.0		
Government (Non-public services)			Federal Assistance Programs	11.5
			New York State Assistance Program	1.0
Consolidated Edison	Restoration Costs	10.0	New Capital Equipment (program and installation)	65.0
	Overtime Payments	2.0		
Insurance[2]			Federal Crime Insurance	3.5
			Fire Insurance	19.5
			Private Property Insurance	10.5
Public Health Services			Public Hospitals--overtime, emergency room charges	1.5
Other Public Services	Metropolitan Transportation Authority (MTA) Revenue Losses	2.6	MTA Vandalism	.2
	MTA Overtime and Unearned Wages	6.5	MTA New Capital Equipment Required	11.0
			Red Cross	.01
			Fire Department overtime and damaged equipment	.5
			Police Department overtime	4.4
			State Courts overtime	.05
			Prosecution and Correction	1.1
Westchester County	Food Spoilage	0.25[3]		
	Public Services equipment damage, overtime payments	0.19		
TOTALS		$55.54		$290.16

[1]Estimate based on aggregate data collected as of May 1, 1978. See previous page for discussion of limitation of these costs.
[2]Overlap with business losses might occur since some are recovered by insurance.
[3]Looting was included in this estimate but reported to be minimal.

These data are derivative, and are neither comprehensive nor definitive.

In the NYC experience only about 20% of the total losses to businesses (as cataloged in the present study) can be attributed directly to the blackout; the balance was related primarily to looting and arson of small business establishments. The major business losses (direct) increased include the following:

- Losses due to the closing of the securities industry
- Wages lost
- Food spoilage
- Banking losses

H. Wellisch (13) of E. F. Hutton Corporation used the following rationale in estimating the losses to the securities industry. The industry annually yields approximately $7 billion in gross revenue, which translates roughly to about $28 million per working day. Wellisch estimates that approximately half the losses due to the blackout can be made up, which leaves about $15 million lost. To date, no detailed analysis of the impacts on the securities industry has been carried out. The Bureau of Labor Statistics (14) roughly estimated approximately $5 million lost in wages and salaries during the week, i.e., wages not paid.

The New York State Clearing House Association, which represents eleven of NYC's largest clearing banks, indicated (15) that the banking industry experienced grave difficulties during the blackout. Problems encountered included:

- Computer services were terminated from 9:00 p.m., July 13 through 4:00 p.m., July 14. As a result, international banking business came to a standstill, domestic banking halted, government securities could not be recorded, checks could not be cleared, and there was a loss of interest payments
- No electrical lighting
- Electrically-timed vaults were inoperative
- Elevators did not function
- Security systems became inoperative.

On one system in the Clearinghouse Association which processes $80 billion per day, lost interest for that one system was approximately $13 million. Total losses were presumably in excess of this figure. Hence the total direct business losses estimated here ($34 million) represent only a lower bound on the total losses. The remaining direct business losses due to the power failure are probably obtainable only through an extensive survey.

The balance of the total estimated business losses, about $155.4 million and approximately 80 percent of the total business losses, is attributed to looting and arson losses affecting small merchants in certain areas of the city. We refer to this as an indirect impact. A preliminary figure for the total number of businesses affected to varying degrees was 1383 according to the NYC Department of City Planning (16), although the New York City Emergency Aid Commission (17) received 2339 applications for assistance grants earmarked for blackout recovery. The final tally to date, according to the NYC Office of Economic Development, is nearly 2500. The Small Business Administration (18) performed a survey of those businesses affected by looting, vandalism, arson, etc., and, based on that survey, reported a total estimated damage of $155.4 million. A more complete discussion of impacts of the blackout on small businesses is given in Section 6.

An important factor in estimating business losses is the sensitivity of business impacts to the duration of a power interruption. In many industrial processes only a one to ten cycle interruption will cause a several-hour outage of plant equipment (Gannon (19)). Several IEEE surveys (IEEE (20)) have dealt with the definition of a minimum or "critical" service loss duration time for various commercial and industrial activities. The results of one of these surveys suggest that many commercial activities (15% of those surveyed) considered a period of less than one second a critical interruption. This is primarily due to on-site computer facilities which did not have emergency power systems. 100% of those surveyed considered a 12 hour interruption "ciritcal".

In particular, the effects of a power failure on computers is of interest considering the ever increasing dependence of business on computer-based systems. In general, the first things that come to mind as potential computer related costs due to a loss of power include:

- Possible damage to the computer and peripheral equipment
- Loss of data
- Costs associated with the inability of the computer to perform important functions or applications.

Most computer systems are designed to shutdown 'gracefully' on detecting a loss of power so that damage to the computer equipment itself is avoided. When power returns, the computer can restart itself automatically. These power automatic fail/restart features are most useful for short duration power outages but would not serve to protect the equipment in an extended blackout situation.

There is generally little danger of equipment damage or loss of data so long as the outage is of short duration. In a prolonged blackout, concerns of the operating environment begin to come into play. This is especially true for storage media where loss of data can result from a degradation of the medium if environmental conditions stray too far from the norm. In fact, there is even some danger of permanent equipment damage. It should be noted that computer systems used for critical applications are almost invariably supplied from an uninterruptible power source (UPS), although such a UPS is not normally designed for an extended blackout. No intensive survey was undertaken to assess the severity of computer-related losses in NYC.

4.3.2 Impacts on Government

City, state, and federal agencies all faced considerable expense in dealing with the blackout. The major expenses were, of course, those related to controlling and recovering from the looting, but, due to the duration of the power interruption, other expenses such as lost tax and public transportation revenue became significant as well. However, in some cases, such as the lost transit revenue, the distinction between direct and indirect expense is not clear. For instance, commuters who could not use the subway but could use buses may not have because the reports of violence kept them away from their places of work.

The major indirect expenses collected to date are

- Overtime payments to fire, police, and other personnel
- Emergency aid payments not covered by insurance.

Government losses not related to public or transportation services, generally center around special programs initiated to aid in the blackout recovery. At the federal level, this assistance package came from five different agencies, a summary of which is given in Table 4-3.

TABLE 4-3

FEDERAL BLACKOUT ASSISTANCE PROGRAMS

Agency	Millions of Dollars
Department of Labor	$ 2.0
Department of Commerce	3.1
Department of Housing and Urban Development	5.0
Department of Justice	1.0
Department of Health, Education and Welfare	.3
Special Projects	.1
Total	$11.5

The Department of Labor program was administered through the Comprehensive Employment and Training Act (CETA) for additional jobs to assist in cleanup and economic development activities. The Economic Development Administration disbursed the Department of Commerce funds for demolition of destroyed buildings ($2 million), technical assistance to impacted areas ($.6 million), administrative support to the City Rescue Fund ($.2 million) and long-range economic development and recovery planning ($.2 million). The Department of

Housing and Urban Development provides its funds in the form of low interest (3%) commercial redevelopment loans. The Department of Justice provided assistance to the NYC criminal justice system through the Law Enforcement Assistance Administration. Finally, the Department of Health, Education and Welfare provided community based economic assistance through the Community Services Administration.

The New York State government implemented a $1 million emergency employment program through the Division of Youth Office (21). Youth workers were made available at no cost to small merchants to aid in business recovery. The major impacts on state and local government were not through provision of necessary assistance programs, but primarily through suspension of revenue producing public services and increased loads placed on other public facilities, e.g., criminal justice and hospitals. We deal with each of these as separate categories shortly. One impact on the NYC government that has not yet been resolved is the $200 million worth of pending legal claims against the City for personal damages stemming from the blackout. The Corporation Council for New York City (22) expects the NYC Comptroller to declare the city free from liability.

4.3.3 Impacts on Consolidated Edison

A large financial burden was experienced by Consolidated Edison itself in recovering from the blackout. In the Consolidated Edison review of the blackout (1), revenue losses and other restoration costs were reported to be nearly $10 million in addition to overtime payments during the recovery period which were nearly $2 million. New capital equipment and installation costs for prevention of future incidents currently total nearly $65 million. Consolidated Edison also indicates that additional costs will be incurred as a result of significant changes in their long-term generation and transmission expansion plans. The bulk of these costs are considered unestimable at this time. Finally, 118 legal suits pending against Consolidated Edison total over $10 billion. None of the suits have yet been resolved. The costs to Consolidated Edison are discussed in more detail in Section 5.3.

4.3.4 Insurance Payments

The combined insurance payments of the New York City Property Insurance Underwriting Association (23), New York Board of Fire Underwriters (24), and the Federal Insurance Administration (HUD) (25), potentially total about $33.5 million. It is important to note that these are potential payments. The actual funds disbursed as of February 1978, amounted to only 40 to 50% of this total. The long-term effects of the blackout on insurance rates are unestimable at this point but insurance executives expect sizable increases, perhaps even to the point where they will be cost prohibitive for many small businesses.

4.3.5 Public Health Services

Both public and private hospitals were affected by the blackout. It appears that many backup power systems were inadequate for many hospital activities. To date the only available cost data is that concerning the increased cost to public hospitals as a result of dealing with the blackout; this figure is currently given to be $1.5 million. (The New York Health and Hospitals Corporation (26).) The inadequacy of many hospital emergency power systems has also prompted the initiation of significant upgrading of these facilities in many hospitals. The direct effects of the power interruption include overtime payments, some of which, however, may turn out to be indirectly related to increased emergency room activity. In addition, food and medical specimen spoilage due to lack of refrigeration appear to be insignificant compared to other costs. The indirect expenses were mainly emergency room charges most of which were generated by victims of street violence.

4.3.6 Other Public Services

Criminal Justice System

The NYC police department (27) reports overtime payments of about $4.4 million over the period of the blackout. Seventy percent (17,000) of the NYC police force was on duty throughout the blackout.

The costs associated with blackout-related arrest, incarceration, and subsequent prosecution are estimated at around $1.15 million (NY State Office of Court Administration (28)).

Public Transportation

Suspension of electrified mass transit facilities as well as gasoline pumps for buses virtually halted much of the public transportation network in NYC. Revenue losses are estimated by the Metropolitan Transportation Authority (29) at about $2.6 million. Vandalism damages and overtime payments amounted to an additional $6.5 million. Since the blackout, MTA has initiated an $11 million program to install new equipment to insure against massive disruption of the mass transit system in the event of a future blackout.

Fire Department

The NYC Fire Department (30) estimated approximately $.5 million in overtime expenses and damaged equipment during the blackout. There were 1037 fires reported, 60 of which were regarded as serious (requiring five companies). New fire stations had emergency power systems, but older stations did not.

Red Cross

The Red Cross (31) in New York City estimated expenditures of $7000 classified as "emergency mass-care" during the blackout.

Miscellaneous

Most other impacts identified to date in the course of this study were either regarded as minimal, or in the case of some potentially significant impacts, data was unavailable. These impacts include civil losses to individuals, costs to private and public health care clinics, and private transportation such as air, and tax revenue losses (city, state, federal).

4.3.7 Westchester County

The economic impacts of the blackout on Westchester County were collected by the Small Business Administration. The following is a general breakdown of the costs recorded:

• Protective services	$ 75,000
• Physical damage to utilities (sewage, water treatment plants, equipment damage)	13,000
• Public facilities	3,000
• Program administration costs	46,000
• Overtime costs and fringe benefits	35,000
• Miscellaneous expenditures	16,000
Total	$188,000

According to the SBA, damages due to looting and food spoilage in the private sector were roughly estimated at $.25 million. Although the looting did not reach severe proportions, a total of 20 arrests were made.

The reason we have not isolated Westchester County as a major economic impact category is two-fold. First, power was restored early Thursday morning (July 14) and though people were prohibited from commuting into the metropolitan area, they were able to resume normal household activities. Industries and manufacturing plants were also able to maintain operations. Second, the demographic and geographic characteristics in Westchester County are on the average very different from New York City. In general, the impacts in Westchester County were relatively small compared to NYC.

4.4 SOCIAL IMPACTS

The social impacts associated with a power outage refer to all the changes in social activities (ordinarily facilitated by electricity-dependent technology), and the social adaptations, which are made in response to these changes. A power outage, much like a natural disaster, is associated with a sudden disruption in a community. It differs from natural disasters (e.g., an earthquake) in that little physical destruction and few physical injuries are visited on the community. The people and institutions affected are those usually more dependent upon a technological economy--living in high rise buildings, electric space heating, computerized information system, etc.

In addition to the above mentioned effects, a more drastic adaptation may take place depending upon the circumstances and duration of the blackout. The interruption of usual community activities may be accompanied by a suspension of certain social norms--particularly those relating to legitimate community leadership and authority, legitimacy of the agencies of law and order, and individual rights and private property. Part of the reason for the helpless ness of police in such situations is that they are trained to enforce generally acceptable rules and are able to do so when they have at least acit community support. When these social norms and community support are in abeyance, they have to resort to force, as in a military situation, to reimpose order. The appearance of what disaster researchers call the "emergency social system," (the many individuals and groups who provide assistance and relief to victims), is a community's attempt to reinstitute the rules to reclaim legitimacy for its organization.

In this section, we describe some of the indicators of social change as a measure of social impacts. We also look at the various end-uses of electricity in different sectors and suggest some approximate estimates for levels of inconvenience.

4.4.1 Social Impact Indicators

The following are some indicators that are useful in characterizing a variety of social impacts.

Movement of People and Goods. This indicator looks at changes in the flow of people and goods within and outside the blackout area. The information tells us little about the types of activities, however.

The Flow of Information. This is useful in getting an impression of public activity in and outside of the impacted area.

Economic Impacts. Indicators of economic activity, particularly market activity, are most likely to be recorded and accessible. This is useful since in some cases social events are paralled by economic events.

Impacts on Health Organizations. Information on health impacts, particularly mortality and morbidity, are available from hospital and city statistics. Health impacts on individuals due to social strains may be difficult to address if at all.

Credibility of the Electric Utility. The effects on Consolidated Edison are primarily economic but may be strongly influenced by emotional and political considerations.

Civil Disorder. Here we consider the acts of civil disorder that were carried out, the geographic, economic, racial and other variables associated with the disorders, and the response of the criminal justice system.

4.4.2 Levels of Inconvenience

In order to arrive at some estimate of the social impacts associated with a power failure, we first identify some of the most significant end-uses of electricity in New York City. These are (in no particular order):

- Elevators
- Space heating

- Space cooling
- Ventilation
- Water heating
- Cooking
- Lighting
- Refrigeration
- Water pumps
- Sewage disposal
- Electric tools and machines
- Office appliances
- Fuel pumps.

Data on percent consumption for each of these categories is generally not available with the exception of some residential space heating, cooling and water heating data. In Tables 4-4 and 4-5, we show these uses of electricity together with occupational classifications in New York City. We further postulate (without supporting data) possible levels of inconvenience that might be encountered by each of these sectors for the various uses of electricity identified above. Figure 4.1 displays a possible approach for representing an inconvenience index for different critical uses of electricity as a function of duration of the power failure. The duration is a key variable in attempting to estimate the costs of a blackout.

Of particular interest when considering the social impacts of a power failure are the inconveniences suffered by residential customers. The dependence on electricity can vary widely from residence to residence depending upon the unique circumstances surrounding that household. In general, detailed information on these inconveniences can only be obtained through surveys of selected residential customers. An approach for doing this is discussed in Section 6. In Table 4-6 we show a classification of residential customers and their possible levels of inconvenience to a prolonged blackout for different uses of electricity. Presumably these inconveniences can be weighted and summed to develop a total inconvenience level for each class of customer.

TABLE 4-4

USES OF ELECTRICITY IN NEW YORK CITY AND LEVELS OF INCONVENIENCE*

Uses of Electricity \ Occupations	Total	White Collar Workers: Professional and Technical	Managers and Administrators	Sales Workers	Clerical Workers	Total	Blue-Collar Workers: Craft and Kindred	Operatives Except Transport	Transport Equipment Operatives	Non-Farm Laborers	Total	Service Workers: Food Service	Health Service	Personal Service	Protective Service	Total	Farm Workers
Percent of Total Employed (1)	100	18.3	11.3	5.8	23.7	59.2	9.4	8.8	3.6	3.4	25.3	NA	NA	NA	NA	15.5	(2)
Elevators (Above 5th Floor)		H	H	M	H		H	H	L	M		H	H	H	H		L
Space Heating (Winter)		H	H	M	H		M	H	L	L		H	H	H	M		L
Space Cooling (summer)		H	H	M	H		M	H	L	L		H	H	H	M		L
Ventilation		M	M	M	M		M	M	L	L		H	H	M	M		L
Water Heating		L	L	L	L		L	L	L	L		H	H	M	L		L
Cooking		L	L	L	L		L	L	L	L		H	L	M	L		L
Lighting		H	H	M	H		H	H	L	M		H	H	H	H		M
Refrigeration		L	L	L	L		L	L	L	L		H	M	L	L		H
Water Pumps		L	L	L	L		M	L	L	L		H	H	M	H		H
Sewage Disposal		L	L	L	L		L	L	L	L		H	H	M	L		L
Electric Tools and Machines		L	L	L	L		H	H	M	H		H	H	M	M		H
Office Appliances		L	L	L	H		L	L	L	L		L	M	L	L		L
Fuel Pumps		L	L	L	L		L	M	H	M		L	L	L	H		H

Key: H - High level of inconvenience, performance and productivity levels are approximating zero.
M - Medium level of inconvenience, performance and productivity levels are lower than normal.
L - Low level of inconvenience, performance and productivity levels are near normal.

1 - Of the total working force in the NYMA (NYC, Putnam, Westchester and Rockland Counties) 1976 Employment Total - 3,666,000.
2 - Less than 1.0 percent.
Note: Items may not add to totals or subtotals because of rounding.
Source: "Geographic Profile of Employment, 1976," U.S. Department of Labor, Bureau of Labor Statistics - 1977, Report #504.
*During a prolonged blackout.

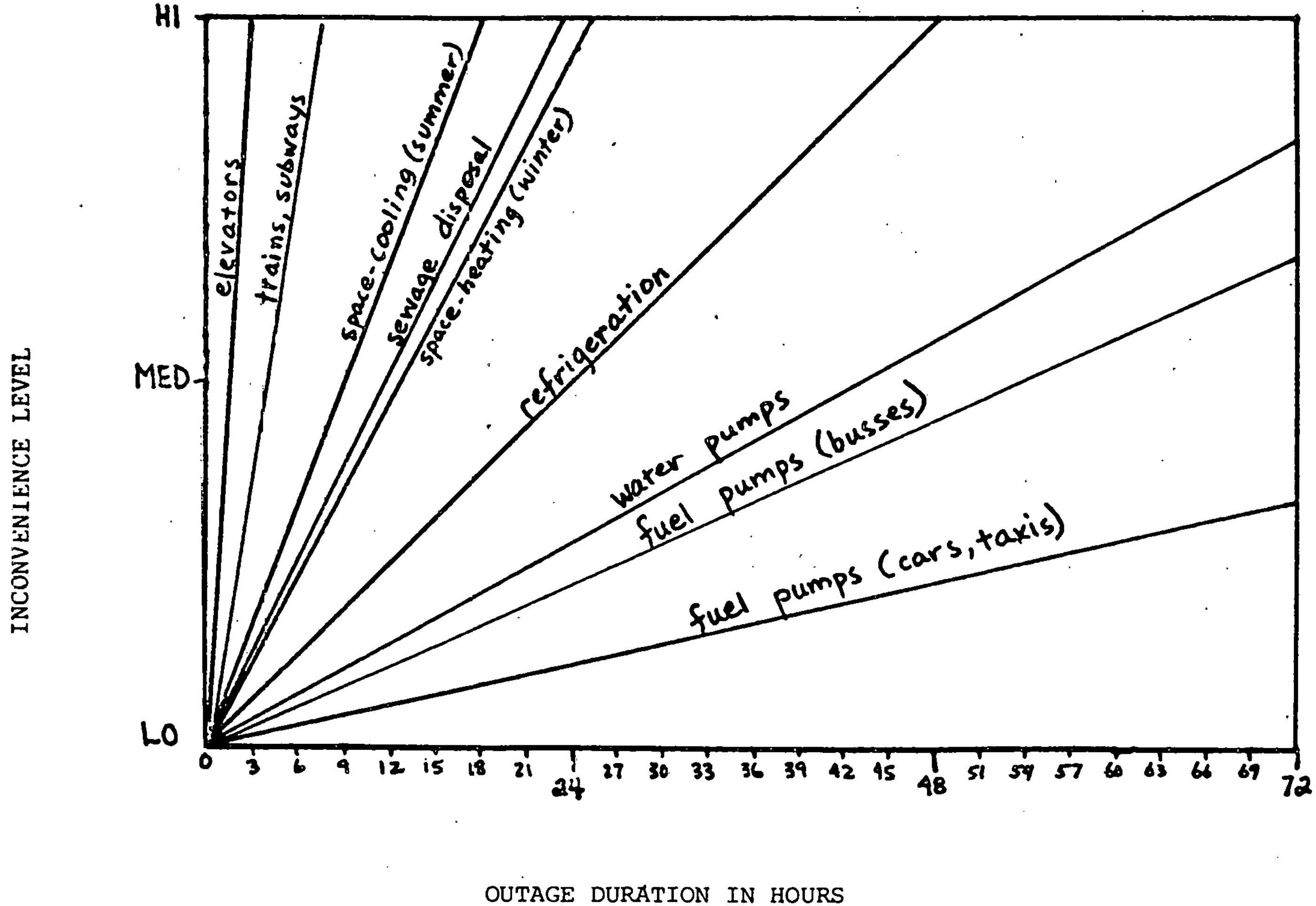
TABLE 4-5

THE IMPACT OF A PROLONGED POWER FAILURE ON MAJOR SERVICES IN NEW YORK CITY

Uses of Electricity \ Services	Communications	Public Health and Safety	Public Services: Police Force	Public Services: Fire Protection	Public Services: Street Lighting	Public Services: Water Supply	Public Services: Sewage Disposal	Public Services: Public Buildings	Social Services	Government	Education	Computer Services	Food Industry	Business, Commerce, Trade	Transportation
Elevators (above 5th Fl)	L	M	M	H	L	L	L	H	M	M	L	L	L	M	L
Space-Heating (winter)	L	M	L	L	L	L	L	M	M	M	M	L	L	M	L
Space-Cooling (summer)	L	M	L	L	L	L	L	M	M	M	M	L	L	M	L
Ventilation	L	M	L	L	L	L	L	M	M	M	M	L	L	M	L
Water-Heating	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L
Cooking	L	M	L	L	L	L	L	L	M	L	L	L	H	L	L
Lighting	M	M	H	H	H	L	L	H	M	H	H	M	H	M	L
Refrigeration	L	M	L	L	L	L	L	L	M	L	L	L	H	L	L
Water Pumps	L	M	L	H	L	H	H	M	M	L	L	L	M	L	L
Sewage Disposal	L	H	L	L	L	L	H	M	M	L	L	L	M	L	L
Electric Machines	H	H	L	M	L	L	H	M	L	L	L	H	M	H	L
Office Appliances	M	M	L	L	L	L	L	M	L	H	L	L	L	H	L
Fuel Pumps	L	M	M	H	L	L	L	M	L	L	H	L	L	L	H

HIGH IMPACT : SERVICE IS COMPLETELY DISRUPTED.
MEDIUM IMPACT : SERVICE IS IMPEDED.
LITTLE IMPACT : SERVICE IS UNAFFECTED.

INCONVENIENCE INDEX FOR CRITICAL USES OF ELECTRICITY DURING A PROLONGED POWER OUTAGE



High - The consumer feels great inconvenience and is forced to make adaptations.

Medium - The consumer feels inconvenience and may choose to make adaptations.

Lo - The consumer feels only slight inconvenience and will not make adaptations.

Figure 4.1

TABLE 4-6

USES OF ELECTRICITY IN NEW YORK CITY AND LEVELS OF INCONVENIENCE FOR RESIDENTIAL CUSTOMERS[1]

USES OF ELECTRICITY \ RESIDENTIAL USERS[2]	CHILDREN 16YRS AND YOUNGER	HOME-MAKERS	DISABLED, HANDICAPPED SICK	SENIOR CITIZENS	UNEMPLOYED	STUDENTS, 17YRS AND OLDER	EMPLOYED
ELEVATORS (ABOVE 5th FL)	H	H	H	H	H	H	H
SPACE-HEATING (WINTER)	H	H	H	H	H	H	H
SPACE-COOLING (SUMMER)	H	H	H	H	H	H	H
VENTILATION	M	M	M	M	M	M	M
WATER-HEATING	L	H	H	H	H	H	H
COOKING (ELECTRIC)	L	H	H	H	H	H	H
LIGHTING	M	H	H	H	H	H	H
REFRIGERATION	L	H	H	H	H	H	H
TELEVISION	H	L	H	H	M	L	L
CLOTHES/WASHING DRYING	L	H	L	H	M	M	M
LIFE MAINTAIN-ANCE EQUIPMENT	NA	NA	H	NA	NA	NA	NA
WATER PUMPS	M	H	H	H	M	M	M
SEWAGE DISPOSAL	M	H	H	H	M	M	M
HOME APPLIANCES	L	M	H	M	L	L	L
FUEL PUMPS	M	M	M	M	M	M	M

1 - During a prolonged power failure.
2 - Source: Classifications, U.S. Dept. of Labor, "Current Population Survey," Census Bureau.

Key: H - High level of inconvenience, performance and productivity levels are near zero.
M - Medium level of inconvenience, performance and productivity levels are lower than normal.
L - Low level of inconvenience, performance and productivity levels are near normal.
NA - Not applicable.

4.4.3 Summary of Social Impacts

The identification of social impacts in this study is dependent largely upon determining the changes in activities and adaptations made by individuals and organizations to the power failure. Aggregate social indicators were used to characterize these impacts. It is still possible within this framework to summarize the key social impacts that occurred as a result of the blackout. A detailed discussion and analysis of these indicators and supporting data for the New York City power failure is contained in Appendix A. The key impacts follow below.

In examining changes in transportation patterns, it became clear that the blackout affected transportation significant distances from New York City. Disturbance in air travel was minor in comparison to train and motor traffic. During the night of the blackout some 15,000 people were stranded at Kennedy Airport after 10 p.m. Furthermore, the number of taxis at the airport declined as the blackout progressed.

The need for increased information flow (and presumably the strain and concern felt by many) was evidenced by the additional number of emergency news telephone messages requested, from an average ten thousand calls to over eight hundred thousand calls during the blackout. Telephone company estimates were that traffic through residential exchanges was up by three hundred percent during the blackout. Furthermore, police emergency calls were up by over five hundred percent reflecting the strain on civil order and critical services.

Most of the data on health effects came from hospital and city statistics. The number of known deaths resulting from the blackout is two. However, an examination of the mortality data suggests that the number of deaths around the time of the blackout increased, particularly for those 65 years or older. The categories of respiratory failure and cardiovascular were predominant. In addition to mortality, it is believed that the blackout led to a number of personal injuries (resulting *e.g.*, from the melee of the looting or accidents in the dark).

The most "visible" aspect of blackout-related social impacts was, of course, the looting, arson and other acts of wanton violence and destruction. The looters tended to come from all segments of the community, cutting across age, sex, and income class lines. Like many other institutions, the criminal justice system found itself severely strained by the aftermath of the looting. There were approximately 3000 arrests reported for blackout-related looting, an extremely large number of individuals even for New York City (compared to approximately 600 arrests for a normal 24-hour period). The questions most asked about the blackout were "why?, and could it happen elsewhere?" While it is impossible to answer these questions with any certainty, it is clear that other cities in the U.S. based on historical experience have a similar potential for social upheavals.

There are many other social impacts beyond the ones cataloged here. In particular, long-term trends can only be postulated at this point. Shifts in population centers, movement of industry, etc., take place over longer periods of time and tend to reflect complex economic and/or social factors.

Finally, it is worth noting that the social impacts and activities associated with the 1977 blackout may reflect a possible emotional conditioning from the 1965 blackout. Such conditioning could be partially responsible for the civil disorders, but might also have benefits such as increased preparedness to deal with blackout-related disruptions.

4.5 ORGANIZATIONS

In any large metropolitan area such as New York City, organizations play a key role in the content of their response to emergency situations. Organizations have been isolated as a major impact category for several reasons. First, they all have certain responsibilities that insure the economic functioning of the community and safety and well-being of individuals who perform various social activities in that community. In a region like New York City, the services provided by these organizations become even more heavily depended upon. Second, many organizations contain charters or mandates which direct their functions during and after an emergency or crisis situation. Some organizations are directed from within (i.e., Board of Directors) while others are mechanisms or tools by which elected officials implement authority and change (e.g., the New York State Division of Criminal Justice Services is controlled by the Governor). These regulated institutions are often directed to review their activities and recommend procedural changes after the crisis, based on difficulties encountered during the crisis. Third, organizations as an aggregate component in the economic market place, may be more sensitive to economic losses (indirectly or directly) incurred by a prolonged power outage. Finally, organizations are a focal point for data collection because of their responsibilities.

As a first task, we therefore identified as many organizations as possible that would have been directly or indirectly affected by the blackout. Directors of these agencies were then contacted and interviews were arranged. The level of analysis was dependent on the nature of the data these organizations had collected. Some, as mentioned earlier, were required to submit formal and comprehensive studies on the specific problems faced during the blackout (i.e., New York Power Pool, Greater New York Hospital Association). The following questions were asked during each interview:

- What were the primary responsibilities of the organization?
- What were the major problems encountered by each (direct and indirect) during and after the blackout?

- What studies were conducted in response to the blackout?
- What recommendations and permanent changes were proposed or implemented after the blackout?

The last question is particularly necessary because procedural changes made within the institution reflect indirect and long-term economic and social costs implemented to avoid future blackouts (e.g., personnel must be trained and this requires time and money). It is interesting to note how many agencies have either developed new emergency "blackout plans" or updated old ones. Several agencies did develop emergency plans and backup systems after the 1965 blackout but deficiencies were revealed during the 1977 blackout. For example, the Federal Aviation Administration (FAA) and the Federal Communications Commission (FCC) developed emergency power systems for their critical facilities after the 1965 Northeast power outage. These systems were implemented during the 1977 outage but problems were revealed. Wire services were hindered because of inadequate auxiliary power according to the FCC, and sufficient emergency services were not available according to the FAA. The level of response (whether it be new planning measures or investments in auxiliary power systems) are a significant indicator of sensitivities to value of reliability.

It should be noted that though Consolidated Edison is not included in the tables which follow, this is not to imply that they were not impacted as an organization. They suffered losses also as a result of the blackout and their specific responses to these losses are examined in detail as a case study in Section 5.3.

The following table (4-7) summarizes the data collected from the major organizations in New York City which relate to recommendations and procedures implemented or under implementation as a result (direct or indirect) of the 1977 power failure.

TABLE 4-7

ORGANIZATIONAL IMPACTS

ORGANIZATION	PRIMARY RESPONSIBILITIES	PROBLEMS ENCOUNTERED	STUDIES CONDUCTED	RECOMMENDATIONS AND CHANGES MADE
American Red Cross	1. Emergency planning organization. 2. Coordinated their efforts with NYC's mayor's emergency task force	1. Provided first-aid to commuters detained at Penn and Grand Central Stations 2. Relocated 2,500 civilians displaced by fire 3. Total expenditures: $7,000 4. Total number of volunteers: 120	None	None
New York City Police Department	1. Emergency response organization 2. Maintain law and order	1. Had to respond to a total of 70,680 "911"-emergency calls 2. Made 2,931 arrests 3. Total number of police force on-duty: 17,411 4. Overtime payments: $4.3M 5. 436 injuries	None	1. Modifications in procedures for off-duty members reporting to duty 2. The processing of large numbers of prisoners needs to be re-evaluated
New York City Fire Department	1. Emergency response organization 2. Response to fire alarms 3. Response to elevator and subway failures 4. Provide emergency power to critical users; health care facilities and handicapped private citizens 5. Control and extinguishment of fires 6. Maintain public health and safety	1. Had to respond to 3,900 requests for aid 2. There were 1,037 fires to extinguish 3. Coordination of returning firemen to their stations 4. Lack of utilities, rest areas and nourishment 5. 80 injuries 6. Total number of firemen and officers: 7,427 7. Emergency power systems exist only in new stations 8. Single alarms: 2,724 Multiple alarms: 14 9. Recall of firemen off-duty 10. Telephone communications were hampered 11. Overtime costs and equipment damage: $.5M 12. Provided portable generators to hospitals and private citizens with life-support systems 13. Fuel shortages due to electrical pump failures 14. Equipment shortages 15. Illegally opened hydrants had to be closed 16. Chaotic traffic conditions 17. Water supply	1. Studies of present emergency procedures and their adequacy are being assessed at this time 2. Questionnaire on activities during emergency and types of responses sent to all stations by department commissioner 3. Report issued October 31, 1977 4. Contingency plans for a 4-day power failure are being developed	1. Red Cross must supply food to firemen at central locations during major emergencies. This new plan has been approved 2. All emergency plans must have flexibility, mobility and control to make optimum use of limited resources
New York City Department of Health	1. Public Health and Safety 2. Maintain safety of perishable foods 3. Waste disposal and sanitation 4. Maintain uncontaminated water supplies 5. Maintain medical facilities, preventive medicine	1. Medical facilities were forced to shut down due to the lack of auxiliary power 2. Maintained surveillance over affected areas to insure adequate and safe food and water supplies 3. Sanitary patrols were organized for one week after the blackout 4. Large amounts of garbage, refuse and spoiled foods had to be disposed of. Services of 200 neighborhood paid workers were used for the clean-up operation 5. Since untreated sewage was dumped into the surrounding bay, notices were posted on recreational beaches prohibiting use 6. Water supply was only a slight problem since most apartment buildings have roof tanks with 24-48 hour storage capacity	1. Routine evaluation of DOH's activities during any emergency 2. No specific blackout study was conducted	1. Improvements made in the DOH master emergency plan, focused on communication within the agency
Federal Communications Commission	1. All major communications services 2. Emergency broadcast services-warning information 3. Oversee the functions of: a. major networks b. radio stations c. common carriers d. wire services	1. For the networks, air time loss ranged from 25 seconds to 7 minutes 2. Auxiliary power systems were used and proved adequate for networks and radio stations 3. Implemented the emergency power system (TV and radio) which was developed after the 1965 NE blackout 4. For the radio stations, minor loss of air time resulted while switching to emergency generators 5. Wire services hindered because of inadequate auxiliary power. Loss of power: 12-19 hours. Could not send activation notices to broadcast station 6. New York City emergency information system--Defense Line 1000--activation was delayed 7. Telephone communication heavily used. 80 million calls were made during the blackout	1. "Effect of the July 13-14, 1977 New York City Area Power Failure on Communications", November 1977 Questionnaires sent to the following stations and networks: ABC, CBS, NBC, WABC, WCBS, WNBC, WOR, AP, UPI Services involved in gathering, assimilation and distribution of emergency information were analyzed.	1. Networks will review their emergency operating procedures, convert their generators from fossil fuel to natural gas and will upgrade emergency power systems 2. Improvements will be made in all areas 3. Defense Line 1000 should be activated immediately with appropriate personnel on hand to disseminate accurate information 4. Ability of the wire services to function adequately during an emergency must be improved. They are now making plans to remedy their situation 5. Greater effort needs to be made in informing local and state officials of the availability of EBS for local use.

TABLE 4-7 (CONT.)

ORGANIZATION	PRIMARY RESPONSIBILITIES	PROBLEMS ENCOUNTERED	STUDIES CONDUCTED	RECOMMENDATIONS AND CHANGES MADE
State Office of Court Administration	1. The prompt arraignment of all defendants in the city after cases have been filed	1. Overtime payments: $50,000 2. Additional arraignment parts had to be organized to handle the workload 3. Criminal case histories and fingerprints could not be transmitted from Albany 4. Total cases docketed in the criminal court between 9:30 a.m., July 14-3:00 a.m., July 19: 4,694	1. Press Release concerning courts reaction to the added caseload caused by the blackout, July 21, 1977	1. Revised emergency plans based on experiences
New York City Criminal Justice Agency	1. Private non-profit corporation 2. Assumed the functions formerly carried out by the pretrial services agency of the Vera Institute of Justice 3. Interviewing defendants after arrests 4. Make release recommendations to the courts before arraignment 5. Notify released defendants of their court-related obligations 6. Criminal justice system research	1. Had to interview over 3,000 people arrested during blackout 2. Made bail recommendations on all defendants based on community ties 3. Inadequate lighting made interviews difficult 4. There was no systematic information on the nature of each arrest	1. "A Demographic Profile of Defendants arrested in the New York City Blackout: A Preliminary Report", August, 1977	1. Future plan for mass arrests is needed 2. Sub-borough breakdown of the defendants arrested is needed
New York State Division of Criminal Justice Services	1. State agency controlled by the Governor 2. Oversee the state criminal justice system 3. Emergency response agency 4. Protection of civil liberties of those charged with criminal offenses 5. Provide swift and certain justice to those found guilty of crimes	1. Total criminal case load costs: $1M 2. Lacked emergency plan 3. Communication and coordination of services between city and state agencies 4. Facsimile machines did not function 5. Serious overcrowding in pre-arraignment detention facilities 6. Delays in arraignment 7. Court and correction facilities were without power 8. Custody and movement of prisoners 9. Detention facilities lacked adequate food, sanitation and health services 10. 62% of all defendants arrested during blackout waited 3 or more days to be arraigned	1. "The Report of the Select Committee on Criminal Justice Emergency Preparedness", October 31, 1977 2. "Grant Application for $1M to Cover Criminal Case Load", submitted by Crime Control Planning Board 3. "Emergency Communication and Coordination Center", grant application, NYSDCJS	1. Emergency preparedness communication center should be developed 2. Direct telephone links with city agencies, state officials and news media are needed 3. Auxiliary power for emergencies of several days duration is needed in critical areas (detention, correction and courthouse areas) 4. An emergency plan for every city in New York State is needed (special attention to mass arrests)
New York Power Pool	1. Comprised of 7 private utilities and the Power Authority of the State of New York 2. Coordinates operation of electric systems so that reliability of service is increased and capital costs are reduced 3. Monitors flows over transmission lines 4. Coordinates the purchase and sale of power within the state 5. Maintains direct computer ties with each utility 6. Coordinates transmission planning and construction 7. Not an enforcement agency	1. The terminology used to communicate critical information between operators was subject to misinterpretation 2. Reserve pick-up porgram would only respone to loss of generation and could not evaluate transmission limits rapidly 3. Responses of member systems to emergency situations needed coordination 4. Senior Pool Dispatcher's concentration was diverted by requests for status information by adjacent pools 5. Data concerning system status was often unclear and unobtainable 6. The NYPP generation reserve schedules and pick-up times were not strictly adhered to	1. "The Electric System Disturbance of July 13, 1977", April, 1978	1. System Protection Subcommittee has been established to make rules and recommendations for future emergencies 2. Audit Spinning-Reserve Policy has been revised 3. Updating of distribution factors has been shortened from 10 minutes to 2 minutes 4. Automatic economic dispatch will be suspended if a system loses a transmission line, until new distribution factors are assessed 5. Audible alarms have been installed at the New York Power Pool (NYPP) Control Center to indicate changes in breaker status 6. Communication procedures have been improved 7. Formal training program for system dispatches should be established

TABLE 4-7 (CONT.)

ORGANIZATION	PRIMARY RESPONSIBILITIES	PROBLEMS ENCOUNTERED	STUDIES CONDUCTED	RECOMMENDATIONS AND CHANGES MADE
New York City Health and Hospital Corporation	1. Represents 17 city owned or affiliated public hospitals	1. Emergency generators used until power was restored 2. Switching problems which inhibited the distribution of available power 3. Failure to support important services, (x-ray, laboratory 4. Lack of refrigeration in: • food storage areas • blood banks • morgue areas • specimen storage areas 5. Elevators did not have back-up power 6. Air-conditioning in critical areas (ICU's, OR's, etc.) 7. Wall outlets failed 8. Microscopes, centrifuges inoperable 9. Lack of power for an internal alarm system 10. Telephone call director lights did not function 11. Shortages: • flashlights • extension cords • batteries • dry ice • linens • fresh milk • disposables • water • sterile supplies 12. Security 13. Emergency rooms were overburdened-- total visits: 5,244 admissions: 805 14. Emergency calls: 517 15. Staffing shortages 16. Communication problems 17. Total costs: $1.5M	1. "Blackout Report", Submitted to Corporation President, July 27, 1977	1. Pretesting programs for auxiliary power must be made more rigorous 2. X-ray equipment, laboratory services, elevators, air-conditioning all need back-up power systems 3. Need for power to operate life maintenance equipment and devices of people who are not hospital patients 4. Education programs for handicapped citizens needed 5. Corporation Command Post is needed to improve communication between facilities • links with emergency medical service • links with mayor's office 6. Up-to-date lists of key personnel 7. Revision of Disaster Plans needed
Port Authority of New York and New Jersey	1. Agency which builds and operates transportation facilities between New York and New Jersey 2. Operates regional airports in New York and New Jersey 3. Law enforcement division 4. Maintains safety of all patrons and employees 5. Security of property 6. Owns 26 transportation facilities	1. All transportation facilities were forced to switch to emergency power which had been installed after the 1965 blackout 2. All New York airports were ordered closed at 9:57 p.m. 3. At Kennedy: • 15,000 passengers were detained • parking lot gates would not open • field lights and emergency landing instruments were powered by auxiliary power • operations postponed until 5:34 a.m., July 14 4. LaGuardia: • 200 passengers were detained 5. 32 aircraft diverted from New York airports to Newark airport 6. Marine terminals: • at Brooklyn piers, constant surveillance was maintained • passenger ship terminal used emergency generators 7. Port Authority Trans-Hudson: • operated on New Jersey power • traffic dropped from 148,000 to 37,000 8. Terminals: • operations conducted on a normal basis via emergency power • many sought refuge in bus terminals • New York truck terminal was closed. 9. Tunnels and bridges: • operated on power supplied by New Jersey 10. 200 additional police officers were used	1. Review session on events which took place during power outage 2. "The Port Authority and the Blackout of 1977", issued January 25, 1978	1. No significant recommendations or changes were made 2. Changes made after the 1965 NE Blackout proved to be adequate • new on-site generation facilities • re-wiring of transportation centers

TABLE 4-7 (CONT.)

ORGANIZATION	PRIMARY RESPONSIBILITIES	PROBLEMS ENCOUNTERED	STUDIES CONDUCTED	RECOMMENDATIONS AND CHANGES MADE
Federal Aviation Administration, Eastern Region	1. Airports 2. Airway facilities 3. Flight standards 4. Air traffic services 5. Air transport security	1. Airway facilities • 28 standby engine generator facilities became operational with minimum delays and were fully maintained • all carrier terminals were without lighting • "dark areas" surrounded the airports • baggage handling apparatus and telescoping ramps were inoperative • operations at Kennedy and LaGuardia were affected • sufficient emergency services were not available 2. Air traffic services • approximately 30 aircraft diverted to Newark Airport • total Newark airline operations increased from 51 to 106 between 9 00 p.m. and 12:00 a.m., July 13 • Westchester Airport airline operations decreased from 10-15 to 7 between 10:00 p.m. and 12:00 a.m., July 13. Airport was closed for 16 minutes	1. Only press releases from each division were issued. No overall studies were conducted	1. Airway facilities • after the 1965 NE Blackout, which left the NYC airports "stunned", major precautionary measures had been taken to insure continuous airport operation during a power failure. These measures included the purchase of 22 new standby engine generators located at strategic airport facilities and frequent testing and maintenance of the equipment. These measures resulted in the proper functioning of emergency power for radar, communications and navigational aids in critical facilities at LaGuardia and Kennedy during the entire blackout period • requested the Port Authority to upgrade their standby power facilities
Westchester County Office of Disaster and Emergency Services	1. Protect health and safety of citizenry 2. Provide disaster relief and emergency services to 18 towns, 22 villages, and 6 cities 3. Control of the Emergency Operating Center which is used by the following agencies: • Parkway Police • Department of Public Works • Health Department • Department of Transportation • Department of Environmental Facilities • Department of Social Services	1. Damages due to looting and food spoilage: $.25M 2. Other costs generated by blackout: $188,000 (protective services, public facilities, overtime, etc.) 3. Arrests: 20 Stores Looted: 43 4. Emergency generators did not function immediately 5. Difficulties in alerting the public 6. Doors to fire houses were electrically run, hence would not operate because of insufficient emergency power	1. Only internal assessment studies have been conducted	1. New training programs on how to operate backup power systems have been established 2. Updating of all alert procedures and the Emergency Operating Center 3. New Disaster Task Force procedures instituted 4. Emergency generators in the County Office Building, County Jail and Parkway Police have been modernized 5. Agreement has been made with Consolidated Edison that notification of the causes of all power failures will be made to the Emergency Operating Center. Prior agreement stated that notification was to be made only if there was a nuclear accident at the generating plant.

TABLE 4-7 (CONT.)

ORGANIZATION	PRIMARY RESPONSIBILITIES	PROBLEMS ENCOUNTERED	STUDIES CONDUCTED	RECOMMENDATIONS AND CHANGES MADE
New York State Public Service Commission	1. Public oversight of the reliability, planning and adequacy of the state bulk power transmission system 2. Regulatory agency which enforces the Public Service Law, which gives the Commission broad, general power over the activities of all private utilities. 3. Review of all transmission plans 4. Regulates each utility's operations and transmission systems 5. Orders management and operations audits 6. Investigative agency	Causes of system collapse: 1. facilities were out of service 2. planning and design deficiencies 3. equipment failure 4. operation without an adequate safety margin 5. lack of coordination and direction in meeting emergencies 6. inability to maintain the isolated system	1. "Events Leading to the Con Ed Blackout of July 13, 1977", Reports I and II. To the Governor 2. "State of New York Investigation of the New York City Blackout-July 13-14, 1977", Norman Clapp. Report III 3. Case 27302-"Proceeding on Motion of the Commission Concerning the Reliability of the Power Supply in the Service Territory of Con Ed", February 1978	1. Automatic call-up of in-city generation following loss of transmission or generation 2. Maintenance of in-city generating reserves available to respond to transmission losses 3. Limitation of automatic reductions in in-city generation under economic dispatch 4. Prompt return of key facilities to service 5. More rigorous design criteria for Con Ed's transmission facilities 6. Stricter safety margins on imports in New York City 7. Strengthened protective equipment maintenance and testing procedures 8. Improved manual reclosing capability 9. Improved cooperation in meeting system emergencies 10. Standards for right-of-way maintenance 11. Standards for operator training and qualifications 12. Continuing public review and inspection of procedures and practices of the New York utilities 13. Single entity be established to oversee the operations of the bulk power system in New York, independent of the utilities 14. Request for additional manpower to improve regulation over utilities has been made by the Commission
Greater New York Hospital Association	1. Represents 66 voluntary, community owned private hospitals 2. Represents 19 non-profit nursing homes	1. Overheating of generator units. 2. Delays in putting units into service 3. Transfer switches and automatic start-up 4. Emergency rooms were overburdened 5. Many hospitals did not have a blackout plan 6. Insufficient extension cords and flashlights 7. Not enough battery powered lights 8. Telephone call director lights did not function	1. "Report to Greater New York Hospital Association on the Blackout of July 13-14, 1977 as Prepared by a Sub-Committee of the Hospital Engineering Society of Greater New York", November 1, 1977 2. "Shedding Light on Hospital Blackout Procedures; A Special Report", December 9, 1977	1. "Fail Safe" written blackout emergency plan is needed for individual hospital use 2. Prepare continuing education program for administrators and engineers so that latest emergency power code requirements will be understood 3. Emergency generators must be tested on a regular and systematic basis 4. Improvements in generator room ventilation needed 5. Automatic transfer battery lighting systems are needed for all critical areas in the hospital 6. Review availability of extension cords and flashlights 7. Written elevator emergency evacuation procedure is needed 8. Emergency electrical outlets should be clearly marked 9. Emergency generators should be on a written, formal, preventive maintenance program 10. All emergency generator systems should have an adjustable timer with a bypass to delay retransfer from the generator back to normal supply

TABLE 4-7 (CONT.)

ORGANIZATION	PRIMARY RESPONSIBILITIES	PROBLEMS ENCOUNTERED	STUDIES CONDUCTED	RECOMMENDATIONS AND CHANGES MADE
New York City Mayor's Office	1. Emergency response organiza-organization 2. Organized a special commission to conduct an independent investigation of the causes of the NYC power failure 3. Conducted an examination of the federal, state and local regulatory framework under which Consolidated Edison operates 4. Organized the Emergency Aid Commission to facilitate the intake and processing of applications for aid by merchants whose stores had been burned or looted during the blackout 5. Organized a public meeting to raise funds for emergency aid from the private sector. Total raised: $3M.	1. A total of 2,123 applications for emergency aid had to be processed 2. Qualifications for aid had to be assessed 3. Emergency Task Force was organized by the Mayor to coordinate relief efforts	1. "The Special Commission of Inquiry Into Energy Failures", December 1, 1977	1. Recommendations in the following areas were made to the agencies responsible for improving system reliability • 3 new members to Con Ed's Board of Trustees, should be appointed by the Governor, Mayor and County Executive of Westchester • New York State Public Service Commission should establish performance standards and economic sanctions which affect stockholders • New York State Public Service Commission should have jurisdiction over the Power Pool • New York State Public Service Commission should order Con Ed to implement specific necessary recommendations • FERC should exercise its authority to the fullest extent so that reliable interstate electric service is insured
Metropolitan Transportation Authority[1]	1. New York State agency which is responsible for the operation of New York commuter rail and bus lines 2. Triborough Bridge and Tunnel Authority--connects various parts of the city 3. Power is supplied by Con Ed and LILCO 4. Long Island Railroad 5. Each operating agency has their own police force	1. Total losses due to outage: $9.3M-revenue loss, damages and overtime 2. New capital equipment costs to insure against massive disruptions: $11M-(estimate) 3. Total trains operating: 213 Trains which did not arrive at stations or emergency exists before power failed: 7 4. Emergency exit evacuation problems were most severe for train stuck on Manhattan Bridge 5. Drainage pumps lost power, thus when service was re-flooding and short-circuiting resulted 6. Fuel pumps-bus 7. Not enough emergency lighting and power	1. "Report of the New York City Transit Authority relating to the NYC Electric Power Blackout, July 13-14, 1977", draft report, August 16, 1977	1. All emergency procedures were reviewed 2. Additional emergency power equipment and pumps were recommended 3. Emergency lighting and fuel handling facilities for the bus depots (total=20). 4. Requested a separate feed from Consolidated Edison, Inc. 5. Auxiliary power is needed to improve • lighting • communications • batteries
Human Resources Administration[2]	1. Largest city agency 2. Operates on Federal Health, Education and Welfare Department funds 3. Coordinates and maintains all major social services in New York City 4. Emergency assistance program	1. Problem areas: • what services were delayed because of the power failure? • which services were irretrievably lost? • what were the blackout generated service needs?	1. "Assessing the Impact of the July, 1977 Blackout on HRA's Clientele: Preliminary Ideas and Questions", March 10, 1978	None, specific problems are being defined and assessed at this time

[1]Source: Conversation with Dr. Raskin (Engineering Department) of MTA on May 1, 1978.
[2]See Section 5.3 for a more complete analysis of this agency and problems encountered during and after the blackout.

5. CASE STUDIES

The characterization of a blackout and its effects is useful in helping to better understand the intrinsic value of electricity to the customer, i.e., what the real worth of electricity is as measured by the costs and inconveniences incurred due to interruptions of critical activities and services. A key difficulty in assessing the worth of electricity to different end-use customers in the past has been the absence of data to support theoretical socioeconomic constructs. A number of existing studies attempt to derive a cost per kW or kWh unserved, but the resulting figures vary widely. The case studies reported in this chapter provide an additional data point on how some key services and activities were affected by the 25-hour power failure. The case studies were chosen to reflect both the importance of the interrupted service, and to illustrate the nature of the impact data available. We consider in this chapter the impacts on public services, small businesses and Consolidated Edison.

5.1 PUBLIC SERVICES

5.1.1 Public Health

Some of the most critical activities affected by the July 1977 New York City blackout, were those in hospitals and other health care facilities in particular, the effects of a prolonged power failure on patient care and emergency room activities.

The majority of the New York City hospitals fall into two fundamental categories: (1) private hospitals and health care facilities or (2) public hospitals and clinics. The former category is composed of 66 hospitals and 19 non-profit nursing homes. These facilities are collectively represented by the Greater New York Hospital Association (GNYHA). The latter group, composed of 17 large public hospitals, is represented by the NYC Health and Hospital Corporation (NYCHHC). The impacts discussed here are based largely on surveys (32,26) undertaken by these two organizations.

Virtually all municipal and private hospitals have some form of power interruption contingency plans, as well as emergency back-up systems that are designed to operate in case of a power failure. Whereas all hospitals had emergency power systems for the most critical activities such as operating rooms, intensive care facilities, and emergency rooms, only slightly more than half of the GNYHA (private) member facilities had formal contingency plans for dealing with a power crisis.[1] Difficulties with the back-up power systems coupled with the inability of many hospital staff to report to work emphasized the inadequacies of the hospital contingency plans in many cases.

Direct Impacts

Throughout the course of the 1977 blackout, all hospital emergency power systems operated.[2] The GNYHA survey indicates that in most hospitals, these emergency power systems were sufficient for at least 24 hours. However, the survey indicated several fundamental technical problems with these systems:

- Delays in bringing emergency generating units on line
- Overheating of emergency generators
- Transfer switches for connecting loads to emergency circuits were sometimes inoperable.

The recommendations subsequently issued by the GNYHA and the NYCHHC concerning upgrading of hospital emergency power systems were made in response to these problems. Perhaps more important than the operation of the emergency power system itself, however, are the activities that these emergency power systems are designed to maintain. The health care activities generally supplied by emergency power are listed in Table 5-1. Particularly important are the activities that were not maintained by emergency power in some facilities. Most notable were x-ray rooms, elevators, nurse call systems, air conditioning in emergency and operating rooms, medical gas and fire alarms, and premature nurseries. In one facility, some important areas such as x-ray rooms were not supported by emergency power, while some low priority areas such as a coffee shop or offices were supported.

[1]Actually this one-half figure is based on a survey of GHNYHA member hospitals to which fifty-five of the total eighty-five members responded.
[2]The only exception was Bellevue Hospital.

TABLE 5-1

ACTIVITIES SUPPORTED BY EMERGENCY POWER

Item	Percentage of Total Facilities[1] Supported	Not Supported	Not Applicable
Operating rooms	83	0	17
Delivery rooms	63	0	37
Intensive care units	81	0	19
Emergency rooms	84	0	16
X-ray room[2]	77	7	6
Elevator[2]	96	4	0
Nurse call system	88	10	2
Air conditioning for items 1 and 2	54	30	16
Medical gas alarms	82	4	14
Fire alarm	96	4	0
Blood bank	86	0	14
Boiler plant	81	0	19
Premature nursery	58	3	39

[1]Based on a sample of 52 facilities surveyed by GNYHA.
[2]At least one facility.

Several important hospital operations were hampered as a result of key activities not supported by emergency power. The NYCHHC survey cited the following significant inadequacies:

- Lack of refrigeration in food storage areas, blood banks pharmacies, morgue areas, and specimen storage areas[1]
- Lab areas (microscopes and centrifuges)
- Multi-unit telephone (key sets) were useless for incoming calls since call director lights were inoperable. This hampered communication within, to and from hospitals.

Finally, the NYCHHC survey found that only 13 of those hospitals responding to their questionnaire maintained battery powered units for emergency operations in critical areas of the hospital. The areas considered most critical for battery powered back-up systems were the following:

- Catheterization units
- Pacemaker implant areas
- Special procedure rooms
- Emergency rooms[2]
- Main power panelboard
- Boiler room
- Generator spaces.

Only one hospital, Bellevue, was required to operate using battery powered units since its main emergency power system was inoperable.

Indirect Impacts

A number of inconveniences and disruptions of important services occurred in the hospitals because of staffing shortages and the inadequacy of the implementation of contingency plans. The contingency plans actually implemented at most hospitals were formulated ad hoc and not in accordance with previously developed plans. This can be generally attributed to one of

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[1] Particularly sensitive to the duration of the power failure.

[2] Most emergency rooms were equipped with battery units.

the following: (1) non-existence of a "blackout" contingency plan, (2) staff unfamiliarity with the emergency plan, even if one did exist, or (3) inability to carry out the developed plan because it assumed circumstances that were not appropriate, (availability of staff, etc.).

The GNYHA blackout report indicated that 28 of those institutions surveyed had a blackout contingency plan, 25 did not. Only 22 of the respondents tested their emergency power system under actual blackout conditions (i.e., tripping the main power switch), although almost all respondents did test their emergency generating equipment regularly.

The shortage of hospital staff was a fundamental reason why many hospitals that had blackout plans could not effectively implement them. The staffing shortage problem turned out to be a major problem for many hospitals, during the midnight to 8 a.m. shift. A number of specific circumstances are worth mentioning. The NYCHHC report cited significant shortages of supplies at many hospitals. Whereas some of these shortages can be attributed to increased patient load (the looting victims), another important source of shortages can be traced back to the staff shortage. In particular, the NYCHHC reported that in some instances only department heads possessed keys to supply rooms or storage closets. If these department heads were absent, supplies were unavailable until they reported to work. As a result, the shortages cited the most were the following:

- Flashlights and other battery powered lights
- Batteries
- Extension cords for access to emergency power circuits
- Sterile supplies
- Disposables.

These shortages could have become critical had the blackout been of longer duration.

The patient loads in emergency and delivery rooms were much higher than normal but the NYCHHC reported that at no time during the emergency was there a significant backlog. However, communications presented severe problems. One of the problems was mentioned earlier--the unlighted telephone key sets. Another was that in hospitals where radio bases were located, radio equipment did not have easy access to emergency power circuits. Radio mechanics were able to make appropriate adjustments in equipment configuration and through ad hoc switching arrangements, gained access to emergency circuits within one hour.

Security in hospitals appeared not to be a major problem during the blackout according to the NYCHHC report. The standard procedure to close all entrances to the hospital except the emergency rooms was enforced. Several minor breaches were reported in the large public hospitals.

The long-term impacts of the 1977 blackout on hospitals in NYC center around recommendations issued by the NYCHHC and GNYHA organizations, some of which are currently being carried out.[1] The following areas were addressed by both organizations:

Formalized Maintenance and Testing Programs: It was recommended that a regular formal testing program be established for all hospital emergency power systems. The tests should be made under full emergency load and, where possible, under actual blackout conditions. However, the NYCHHC identified a tradeoff between patient risk and blackout testing in some cases.

Maintenance programs should be written, formal and supervised. They should also include regular assessment of emergency load requirements.

Emergency power circuits and transfer switches should be carefully designed to provide power to all critical hospital activities. The requirements for emergency power systems in New York City hospitals are established by five separate agencies: (1) Joint Commission on Accreditation of Hospitals,

[1]See Table 4-7.

(2) New York State Department of Health, (3) New York City Bureau of Gas and Electricity, (4) National Fire Protection Agency, and (5) the U.S. Department of Health, Education and Welfare. Some hospitals in the GNYHA survey were not certain whether their emergency systems were in compliance with these established standards. It was recommended that these power system requirements be standardized and adhered to by all hospital establishments.

Formal Established Blackout Plans: It was recommended that standardized blackout plans be adopted by all institutions, personnel be familiar with these plans, and that the plans be regularly exercised.

Economic Costs

The dollar costs to hospital and health care facilities appear to be significant. At this time only the estimated total cost to public hospitals was available. This is summarized in the next table. A more detailed account is given in the NYCHHC report.

Estimated Excess Costs Due to the 1977 Blackout: Health and Hospitals Corporation

Overtime to Hospital Staff	$ 431,550
Overtime to Affiliated Staff	129,600
Net Compensatory Time Equivalent Costs	431,550
Supplies, Operation of Generators, etc.	134,246
Lost Revenue (Closed Clinics)	365,000
TOTAL	$1,491,946

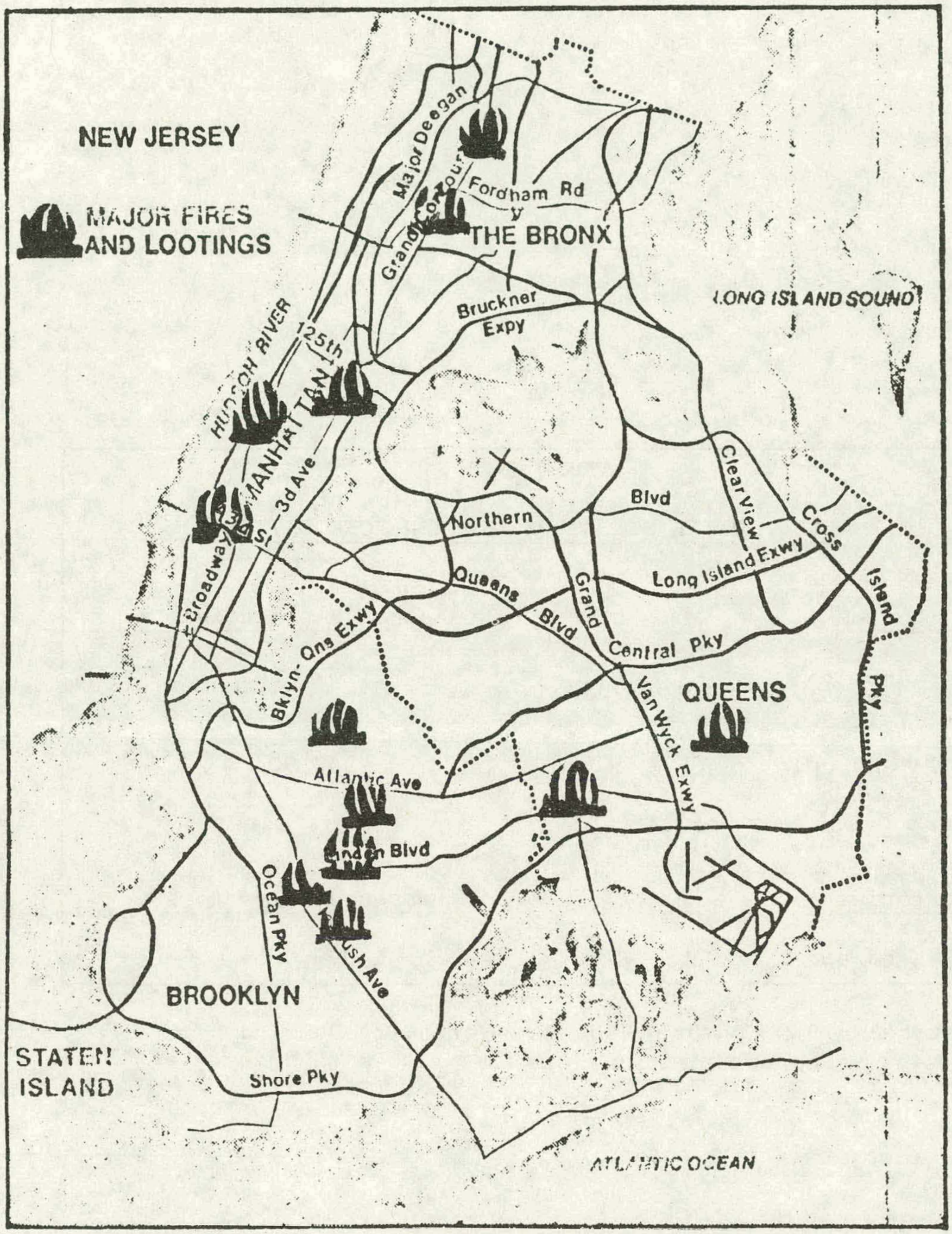
The long-term economic costs to hospitals will be those incurred by upgrading existing emergency power systems, modifying them where necessary so that they can service the most important loads, constructing and implementing carefully planned blackout emergency procedures for all hospital facilities, and finally, emergency power system maintenance programs recommended by the NYCHHC and the GNYHA. All of these costs are at this point unestimable.

5.1.2 Fire Protection

The role of the fire department is always critical during periods of crisis and disaster. The blackout was no exception. In addition to fire protection activities, the fire department is responsible for the evacuation of subways and elevators, alarms and emergency calls, and supplying back-up power to health care facilities and handicapped citizens. During the period of the blackout, there were a total of 1037 fires which were primarily a result of arson. These were located in commercial buildings, supermarkets, appliance and clothing stores. They were started by looters and arsonists on lower floors and due to the age, height and density of the buildings spread quickly. The number of alarms totaled 2780 compared to a normal average of 1274 during the 25-hour period. This rapid increase in the number of alarms coupled with an abnormal number of large-scale fires, had to be handled by a fire force substantially reduced in strength because of limited overall resources (See Figure 5.1).

In a report submitted to the New York State Public Service Commission in 1971 (33), in response to procedures of electric corporations for load shedding in times of emergency, the following statement was issued:

> There are high rise buildings in virtually every sector of Consolidated Edison's service area. These present a number of special problems. Probably the most serious is failure of a building elevator. This has two possible adverse consequences. First, the elevator may be in use at the time of the power failure, in which case passengers would be trapped until power is restored or a rescue team with auxiliary power equipment arrives. Second, the unavailability of the elevator may impede evacuation of the building, particularly with regard to very tall buildings and/or inform occupants. A related problem is failure of corridor and stairwell lights. Even during daylight hours this could pose a problem in the case of corridors or stairwells lacking windows. Obvious safety problems are presented if occupants must stumble around darkened corridors and stairwells during evacuation. (See Table 5-2)



Map shows where fires were heaviest during the blackout's looting and arson spree: On Jamaica Av. and along Linden Blvd. in Queens; on Utica Av., Flatbush Av., Eastern Pkwy. and Broadway in Brooklyn; on Third Av. in Harlem; along Seventh and Eighth Avs. near 43d St. and on the Upper West Side in Manhattan, and on the Grand Concourse and along Tremont Av. in The Bronx.

Source: The New York Post, July 15, 1977, pg. 17.

FIGURE 5.1 MAJOR FIRES DURING BLACKOUT

TABLE 5-2

RESIDENTIAL STRUCTURES IN NEW YORK CITY

Stories	Number of Residential Units
4-6	1,107,854
7-12	235,488
13 and up	357,904

Structures with Stories	Passenger Elevators
4 and up	1,090,085

Source: 1970 Census, SMSA, New York City Housing Characteristics.

The most serious problem, according to the New York City Fire Department, was the need to respond to over 3900 emergency calls. People trapped in elevators, senior citizens who could not find their way in the darkened stairwells, and individuals dependent on life support equipment (there are over 1100 such people according to Consolidated Edison) all needed immediate attention.

The increase in alarms was briefly mentioned above. It is necessary to explain the implications of this in greater detail. In 1971 the New York City Fire Department issued standardized procedures for operation during electrical power failures.[1] According to this report, the following would operate on an emergency power system in the event of an outage.

- Voice alarm system
- Department telephone system
- Department radio system
- Primary bell circuit
- Street boxes
- Public telephone system
- Emergency power in hospitals and nursing homes.

It was stressed that all private fire alarm and fire protection systems would probably be out of service. The reason for this is that water flow signals would not be sent to the private firm alarm companies in the absence of power in the customer's buildings. Property protected by automatic fire alarm systems (rate of rise and heat actuated) would be without that service. It was stated that delayed alarms and severe fire conditions should be anticipated. Finally, buildings dependent on fire pumps to maintain pressure on the upper floors, would be without protection on those floors if auxiliary power was unavailable.

The following four items were discussed with respect to water supply:

- Standpipe and sprinkler systems in buildings up to six stories high would remain operable because of their direct connection to city water mains.

[1] "All Units Circular #213, Procedures for Electrical Power Failure", New York City Fire Department, February 18, 1971.

- Standpipe and sprinkler systems in taller buildings would remain operable as long as water remained in the pressure or gravity tanks. This would be quickly depleted under fire conditions.
- Booster pumps would not function (except in hospitals, and in nursing homes where auxiliary power is maintained).
- The Coney Island high pressure pump would be out of service. However, fire boats could be used to augment the system.

As the blackout continued, and the situation began to stabilize, there were other problems which the fire fighting forces were faced with. First, a pattern of repeated incendiary fires occurred in the same buildings despite extinguishment and this continued until the structure was completely demolished. There were many injuries due to the abnormal fire activity and exhaustion was common due to the extreme temperature and humidity. In addition, food supplies and rest areas were not readily available. Equipment was also in short supply due to the great demand for service. Fuel supplies were quickly depleted because of electrical pump failures.

When the power returned, thousands of buildings, especially those used for commercial activity, presented fire hazards and structural hazards due to rubbish, debris and partial structural collapse. These had to be inspected by units, and either destroyed or boarded up to prevent injuries and deaths.

The Fire Department regard problems such as the lack of utilities (i.e., water), the prevision of portable generators for lung respirators in homes, and fatigue, to be of paramount importance in the event of future blackouts of longer duration. Emergency and pre-fire plans are presently being reviewed for adequacy and contingency plans for a 4 day power failure are being developed.[1]

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[1]See Table 4-7 for an analysis of the changes and recommendations made in the NYC Fire Department.

5.1.3 Police Protection

During the July 13-14 power failure, the Police Department was in great demand throughout New York City. Calls to the police emergency number "911", which indicate efforts by individuals and households to seek help, totaled 70,680. Normal traffic in a 24-hour period is usually about 18,500. There was also the looting and property damage which intensified the police response. A total of 1809 incidents of property damage as a result of looting and vandalism was reported. The police force in New York City, which is the largest in the United States, totals 24,960; 18,858 were considered available for emergency duty. Excluded from that available contingent were 6102 members on vacation, sick or military leave. Hence, 17,411 reported for duty compared to a normal tour of duty of about 4700. Arrests totaled 2931 and injuries sustained by the police force totaled 436. The Assistant Chief of Operations, however, made this statement dated April 6, 1978:

> "The impact of the 1977 Blackout upon the Police Department was basically one of a financial nature... The impact on its services was greatly diminished by the preparation of contingency plans formulated after the 1965 Blackout. These plans are continually updated and coordinated with other city services by our Office of Civil Preparedness. It is anticipated that certain modifications will be made in our procedures for off-duty members reporting to duty and for processing of large numbers of prisoners."

Of all the emergency calls received, the Police Department estimate that only 10-20% required a radio car run. Thus, the additional calls were for accident and non-emergency services. The non-emergency calls involved blackout-related needs. People in high rise buildings were trapped in elevators or could not get down the stairs, handicapped and elderly needed assistance, and ambulances were called for people who depend on life maintenance equipment. Early in the blackout, an enormous number of people called to find out what was happening or simply for information about public transport. During the power failure, the role of the police expanded considerably--their non-criminal related services becoming relatively more significant.

5.1.4 Sewage Disposal

"Electric power is required in two aspects of sewage disposal: treatment and pumping. If there is a lack of power at a treatment plant, raw sewage will by-pass the treatment process and flow into the waterways as unprocessed sewage. If there is a lack of power at a pumping station, sewage will not flow and ultimately will back up at the lowest points of input (usually basements in low-lying areas). Both consequences must be avoided for reasons of public health and environmental protection."(33)

This assessment was presented to the State of New York Public Service Commission in order that procedures for load shedding by electric utilities be thoroughly investigated. According to this study which was done in 1971, many of the sewage treatment plants and pumping stations in Westchester County and New York City, had standby power supplies to accommodate electrical interruptions of short durations. There were a total of 12 sewage treatment plants and 33 sewage pumping stations in Westchester County and a total of 25 pumping stations located in Brooklyn, Queens and Staten Island, which had been reviewed by Consolidated Edison at that time (1971). The basic conclusion was that raw sewage would have to be dumped into the surrounding waters if power interruptions were of long duration.

This conclusion was supported by the events which took place during the 1977 power outage. According to the New York City Department of Health, untreated sewage flowed continuously into the harbors. The environmental, health and ecological impacts indeed are significant. Signs were posted on all neighboring beaches prohibiting use to bathers and swimmers. But to date, no studies investigating these impacts have been conducted. It is not known how many people were affected and what the real impacts were.

5.1.5 Water Supply

The New York City water supply system relies primarily on gravity to move water from its reservoirs, through the City's mains and to maintain pressure throughout the system. Some power is required, however, at pumping stations and reservoirs. In addition to the importance of adequate water supply for fire-fighting purposes, loss of pressure in water mains may permit contaminants to seep into the water supply. Hospitals also cannot perform certain vital services without water. During the recent power failure, the lack of water was not a significant problem for several reasons. Most apartment buildings have roof tanks with a storage capacity of 24-48 hours. Since New York City maintains gravity pressure of 60 feet, water will flow naturally up 5 or 6 stories. High-rise buildings must use electric pumps to provide adequate pressure on upper floors. Residents were forced to retrieve water from neighbors if they lived above the 7th floor. For senior citizens this was of course more difficult and hazardous than for others. If the power failure had occurred during working hours, more people would have been subjected to such inconveniences. This would especially be the case in downtown Manhattan.

5.1.6 Transportation

According to the New York Metropolitan Transportation Authority (MTA) there are on the average, 7.5 million transit trips taken during each weekday. The Authority is responsible for all commuter trains, subways and public buses which operate in and out of the City. This represents about 80% of all public transit operations. According to the MTA, a total of 5.8 million transit trips were directly affected because of the power failure. This does not include the millions of automobile trips which were indirectly hampered bacause of the failure of traffic control devices, and inoperable gasoline pumps. Sixty percent of all trips taken in New York City involve the use of private vehicles, thus without the use of a questionnaire or interview directed at these riders it is impossible to calculate the true extent of inconvenience. It is possible, however, to give a brief analysis of changes in transportation patterns due to the power failure. The table below provides a base line for understanding normal transportation patterns in the New York City area.

	ANNUAL RAPID TRANSIT RIDES* (in thousands)				
	NYCTA[1]	PATH[2]	SIRTOA[3]	Newark[4]	Total
1975	1,053,933	38,340	4,400	2,409	1,099,082

[1]New York City Transit Authority
[2]Port Authority Trans-Hudson Corporation
[3]Staten Island Rapid Transit Operating Authority
[4]Newark Subway

*Source: Regional Plan Association, "The State of the Region 1977", November 1977.

Rapid Transit

The subway system constitutes a principal form of transportation within the Metropolitan area. It is used by people engaged in work, family and leisure-related activities. It is integrated into the bus and automobile systems, especially for those entering and leaving the inner city. The majority of passengers who arrive in New York City by bus, commuter train or automobile, transfer to the city subway system for the completion of their trip. The dependence of New Yorkers commuting to work on these various modes is shown below.

MEANS OF TRANSPORTATION TO WORK* (in percents, in thousands)									
	New York Counties					Suburban Counties			
	Bronx	Kings	New York	Queens	Staten Island	Nassau	Suffolk	West-chester	Rock-land
Auto (%)	25	15	10	25	52	72	84	63	83
Bus or Train (%)	65	74	65	65	33	19	8	23	6
Other (%)	10	11	25	9	15	9	4	14	11
Total ($s)	(512)	(939)	(686)	(859)	(110)	(559)	(383)	(366)	(83)

*Source: 1970 Census Tract of Population and Housing Characteristics, N. Y. SMSA.

Approximately 74% of the trips to work are facilitated by bus or train in Brooklyn and 65% among Manhattan, Queens, and Bronx households. These forms of transport are less significant in the suburban counties where the automobile accounts for some three-quarters of the home to work connections. Hence, during the power outage, the immediate response to shift to automobiles was most likely made by the suburban commuters. The next table shows the proportion of households having at least one automobile available.

AUTOMOBILES AVAILABLE BY HOUSEHOLD*
(in percents, in thousands)

	New York Counties					Suburban Counties			
	Bronx	Kings	New York	Queens	Staten Island	Nassau	Suffolk	West-chester	Rock-land
1 or More (%)	62	59	21	64	80	92	93	83	90
None (%)	38	41	79	17	20	8	7	17	10
Total ($s)	(497)	(876)	(686)	(691)	(85)	(401)	(296)	(281)	(61)

*Source: 1970 Census Tract of Population and Housing Characteristics, N. Y. SMSA.

The proportion of automobiles available by household is as low as 21% in Manhattan and as high as 80% in Staten Island. In the suburban counties, almost all households have cars. The exceptions would tend to be for the elderly and handicapped.

On a typical workday, the Long Island Railroad brings 101,300 passengers into the City, 79,100 of whom arrive at Pennsylvania Station. Conrail carries 72,000 from the suburban counties in northern New Jersey and New York into the central business district. All of these trains depend on electricity within New York City, hence, were inoperable during the blackout. Motor transport was the only means of travelling in the city and into the city beyond walking distance. An examination of the motor transport passing selected crossings into and out of New York City suggest a trend to shift the center of activity away from the affected area.

COMPARISON OF TRAFFIC FOR JULY 7 AND JULY 14 AT SIX PORT AUTHORITY CROSSINGS East Bound Traffic			
Crossings	July 7	July 14	% Difference
Holland Tunnel	31,780	24,203	-23.8
Lincoln Tunnel	49,717	28,371	-42.9
George Washington Bridge	114,560	95,676	-16.4
Hudson River Subtotal	196,057	148,250	-24.4
Bayonne Bridge	5,625	6,297	+11.9
Gothals Bridge	24,344	25,838	+ 6.1
Outerbridge Crossing	14,817	17,012	+14.8
Staten Island Subtotal	44,786	49,147	+ 9.7
ALL CROSSINGS	240,843	197,397	-18.0

All motor approaches from New Jersey directly into New York City (Holland, Lincoln and George Washington Crossings) experienced a decrease in traffic on the day of the blackout. In fact, the drop was as high as 43% for the Lincoln Tunnel leading into mid-town Manhattan. In contrast, movement between New Jersey and Staten Island increased. These would be mostly Staten Island residents who work in New Jersey but they do not compromise a significant component dependent upon transfer to trains. Traffic volume, however, does not reflect the social activity which these commuters are engaged in. We do not know whether these people were engaged in work, pleasure or family-related activities on the day of the blackout. We can get some sense of that by partitioning the traffic according to the various means of transport. This is shown below for the Lincoln and Goethals crossings.

COMPARISON OF BUS, TRUCK AND CAR TRAFFIC AT TWO CROSSINGS ON JULY 7 AND 14 East Bound Traffic				
LINCOLN TUNNEL	Buses	Trucks	Cars	Total
July 7	3,957	4,645	41,115	49,717
July 14	3,204	1,815	23,352	28,371
GOETHALS BRIDGE				
July 7	139	1,445	22,760	24,344
July 14	84	1,158	24,596	25,838

The significant decrease was in passenger traffic going to Manhattan. The number of buses decreased only slightly, as the Port Authority reports that these buses had fewer passengers. With business activity at a virtual standstill, the trips to work must have been minimal. The number of trucks declined even more. Thus, the delivery of goods to and from Manhattan was sharply curtailed. This includes food supplies, merchandise and materials used for the various manufacturing and retail industries in the city. The lack of refrigeration for foods, elevators to assist in deliveries, and workers, rendered mercantile activities virtually useless. One can begin to picture the chain of events which takes place when electricity is not available. Though trucks, cars and buses were able to function other factors like the loss of refrigeration and elevators inhibited their usefulness. It is important to keep in mind, however, the fact that fuel would have been a problem if the power outage was of sufficient duration due to the inoperation of fuel pumps.

The impacts were less at Goethals Bridge between New Jersey and Staten Island. Bus and truck traffic declined somewhat, but there was an increase in cars. At the Staten Island bridges, emergency generators automatically provided sufficient power to operate essential services. The switchover at the Outerbridge Crossing failed at the onset of the emergency but was repaired within a half hour.

The Port Authority Trans-Hudson operations (which automatically draw full power from one side of the Hudson in the event of a power failure on the other) were normal, except for the fact that the decision was made to increase the headway between trains from 3 to 6 minutes because of the decline in passengers. On a normal day, 148,000 people enter Manhattan on these trains. On the 14th, traffic was reduced to 37,000 people. This was not a result of a transit failure, though the lack of a subway connection would have discouraged many riders. Basically, there was no place for people to go when they arrived in Manhattan unless they were met by a car, taxi or bus.

The following report on operations at terminals was provided by the New York City Port Authority.

> Operations at the Port Authority Bus Terminal were conducted on a normal basis, though the use of emergency generators and additional temporary lighting was provided where necessary, particularly

in the ticketing areas. Hundreds of visitors and theatergoers, unable to get home, and community residents afraid of crime in dark areas stayed through the night of July 13th under Port Authority police protection. All tours of duty were extended, enabling the police, operations, maintenance and sanitation units to function at normal efficiency.

At the George Washington Bridge Bus Station, emergency power available from New Jersey provided sufficient illumination. After the last bus departure, just before 2:00 a.m., July 14, all entrances but one were closed. The Fort Washington Avenue end of the building was kept open as a public service to shelter distressed area residents. Traffic was light on July 14th. The stations's consumer service tenants, closed when the blackout occurred, began reopening after noon on Thursday. All services were restored at 4:15 p.m.

At the New York Truck Terminal, maintenance personnel arranged emergency lighting and fire protection. Tenants, closed down and released all employees except security personnel. Normal operations were resumed Friday, July 15th.

Marine Terminals

The Brooklyn piers and Passenger Ship Terminal were affected by the blackout. Constant surveillance had to be maintained by the Port Authority security personnel to protect the facilities. At the Passenger Ship Terminal, the ocean liner, Queen Elizabeth 2, was scheduled to arrive with 1400 passengers early in the morning of July 14th. Emergency power generators were borrowed from the Lincoln Tunnel and Port Newark and alternate means of discharging the passengers were arranged. Passengers with hand luggage began leaving the ship at 9:30 a.m. and baggage and automobiles from the hold were unloaded by 12:00 p.m. People were forced to use taxis for any travel beyond the terminal's premises. Power returned at 2:00 p.m. and normal embarkation procedures were put back into operation at that time.

Aviation

Disturbance in air travel was minor in comparison with that of the rail transit and motor traffic systems. The power failed at Kennedy International Aiport at the end of the peak departure hours, with many aircraft loaded with passengers and prepared for takeoff. Some carriers discharged their passengers immediately into the terminals. Others kept passengers temporarily in the relative comfort of their aircraft. During the night, some 15,000 people were stranded after service was terminated at 9:57 p.m. Mostly, these were arrivals awaiting transportation from the airport or departures awaiting scheduled flights which were forced to be cancelled. A total of 108 airline operations were scheduled between 9:00 p.m. and midnight on July 13, and of those, 37 operated before the airport was closed.

Emergency generators automatically supplied the terminals with light and power. Other generators powered field lights and landing instrument lights to enable an aircraft to land in an emergency. Although some power returned temporarily at 3:30 a.m. on July 14, full operations were postponed until daybreak. The first authorized takeoff was at 5:34 a.m.

At LaGuardia Airport, the impacts of the power failure were relatively minor. This was primarily because the airport had been scheduled to be closed from 12:00 a.m. to 7:00 a.m., July 14th, for nighttime repair and construction work on the runways. Therefore, a total of 60 airline operations were scheduled between 9:00 p.m. and midnight, July 13th, and of those, 39 had operated before the airport was closed. When the blackout occurred, only three aircraft were loaded and ready for takeoff. They were guided back to the ramp by surface vehicles. Two-hundred passengers were detailed at the airport. Departure from the parking lots was a major problem since the gates and ticketing were electrically operated. As at Kennedy, parking area employees computed parking fees manually. This resulted in severe traffic jams and long delays.

Newark International Airport readily handled 32 diverted aircraft from Kennedy and LaGuardia Airports. Three departure aircraft were delayed for 15 minutes because of severe weather conditions. There were no reported arrival delays. There were a total of 51 airline operations scheduled between 9:00 p.m. and midnight, July 13. The total number of airport operations during this period came to 106.[1] (See table below)

ANNUAL AIR TRIPS TO AND FROM PORT AUTHORITY AIRPORTS (in thousands)	
1975	41,874*

*Trips to and from the Port Authority airports represents total revenue passenger traffic on domestic and overseas flights at J. F. Kennedy, La Guardia, and Newark Airports only.
Source: Regional Plan Association, "The State of the Region 1977", November 1977.

Taxis were available for most of those commuters terminating at Kennedy, LaGuardia and Newark Airports, as they were throughout the city, at least during the early hours of the blackout. When the blackout occurred, most of the fleet cabs were already fully gassed and in repair, though maneuvering through the crowded streets without traffic signals was a problem. The number of available taxis declined, however, as the blackout progressed because most of the gasoline pumps were electrically activated.[2]

5.2 SMALL BUSINESSES

5.2.1 Introduction

The most visible impact of the blackout was the looting and damaging of small businesses in New York City. Much has been speculated and theorized about the causes of the looting and its relationship to the blackout. Not unnoticed was the fact that the 1965 blackout in the northeast had little or no criminal activity associated with it, although much has changed in the intervening years. Without attempting to forecast the possibility of future criminal activity given a similar set of circumstances, it is important to note that society and its economic and social activities

[1] See Table 4-7 for a more complete analysis of the problems associated with the Federal Aviation Administration and Westchester Airport.
[2] This information was provided by the Taxi News Service in New York City.

have become increasingly dependent upon a reliable supply of electricity. Unanticipated future power shortages of significant duration will undoubtedly provide the opportunity for some members of society to vent their anger at the social system. Of even greater interest will be the responses of individuals and organizations to electricity shortages that occur more frequently whether of short or lengthy duration.

5.2.2 Damages

The Small Business Administration (SBA) performed a survey of those businesses damaged and/or looted during the blackout. According to this survey, damages totaled approximately 155 million dollars (See Table below). This loss is close to 50% of the known economic costs associated with the blackout.

ESTIMATED TOTAL DAMAGE

Type[1]	Amount
Major Damage	$ 75,000,000
Minor Damage	80,400,000
TOTAL	$155,400,000

[1]Major damage was defined in terms of structural damage and inventory losses by retailers and wholesalers as a result of the looting and riots. Minor damage was defined as the losses directly associated with no electrical power, (e.g., food spoilage).

Source: Small Business Administration, correspondence file.

Other NYC agencies such as the City Office of Economic Development, Emergency Aid Commission, and the Department of City Planning also surveyed the aftermath of the looting and played a part in the loan and other reconstruction programs designed to assist small businesses to reopen as soon as possible. The material in this section is largely taken from these surveys.

5.2.3 Aid Programs

During the week of July 18th, meetings were held at the request of the Mayor to determine the appropriate response to the victims of the looting and severe destruction. It was decided that a special emergency relief fund would be established to aid the many small businesses and the aid would be administered by a special task force called the "Emergency Aid Commission (EAC)." The EAC was organized by the Mayor and its members were chosen from various city agencies. The city contributed a total of $1 million of public money to the emergency aid program. From the private sector, a total of $2,028,286 was pledged. More than 2600 individuals, corporations or foundations contributed to this fund. The Emergency Aid Commission received a total of 2339 applications for aid from the total of approximately 2500 businesses damaged.[1] Of those, 419 did <u>not</u> meet the necessary criteria and 1920 were approved by the Commission. The next table provides a breakdown by borough of the applications received and dollar values of the assistance package.

<u>BOROUGH SUMMARY OF SMALL BUSINESSES DAMAGED DURING THE BLACKOUT</u>

Borough	Applications Approved	Dollar Value of Grants
Manhattan	373	$ 539,177
Bronx	487	739,721
Brooklyn	941	1,425,822
Queens	96	149,225
Staten Island	23	34,905
TOTAL	1,920	$2,888,850

On the basis of a completed application, site and bank verifications, a recommendation was made to the members of the EAC for approval or disapproval. Each merchant, if approved, was entitled to a $300 personal assistance grant and a $1,500 reestablishment grant. By November, 1977, $382,890 had been approved for the cash assistance grant and $2,505,960 for the business re-establishment grant. A total of 1771 businesses were eligible for the re-establishment grant based on the type of damages reported to the Commission. It is noteworthy that the number of businesses that suffered losses greater than $100,000 totaled 129. (See following tables)

DAMAGES REPORTED BY BUSINESSES APPROVED FOR REESTABLISHMENT GRANTS	Number of Businesses
Less than $1,000	77
$1,000 to $2,999	233
$3,000 to $4,999	159
$5,000 to $9,999	262
$10,000 to $24,999	361
$25,000 to $49,999	289
$50,000 to $99,999	215
Greater than $100,000	129
No information	46
TOTAL	1,771*

TOTAL DOLLAR DAMAGE BY BOROUGH

Borough	Dollar Value of Damages Reported
Manhattan	$10,833,979
Bronx	15,146,772
Brooklyn	34,625,534
Queens	987,613
Staten Island	161,165
TOTAL	$61,755,063

Businesses were also asked during the application process how long it would take for them to open if they received the grants. The merchants who qualified for the reestablishment grant were optimistic at the time they filed the application; 1125 businesses stated that they would reopen immediately. The Commission accepted applications over the course of one month and estimates were tabulated throughout that period. The next table lists these responses provided by the 1771 businesses.

ESTIMATED PLANS FOR REOPENING

Time Span	Number of Businesses
Open as of date of filing	1,125
Plan to reopen in 2 weeks or less	368
Plan to reopen in 3 to 6 weeks	94
Plan to reopen in more than 6 weeks	2
No information	182
TOTAL	1,771*

Applicants for the reestablishment grant were also asked if their losses were covered by insurance. The 1069 businesses listed on the final line in the next table, indicated that insurance did not cover their immediate needs, but did not specify whether they expected to receive compensation some time in the future.

[1]This total of 2500 businesses damaged differs from the Planning Commission estimate because the latter survey did not attempt to calculate inventory loss, only exterior physical damage. It was estimated that 80% of the stores that were looted or burned during the blackout applied for aid.

INSURANCE COVERAGE	Number of Businesses
Damage covered by insurance	103
Damage partially covered	146
Losses not covered	317
Extent of coverage not yet determined	136
Immediate business expenses not covered by insurance, insurance coverage unknown	1,069
TOTAL	1,771*

The number of merchants who reported that none of their damages were covered totaled 317. There were many different types of businesses which received reconstruction grants from the EAC. The next table lists the major commercial activities that were assisted.

TYPES OF BUSINESSES ASSISTED	
Apparel	254
Grocery	278
Liquor store	96
Furniture store	112
Pharmacy	57
Jewelry	83
Bar and restaurant	117
Appliance	41
Florist	8
Hardware	35
Auto service stations	69
Personal services (e.g., dry cleaners and barber shop)	105
TV, records and stereos	77
Other (pawn shops, accounting offices, etc.)	436
No information	3
TOTAL	1,771*

The Small Business Administration played an active role in assisting the small businesses that were affected by the blackout by providing loans. As of December 31, 1977, the SBA accepted 1941 applications for loans totaling approximately $78 million. 1905 were received from businesses ($77.5M) and 36 from homes ($.3M). The next table summarizes the type and amount of loans that have been disbursed to date.

LOANS WHICH HAVE BEEN DISBURSED

	Type of Loan	Applicants	Dollar Amount
Fully Disbursed Loans	Businesses	830	$15,516,100
	Homes	12	30,400
Partially Disbursed Loans	Businesses	1,296	23,338,400
	Homes	12	30,400
TOTAL		2,150	$38,915,700

Source: Small Business Administration, correspondence file.

The combined responses of the Federal, State and Local agencies and private sector played a key role in reconstructing the destroyed small businesses and their owner's morale. The fact that nearly 80% of those businesses affected have indeed reopened should not suggest, however, that there are no long-term impacts. According to the New York City Property Insurance Underwriting Association, many shopkeepers may not be able to buy adequate amounts of property insurance coverage in the future because of rate increases. In a New York Post article, dated February 15, 1978, the following account was recorded:

> "Brooklyn's Bushwick business district is one blackout victim that never recovered. Business in other areas hit by the looters and arsonists have been recovered, but not in Bushwick, where as many as 90% of the stores hit have not reopened. The reason is that landlords and storekeepers feel police protection is inadequate and insurance rates too high."

5.3 ELECTRIC UTILITY IMPACTS -- CONSOLIDATED EDISON

Consolidated Edison was affected by the events on July 13-14 perhaps as seriously as any other economic sector in New York City. In addition to significant economic costs, the utility suffered further erosion of credibility in the community at large. Direct impacts to the utility included costs associated with lost revenue and personnel overtime, restoration investments, and changes in planning and operating procedures. The following sections provide a brief overview of each of these areas.

5.3.1 Economic Costs

In this section, we make no distinction between direct and indirect costs because of the unique position of the utility as supplier of the electricity, however, the costs incurred by the utility directly related to the event included revenue losses, personnel overtime, system restoration and equipment damage. These and other actions taken to prevent another occurrence were estimated by Consolidated Edison to have cost the company approximately $10 million.(34) A breakdown of this cost is as follows:

• Revenue lost as a direct result of the blackout	
Electric	$5,470,000
Steam	230,000
• Personnel overtime costs for system restoration	375,000
• Subsystem maintenance costs (substation equipment damage)	$1,285,000
• System operations (Storm Watch Program and increased staffing of Energy Control Center)	120,000
• Gas turbines (around-the-clock staffing and improved black-start capability)	555,000
• Other substation costs (communication changes and temporary emergency generators)	365,000
• Miscellaneous expenditures	1,000,000
TOTAL	$9,400,000

This estimate does not include the cost of increasing in-city generation as now required by the Public Service Commission (35) during extreme weather conditions which is estimated to cost approximately $2 million per year.

5.3.2 Potential Losses

In addition to the economic costs incurred as a result of the blackout, Consolidated Edison is potentially liable for damage suits brought against it as a result of the blackout. These include:

- Three class action suits: $10 billion filed by the Manhattan borough President. $10 million, filed by a private citizen; and one for an unspecified amount.
- Twenty-four Supreme Court suits totaling $19,800,000 for perishable merchandise, injury and loss of business.
- Thirteen Civil Court suits totaling $58,600 for perishable merchandise, injury and loss of wages.
- Seventy-eight Small Claims Court suits totaling $26,300.

According to Consolidated Edison, their liability is limited to proof of "gross negligence, willful and wanton acts." These suits have not been settled hence the actual loss to Consolidated Edison cannot be evaluated at this time. It does not appear that the magnitude of these claims is related to the actual costs incurred by different sectors as determined in this study.

5.3.3 New Capital Investments

As a direct result of the blackout, Consolidated Edison plans to invest $65 million in permanent capital improvements for the prevention of other system failures. The majority of these new investments are for transmission facilities. The items comprising this investment program are listed below.(1)

• A new 345kv transmission circuit between Buchanan and Millwood substations	$37.0M
• Separate the transmission facilities in the proximity of Millwood substation	5.0M
• Separate the transmission facilities south of Millwood substation by obtaining and building upon a new right-of-way	4.0M
• Improve transmission tower grounding where tests reveal inadequate lightning protection	1.1M
• Improve the load shedding equipment on the Consolidated Edison system. This includes improvements to the existing equipment and controls as well as the installation of a new tie line	2.6M
• Improve the protective relaying system. These changes will permit better generating unit operation during system disturbances and also will permit faster restoration of substation equipment	1.2M

• Install new control equipment in the Energy Control Center. This includes better indicators, metering and supervisory control equipment	0.8M
• Install all diesel generators at major substations to provide emergency power for critical facilities (e.g., hospitals)	8.0M
• Install a new Operator Training Simulator for training system operators.	5.0M
Total Capital Expenditures	$64.7M

Consolidated Edison has also given high priority to the establishment of increased interconnections with neighboring utilities to improve the integrity of its transmission system.

5.3.4 Procedural Changes

In addition to the capital investment program, Consolidated Edison has instituted a number of procedural changes in order to decrease the possibility of a system disturbance. The following is a summary of the procedural changes that have been or are being implemented. In general, the costs of these changes have not been reported.

- Increase the number of periodic simulations of black-start at major generating stations
- Perform tests on all generating units to assure their availability for fast load pick-up
- Improve the reporting of problems affecting the capability of area generators
- Improve communications among New York Power Pool member systems
- Conduct measurements of transmission tower grounding every five years
- Modify system operating procedures for improved system voltage control during emergency conditions
- Increase the extent and frequency of power system dynamic performance studies
- Perform generator field tests to assure that the data used in system studies is correct
- Modify operating procedures for loading gas turbine generators in the event of system emergency conditions

- Increase staffing of the Energy Control Center
- Improve the training and testing of system operators
- Test emergency generators monthly
- Implement new procedures for system restoration.

6. APPROACHES TO DETERMINING THE VALUE OF RELIABILITY

6.1 INTRODUCTION

One motivation for examining the costs and other impacts that resulted from the New York City blackout was to see if it was possible to extrapolate from this information base to a more general characterization of the "value of reliability", i.e., the value of uninterrupted service to the customers. We have examined three basic components of this real cost--economic, social, and organizational. This section of the report now considers how to relate these components to an overall value of reliability. Simple integration of these different components is obviously not possible because of the inability to quantify social costs in any meaningful way. Furthermore, in many instances data is not available or would be very time-consuming to gather. Yet the New York City blackout demonstrates the importance of incorporating both economic and non-economic costs into a framework for determining the value of reliability.

Further complications arise in trying to develop a suitable measure of the value of reliability because the cost to a particular sector might vary considerably depending upon such circumstances as blackout duration, time of day, week, and season.

Therefore, any methodology used to assess the value of reliability should exhibit at least the following characteristics:

- It should disaggregate end-use sectors
- It should be sensitive to time and seasonal considerations
- It should explicitly include the duration of the blackout
- It should be capable of representing both economic and social costs.

Before considering an outline of a methodology which has all the desirable characteristics, we first briefly examine and compare several other approaches found in the literature which attempt to estimate the economic costs of an outage. For purposes of comparison, we have also included the present results for economic losses. It should be noted that none of the approaches reviewed exhibit all the characteristics cited above.

6.2 ALTERNATIVE APPROACHES

All past and current approaches to assessment of economic impacts of power failures (reviewed in the course of this study) focus on direct impacts. In general, neither indirect nor social costs are taken into account. The result is generally a cost per unavailable kwh for each class of customers, e.g., industrial, commercial, or residential.

Most of the theoretical approaches to the cost assessment problem fall into the following four basic categories:

- GNP/Kwh ratio measures (Telson (36), Shipley et al (37)
- Wages paid measures (NY EDA (38), Hauugard (39))
- Cost-benefit analysis (NERA (40))
- Models of blackout recovery (Myers et al (41)).

Telson and Shipley et al examine marginal changes in overall system reliability; in both approaches a measure of the value of power system reliability is developed as the ratio of gross product to total electrical energy consumption (although neither approach includes residential consumption in the value of regional production). The basic assumption is that a reduction in electricity consumption will result in a proportionate drop in the value of goods and services produced in the region. Hence the unit cost figure ($/kwh) is multiplied by the total amount of electrical energy not delivered during the blackout to yield an overall cost figure. The problem is, of course, that in most cases production is only delayed during a blackout, unless the blackout is of extended duration. Hence the costs are overestimated. This overestimate, however, may be offset somewhat by the fact that damages to equipment or materials ("off-specification" products) are not included in the assessment. Finally, this approach also has the limitation of not being industry or region specific,[1] i.e., it ignores the wide variation of the GNP/kwh ratios among geographic regions.

Several variants of this approach have been proposed (Gannon (19),

[1]Myers et al (41) discuss this problem in more detail.

Hersing (42), Dickenson (43), Patton (44). The general modification is to divide the ratio of GNP (again non-residential) to non-coincident peak load by an interest rate, which, in effect, measures the cost of the outage as if it were a loss of an investment in a productive capital good that would earn a rate of return over the life of the good. The obvious limitation is assuming the economy is producing only investment goods, no consumer goods. The approach is also not industry specific.

The New York Economic Development Administration and Hauugard both attempt to measure costs in terms of wages paid but not earned during a blackout. This would provide a relative approximation of costs during interruptions of short enough duration not to damage equipment or materials. The problem of delayed production (increased activity following the blackout) is present here as in the GNP/kwh ratio. Myers et al discusses other limitations as well.

Another common procedure (NERA) has been to employ concepts of economic cost-benefit analysis; another is to use the notion of economic opportunity cost. All these methods are not industry specific and, as a result, are only approximations, at best, of the total economic cost of a blackout. Moreover, as mentioned earlier, they address only direct costs.

Perhaps the most comprehensive theoretical approach to economic impact assessment of blackouts to date (again, only direct impacts) in terms of prolonged blackouts, is the formulation presented by Myers et al. In this approach an attempt is made to account for the recovery period following a blackout. The basic model is formulated as follows:

$$C_j = A \alpha_j K_j F_j [1 - (D_j + S_j)] \int_{t_1}^{t_2} r_j (t) \, d t,$$

where $j = 1,2, \ldots, m$ customer classes

α_j = sensitivity to outages of customer class j

K_j = economic loss function for customer class j

F_j = fraction of total customers in affected area that are in class j.

A = fraction of total geographic area without power

D_j = total number of customers in class j affected by the blackout

S_j = number of customers in class j with emergency power supplies

t_1 = time power interruption commences

t_2 = time when 100% power is restored

$r_j(t)$ = system recovery function for customer class j.

The original model was developed for examining the impacts of a blackout resulting from an earthquake. The unique feature of the model is the recovery function $r_j(t)$, which allows one to characterize the recovery of the power system over time. Myers notes that derivation of a suitable $r_j(t)$ is a very complex matter. Indeed this function, as well as many of the other parameters, are difficult to develop under specific blackout conditions. However, the method warrants further study in the application to specific cases, particularly to the problem of effectively estimating costs to areas of limited geographic scope.

6.2.1 Results of Theoretical Approaches

As mentioned earlier, most theoretical model results are expressed in terms of a cost per unavailable kilowatt or kilowatt hour. In addition, these costs are usually only estimated for "generalized" industrial or commercial customers. Table 6-1 compares these estimated costs for various approaches, including the results of the present study for the New York City blackout.

The estimated costs, regardless of the differences of methodologies, exhibit some similarity. The cost per kwh based on the present study is similar to that of Shipley if only the direct impacts are considered. Gannon's cost per kwh for industrial activity is less than our total cost estimate, but his commercial cost per kwh is roughly double our estimate. Our estimates also fall below the Ontario Hydro study[1]. It must be restated that all of the estimated cost figures exclusive of the present work do not deal with prolonged blackouts as was the case for New York City.

TABLE 6-1

COMPARATIVE COST ESTIMATES OF POWER OUTAGES

	Geographic Scope	Estimated Cost	Date
Hauugard[1]	New York State	$2.17 million/hr	1971
NYEDA[1]	NYC	$2.5 million/hr	1971
Shipley[1]	U.S.	$.60/kwh	1971
Telson[1]	New York State	$.33/kwh	1973
NERA[1]	U.S.	$1/kwh	1976
Gannon[3]	U.S.	$2.68/kwh(ind), $7.21/kwh(comm)	1976
Ontario Hydro[2]	Canada	$15/kwh(15min), $91/kw(1 hr)	1977
Present Study[4]	New York City, 1977	$4.11/kwh	1978

[1]As reported in Myers

[2]Ontario Hydro, "Ontario Hydro Survey on Power System Reliability: Viewpoint of Large Users", April, 1977.

[3]P. E. Gannon, "Cost of Interruptions: Economic Evaluation of Reliability", May, 1976.

[4]Direct plus indirect costs divided by estimated kwh sales lost due to the blackout (see Section 4). Disaggregated, direct was $.66/kwh and indirect was $3.45/kwh.

6.3 PROPOSED METHODOLOGY FOR DETERMINING THE VALUE OF RELIABILITY

In this section we attempt to outline a conceptual methodology for relating the expected costs of a power failure to the value of reliability. We hypothesize a generic loss function, L_i for the i^{th} end-use sector as follows:

$$L_i = L_i\ (T, D, S, I, W, A) \qquad i = 1,2, \ldots N \qquad (1)$$

where

L_i = an aggregate loss function for the i^{th} sector

T = time of day

D = duration of the blackout

S = season of the year

I = a level of inconvenience associated with blackout conditions

W = A "portmanteau" variable reflecting weather and other environmental conditions

A = the value placed on activities disrupted.

The function L_i is not the value of reliability. It only indicates the magnitude of the total loss when a blackout occurs given values for the arguments of the function. Reliability deals with the likelihood of a power outage, and the value of reliability is the combination of the expected level of L_i (since the arguments of L_i may take on a wide range of values) with the likelihood of a power failure. Hence, a probability distribution for each sector which can assign weights to all possible outcomes of L_i is necessary. That is to say, one must look at the expected loss which can be represented as follows:

$$L_i \cdot P_i\ (L_i/\theta_i) \qquad i = 1,2, \ldots N \qquad (2)$$

where

P_i is the probability distribution for each i^{th} sector for the outcome of L_i $\quad 0 \leq L_i < \infty$;

θ_i is a vector of parameters describing the shape of P_i

The parameter vector θ_i is expected to be dependent on the sector considered. This may reflect the fact the a power disruption has a greater chance of causing more serious consequences in the public health sector than, say, in the industrial sector. However, as mentioned above, reliability deals with the uncertainty of a power outage (hence the term "loss-of-load probability" by electric utilities to reflect the design reliability of a system). Therefore, Equation 2 must be multiplied by the independent probability of an outage, p_t (LOL), where p_t (LOL) is the probability at any time, t, that the system will suffer a loss of load (LOL). We include the possibility that reliability of a system may deteriorate or improve over time by making p_t (LOL) time-dependent.

The equation is not yet complete. One must take into account the fact that losses and gains in the future are discounted over time. To measure the actuarial value of an expected loss of a blackout, and ultimately the value of reliability, a discount factor $e^{-r_i t}$ is applied to each expected loss at time t and the values are summed over the entire range:

$$\int_0^\infty e^{-r_i t} L_i \; (T, D, S, I, W, A) \; P_i \; (L_i/\theta_i) \; p_t \; (LOL) \; dt \qquad (3)$$

where

r_i = the discount rate for sector i, $\quad i = 1, 2, \ldots N.$

It is claimed that Equation 3 is the value of reliability (VOR) equation for the i^{th} sector. Stated otherwise,

> The value of reliability equals the present value of the expected loss from all future blackouts.

We now consider some of the implications of this equation using three examples. The first case involves an outage at a known time in the future, say t = t*. For a given sector,

$$VOR_i = e^{-r_i t^*} \left[L_i \; (\cdot) \; P_i \; (\cdot) \right] \qquad (4)$$

or the present value of the expected loss since p_{t^*} (LOL) = 1. For all sectors the value of reliability would be,

$$VOR = \sum_{i=1}^{N} VOR_i \qquad (5)$$

Hence, the expected loss from an unanticipated blackout must exceed the expected loss from an anticipated one since for all sectors the value of Equation 5 must exceed that for Equation 4. Now, let us suppose that a major unanticipated blackout occurs, and, for the first time, with vandalism, rioting and looting. We would expect that the probability distribution, P_i (·), would shift to the right by placing larger weights on higher L_i's and lower weights for the low L_i's. The overall impact would be an increase in the value of reliability. Finally, let us look at a residential customer who is transient and expects to leave the territory at time t". Then, for that customer,

$$VOR_j = \int_0^{t''} e^{-r_j t} L_j (\cdot) P_j (\cdot) p_t (\cdot) dt, \quad (6)$$

implies that the j^{th} customer might place less emphasis or devote fewer resources on things which might mitigate the impacts of a blackout, relative to another person who expects to spend the rest of his life in the service territory, i.e., he would integrate his expected loss over an infinite time horizon. (This assumes that for the two customers being compared their discount rate and expected loss are roughly equivalent.)

6.4 ESTIMATING THE VALUE OF RELIABILITY

The equation for value of reliability derived in Section 7.3 is useful in characterizing the relationship between observable events and the value of reliability (VOR). In principle, the values of reliability could be estimated by evaluating the components of Equation 3 in Section 7.3. However, these components are difficult to evaluate and not well defined. It might be possible to estimate the value of reliability by looking instead at activities and transactions which would be undertaken to mitigate or offset the effects of a power outage. This will help approximate the value of reliability.

We posit that the net value of all equipment, fuel, and procedures must be a lower bound of the VOR for any given sector. The "lower bound" is due to a) the sum of the market prices for equipment, fuel and time for creating emergency procedures might exceed the customer's VOR and, assuming rational customer behavior, no expenditure of time or other resources would be made under these conditions. The fact that no expenditure is made does not imply a zero VOR. Thus, the sum of all expenditures might necessarily be less than the VOR for a given sector of end users; b) equipment to supply power during emergency blackouts might not be commercially available to all consumers in all sectors. Indivisibilities exist in commercial equipment such that the optimal or desired equipment, such as a 1-kw generator, is not an available item.

For each sector then, the following data might be valuable for estimating VOR:

- The net value (in current dollars) of all emergency generating equipment inclusive of installation and maintenance costs
- The value of all fuel in stock to run the existing emergency generators at current market prices
- The value of time to create special procedures which go in effect when a blackout occurs, at current wage rates
- The market value of all insurance policies which cover damage due directly or indirectly to blackout conditions
- The current net value of all special equipment to shutdown computer machinery or industrial processes during a power interruption.

The sum of these items in current dollars, then, gives a lower bound for the VOR.

Another approach for estimating VOR might be to survey different customer classes to see what they might be willing to spend on equipment, etc. to avoid a future power interruption of some specified duration. For example, Ontario Hydro conducted a survey on the value of power system reliability to large users (45). In that survey, companies were asked to identify the type of electrical standby equipment to replace electrical supply, its capacity, duration of emergency supply, estimated cost for depreciation and maintenance, and estimated running cost per kwh. Similar questions were posed for emergency non-electrical standby equipment.

A general survey for different types of customers and end-users similar to the Ontario Hydro experiment could be designed and submitted to a randomly selected group within a service territory. For relatively small users such as residential customers, a survey might pose the question: what would you be willing to pay for a device which would generate all your electrical needs during a power interruption? The amount may go from $0 to $100, say, in convenient increments to estimate the value of reliability. These dollar figures could then be compared to personal disposable income in order to measure the share of income that the household is willing to allocate to electrical reliability.

In regard to this study, data are available to estimate the VOR for some sectors, notably the organizations in NYC which devised new procedures to take effect if a blackout should occur. Based on the premise that the value of time is the major cost in developing new procedures, the number of man-hours times the appropriate wage rate (before taxes) for each organization would yield a lower bound to the VOR. If any special equipment was in place or was recently purchased, the cost of those components would be added on to the wage bill.

7. CONCLUSIONS

1. Regarding General Impact Characteristics:

- The impacts of a power failure are in large part determined by the size of the area's population, ethnic diversity, income, housing characteristics, density, economic activities, and employment statistics. New York City, which is unique in terms of both demographic features and its position as the financial capital of the world, experienced substantial costs that are not easily extrapolatable to other regions of the country. Nonetheless, our examination of the NYC power failure has revealed important elements central to any future analysis of the consequences of energy shortages.

- The costs associated with a blackout are also sensitive to the geographic characteristics of the affected area. Areas such as NYC which are characterized by extreme weather conditions (hot, humid summers and cold winters) will be heavily impacted by the loss of electricity for air conditioners and heating systems.

- In high-density areas, like New York City, most travel per capita is done via the public transportation system. A high level of dependence on electrified transport systems results in greater economic and social costs during an extended power failure. Most people during the blackout were unable to report to work and perform productive activities because of the lack of an adequate transportation mode.

Regarding the Impact Classification Scheme:

- The development of an impact classification scheme highlighted an important distinction with respect to impacts resulting from a blackout. Direct impacts, i.e., those impacts resulting from the cessation of electricity such as refrigeration and transportation, are often accompanied by another class of potential costs referred to as indirect. These indirect impacts are unpredictable and reflect adaptations or responses to blackout conditions. The looting and arson is an example of an indirect impact. This distinction is useful because it provides further insight into the determination of the most cost-effective strategy for dealing with electricity shortages and interruptions in the future. It is possible that indirect impacts can be mitigated through improved communications and contingency plans while direct impacts can only be avoided through improvements in reliability standards.

Regarding Economic Impacts:

- Our survey indicated that economic costs attributable to the the blackout either directly or indirectly were in excess of $350 million. This figure, however, is based on a selective and stratified impact assessment and should be regarded as no more than a reasonable lower bound to total costs. The actual cost of the blackout taking into accound both short and long term impacts might substantially exceed our estimate.
- The looting and arson (defined as an indirect impact) accounted for almost one-half of the total economic costs associated with the blackout. This fact supports a basic premise of this report, that the indirect impacts as well as the direct impacts must be considered if a realistic economic and social cost estimate of power outages is to be measured.
- The costs to Consolidated Edison were significant, both in terms of lost revenue, restoration costs and, most importantly, new capital investment programs to upgrade system security. What has not been ascertained is whether other utilities in the country, either voluntarily or involuntarily, are initiating or plan to initiate similar programs.

Regarding Social Impacts:

- The social costs of the blackout, as defined in this study, are difficult to measure. Adaptations to the blackout by people and organizations were significant, particularly in light of the extended duration of the power failure. Levels of inconvenience to individuals as evidenced by changes in macro-indicators of social activities appeared to be substantial. A structured survey of affected individuals will be necessary to accurately document these impacts in any detail.

Regarding Organizational Impacts:

- A number of organizations in New York City have implemented (or are in the process of implementing) new contingency plans and procedures as a result of the blackout. In some cases, new back-up generation systems have been added to facilities. Hospitals, in particular, had difficulty in starting and operating emergency back-up systems and have implemented new testing and maintenance schedules.
- In many cases, of equal or even greater importance than actual economic losses was the loss of credibility suffered by major industrial firms in NYC such as the banking and securities industries. (As an example of this concern, the NYC banking community is now planning to relocate certain computer facilities in New Jersey outside the Con Edison service territory.)

Regarding the Value of Reliability:

- Characterizing the New York City blackout has helped to identify important components, both quantifiable and non-quantifiable, that determine the value of electrical reliability. In previous studies which have attempted to assess the cost of power outages to customers, key factors (e.g., duration of blackout, indirect impacts and time of day) which were significant determinants in the New York City experience, were not taken into account.

- A lower bound on the value of reliability for end-users can be established by estimating the :

  --net-value of all equipment and materials for emergency back-up systems
  --value of time used to develop emergency procedures
  --value of insurance policies purchased to cover damage incurred (directly or indirectly) by power failures.

- A comprehensive methodology for determining the value of reliability is not presently available because of the difficulties in representing the complex losses that result from an extended power failure. A conceptual framework for characterizing these losses has been presented in this study (see Chapter 6). No attempt has been made to estimate the value of reliability using this framework. One approach for demonstrating its appropriateness and validity might be through the use of a survey designed to estimate what different classes of customers would be willing to pay for uninterrupted service.

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APPENDIX A

DOCUMENTATION OF SOCIETAL IMPACTS

This appendix documents a preliminary investigation of the societal impacts and adaptations to the New York City Blackout. The approach taken was to examine available gross data on some key macro-social indicators such as transportation flows, information flows, economic indices, and other important indicators of changes in social activities. A more detailed analysis via primary data collection would be required to document these impacts at the individual level.

The Movement of People and Goods

In examining the flow of people and goods within the affected area, the interruption of subway service is the most significant event. The city subway, the principal form of transportation within the Metropolitan area, moves people from home to work and back and on work, family, and leisure trips. It is integrated into the bus and train and automobile systems, especially for those entering and leaving the city. The majority of passengers arriving by bus and train depots ordinarily transfer to the city subway system for the completion of the trip. The dependence of New Yorkers on these various modes is shown in Table 1.

Table 1

MEANS OF TRANSPORTATION TO WORK*
(in percents, in thousands)

	New York Counties						Suburban Counties			
	SMSA	Bronx	Kings	New York	Queens	Staten Island	Nassau	Suffolk	West-chester	Rockland
Auto	40	25	15	10	25	52	72	84	63	83
Bus or Train	48	65	74	65	65	33	19	08	23	06
Other	12	10	11	25	09	15	09	04	14	11
TOTAL N=	(4497)	(512)	(939)	(686)	(859)	(110)	(559)	(383)	(366)	(83)

*Source: 1970 Census Tract of Population and Housing Characteristics, N.Y. SMSA.

About half of the trips to work in the SMSA are ordinarily made by bus or train. This reaches seventy four percent among Manhattan and sixty five percent among Brooklyn and Queens households. These forms of transport are less significant in the suburban counties where the automobile accounts for some three-quarters of the home-work connections. The option of shifting to autobobiles was most available to the suburban population. Table 2 shows the proportion of households having at least one automobile available.

Table 2

AUTOMOBILES AVAILABLE BY HOUSEHOLD*
(in percents, in thousands)

	New York Counties						Suburban Counties			
	SMSA	Bronx	Kings	New York	Queens	Staten Island	Nassau	Suffolk	Westchester	Rockland
1 or M	55	62	59	21	64	80	92	93	83	90
None	45	38	41	79	17	20	08	07	17	10
TOTAL N=	(3886)	(497)	(876)	(686)	(691)	(85)	(401)	(296)	(281)	(61)

*Source: 1970 Census Tract of Population and Housing Characteristics, N.Y. SMSA.

The proportion is as low as twenty one percent in Manhattan but eighty percent in Staten Island. In the suburban counties, almost all households have cars. The exceptions would tend to be the households of the elderly or in which there is no ablebodied adult. On a typical workday, the Long Island Railroad brings 101,300. passengers into the city, 79,100 of whom arrive at Pennsylvania Station. Conrail carries 72,000 from the suburban counties in northern New Jersey and north of the city. All of these trains rely on electricity within New YOrk City and none ran during the blackout. Motor transport was the only means of moving in the city and into the city beyond walking distance. An examination of the motor transport passing selected crossings into and out of New York City suggests a trend to shift the loci of movement away from the affected area.

Table 3

COMPARISON OF TRAFFIC FOR JULY 7 AND JULY 14 AT
SIX PORT AUTHORITY CROSSINGS

	East Bound Traffic		
	July 7	July 14	% Difference
Holland Tunnel	31,780	24,203	-23.8
Lincoln Tunnel	49,717	28,371	-42.9
George Washington Bridge	114,560	95,676	-16.4
HUDSON RIVER SUBTOTAL	196,057	148,250	-24.4
Bayonne Bridge	5,625	6,297	+11.9
Gothals Bridge	24,344	25,838	+ 6.1
Outerbridge Crossing	14,817	17,012	+14.8
STATEN ISLAND SUBTOTAL	44,786	49,147	+ 9.7
ALL CROSSINGS	240,843	197,397	-18.0

All motor approaches from New Jersey directly into New York City, the Holland and Lincoln Tunnels and the George Washington Bridge, had a decrease in traffic on the day following the blackout. In fact, the drop was as high as forty three percent for the Lincoln Tunnel leading into midtown Manhattan. On the other hand, movement between New Jersey and Staten Island increased. These would be largely Staten Islanders, and others transiting Staten Island, to work in New Jersey. This latter traffic does not have a significant component dependent upon transfer to trains. Knowing only traffic volume, however, we do not know the socially important fact of trip purpose, whether for work, family visit, or produce delivery. We can get some sense of that by partitioning the traffic according to the various means of transport. This is shown in Table 4 for one Staten Island and one Manhattan crossing.

Table 4

COMPARISON OF BUS, TRUCK AND CAR TRAFFIC AT
TWO CROSSINGS FOR JULY 7 AND 14

East Bound Traffic

LINCOLN TUNNEL	Buses	Trucks	Cars	Total
July 7	3,957	4,645	41,115	49,717
July 14	3,204	1,815	23,352	28,371

GOETHALS BRIDGE	Buses	Trucks	Cars	Total
July 7	139	1,445	22,760	24,344
July 14	84	1,158	24,596	25,838

The major drop was in passenger traffic coming into Manhattan. The number of buses decreased slightly, as the Port Authority reports that these buses had fewer passengers. With business activity at a virtual standstill, the trips to work must have been quite small. The number of trucks declined even more. Thus, the delivery of goods in Manhattan and shipment from them was sharply curtailed. This includes foodstuffs, merchandise being delivered to and from stores and materials for and from the various manufacturing industries in the city. Lack of refrigeration for food, the lack of elevators to help with deliveries and, on top of it all, no workers in many plants and stores made the mercantile activity useless. This is not a failure of transportation but of the activities at the transport termini. The impact is less at Goethals Bridge between Staten Island and New Jersey. Bus and truck traffic declined, but more cars moved through. The Path trains, traveling from Hoboken, New Jersey into Manhattan rely on electricity from New Jersey and, therefore, were running, but they, too, experienced a decline in passengers. On a normal day, 148,000 people enter Manhattan on those trains. On the first day of the blackout, traffic was reduced to 37,000 people. Here, again, it is not a transit failure, though for some the lack of a subway connection would discourage people. Basically, there was no place for people to go when they arrived in Manhattan unless they were met by a car or took a taxi or bus.

Disturbance in air travel was minor in comparison with that of the trains and motor traffic. During the night of the blackout, some 15,000 people were stranded at Kennedy Airport after service terminated at 10:00 P.M. Mostly, these were arrivals awaiting transportation from the airport or were due to depart on canceled flights which had been scheduled later than this hour.

Taxis were available for most of those terminating at Kennedy, as they were throughout the city, at least during the early hours of the blackout. Because of the time at which the blackout occurred, most of the fleet cabs were already fully gassed and in repair, though maneuvering without traffic lights was somewhat of a problem. However, since most gasoline pumps are electrically activated, the number of taxis declined as the blackout progressed (information from Taxi News Service).

Changes in transportation patterns away from the center of impact indicate more distance effects of the blackout. People from New York failed to arrive at destinations out of New York City when they depended upon trains originating in the city. The main inter-urban line stopped outside the city, AMTRAK, ran some shuttle trains to Newark, but they estimate that not more than a thousand people used the service. Most of the trains terminated at Newark. Going north, AMTRAK provided buses to New Haven where trains from Boston turned around. Conrail trains serving Trenton, New Brunswick and South Amboy were also denied the New York terminal. Most trains moving on these routes outside of New York City experienced delays up to several hours.

The Flow of Information

Operational Knowledge in the Affected Area

Transportation flow not only indicates the interruption of passengers and goods movement, but of information as well. The New York newspapers were sparse as was the information ordinarily brought personally by travelers. With respect to general information on the blackout conditions, there were, of course, radios. The radio stations were, by and large, able to continue broadcasting on emergency generators. Their transmitters were often outside of the city. Transistor and automobile radios became an important source of information. In this was, people could make judgments about the advisability of trying to get into the city in the morning. The radio information flow on civil disorders in scattered parts of town, may have helped trigger disorders in other areas. While no measure is available on the use of these information channels, a record of telephone service is available.

The New York Bell Telephone Company provides a taped message containing information about current news in the city. This is the "New York Report," available by dialing 999-1234. On a normal twenty-four hour day, some eight to ten thousand calls are received. During the twenty four hours ending Thursday morning, July 15, 859,589 calls were received on this number. In the next twenty four hours, 201,672 calls were received. This is an example of an immediate adaptation to the interruption of the usual information flow and the special information needs generated by the disruption. The increase by about one-third between the first and second days of the blackout may represent a learning curve--more and more people becoming aware of the service. It is also an aspect of the generally increased significance of the telephone under the circumstances. With normal activities interrupted, it becomes important to communicate with those with whom one would ordinarily be in interaction to ascertain the changes in the rules of action. It is also a way of retaining the role relationships in latency when they could not be enacted. Communication between individual households and between households and places of work relied primarily on the telephone. The social role of telephone communication in the situation of action in abeyance is suggested by the volume of telephone traffic. The central office buildings, of which there are seventy four housing the exchanges, were on emergency power. The total telephone traffic of exchanges within New York City is thirty six million calls per day. During the first full day of the blackout, eighty million calls were made. On Friday, with most of the lights back on, forty one million calls were recorded, about thirteen-fourteen percent above a normal day. Since businesses were closed on those days, the greater volume of calls originated in residential offices. Telephone company estimates were that traffic through residential exchanges was up by about three hundred percent most of the first day.

While excess telephone calls, in general, reflect an adapatation to the non-fulfillment of ordinary roles, police emergency calls reflect deviant role behavior and disabilities to which individuals are subject due to the failure of others to function. Calls to the police emergency number, 911, indicate efforts by individuals and households to seek help. Only a small portion of these calls relate to what is ordinarily considered criminal activity. The police are, and are more so in an emergency, a general public service, providing rescue in case of accident, transportation to hospitals and first aid. They often respond as intermediaries between the public and hospitals, the sanitation department, street maintenance, water and sewage services, and the fire department. The log of 911 calls does not differentiate by the social activity for which police are called but by the operational activity in which the police were asked to engage. Generally, normal traffic in the twenty four hour period is 17,700 calls. During the first eight hours after the blackout, 45,000 calls were received. Some impressionistic evidence is available on the action requested by the callers. Supervisors at 911 estimate that normally about forty five percent of the calls require radio car runs. That is, direct police intervention and fifty five percent require transmission of information to other city agencies, calling ambulances, fire fighters and non-emergency services. No exact figures have been tabulated, and we do not know whether the distribution held when the total number of calls increased by over three hundred percent. The police estimate is that only ten to twenty percent of these calls required a radio car run. Thus, the absolute number of police radio car runs remained about constant, and this despite a large force of men on duty during that period. Thus, the additional calls were for accident service and non-emergency. The non-emergency calls involved blackout related events. People in high rise buildings were trapped in elevators or could not get down the stairs, handicapped and elderly needed assistance, ambulances were called for people with kidney problems needing emergency transport to dialysis centers.

Early in the blackout, an enormous number of people, by police estimate, called to find out what was happening or simply for information about public transport, such as people in Staten Island complaining about loss of water pressure and a nursing home asking for a police car to use its battery to start its electric generator. Thus, in the blackout, the role of the police expanded considerably—their non-criminal related services becoming relatively more significant.

The Blackout As Drama in the Affected Area

Information flow assists in the cultural interpretation of the event. Thus, the information given by the radio or by the police and the response of the police are dramatic evidence of the meaning of the event—meanings which individuals take into account in their own actions. The newspapers suggest the ways of interpreting what is happening to a variety of publics. Here, again, the impact is not limited to New York City, but viewed as a morality play by people in other localities. Newspaper coverage followed a pattern. Because of the nature of the event, the first information provided was technical, an explanation of the event in terms of technological malfunction. Interest moved rapidly to the behavior of people responsible for the technology, the individuals high in the corporate structure who set the decision conditions and the operating personnel who make and implement decisions.

The impacts on the city of the blackout then becomes a fascinating tale--the disrupted activities and the adaptations to the disruption.

Victimization by technical and technically related social factors is the first feature. The issue of law and order and the ability of society to maintain order under stress, the role of the political system and of political leaders then come under scrutiny. The unfolding of the drama and the search for antagonists and protagonists, villains and heroes, proceeds. The newspapers used the occasion for advancing whatever cultural analyses of social problems they favored. The interpretations offered at this stage are consistent with the diagnosis that the editorial staff is predisposed toward for any social ills. At an early point, local utility officials in each of the locations declared that the event would not occur there. In assuring the residents that they, indeed, merely are audience to a drama taking place elsewhere. The populations do not accept the dramatic image in its totality but see it as a precursor to events in their own areas. As such, their witnessing through their newspapers develops attitudes toward the utilities and other social actors involved in their own communities. Press reports appearing at the impact center itself provide a frame of reference--the drama as it was constructed by the participants. The July 14th Daily News did not have wide circulation. The story is picked up on the 15th with a series of articles detailing the impact; ten million people without electricity, the looting, the economic costs, the essential services interrupted, and the police and fire departments overwhelmed. The articles shift quite quickly from the technical analysis of the causes of the blackout to article seeking to blame. An article on page 4 reports that four days before the blackout, Consolidated Edison's chairman, Charles Luce, had said, "I can guarantee that the chances of a brownout or a blackout are less than they have been in the last fifteen years, and that the chances are less here than most other cities of the United States."

After this comment, the paper begins to relate social events around the blackout. Mayor Beame is reported trying to use the blackout as an occasion to demonstrate leadership in an election year. An analytic article on the insurance protection for those damaged notes that state law allows that the utility can be sued for only interruption of service as a result of gross negligence of willful misconduct. Service regulations state that when the lights are out for twelve or more hours because of the malfunction of that company's distribution system, residents may claim up to $100 and businesses up to $2000 for losses, but limit the utility's liability to $1,000,000.

The July 16th paper continues the discussion of the economic costs. Serious analyses of the reasons for the social disorder appear, calling for investigations of the looting. Demographic descriptions of the looters are given which supplement the already implied communication that they are black and Hispanic, with the notion that some are on welfare. The political activity of Mayor Beame receives further coverage. The Small Business Administration declares parts of New York a disaster area on the basis of riots or civil disturbances. An editorial questions the competence of Consolidated Edison both in preventing the crisis and keeping the outage limited. By the 17th, Consolidated Edison is reporting plans to prevent future blackouts. The local utility is saying it is unlikely to happen again. One article suggested that privately owned small generators would reduce dependency on Consolidated Edison. The police response is discussed. Officer Codd had ordered that no looters be shot and, thus, bloodshed was avoided. Another editorial complains that the looting ruined what progress the city had made in improving its image as a city of national conventions and tourism. The July 19th edition describes some of the financial aid programs for businesses, such as the Small Business Administration's Emergency Aid Commission, a matter that came in for praise in the next day's editorial. Other articles deal with court backlogs of alleged looters. The July 20th edition describes Carter's plan for aid. The next day's paper wrote critically of the Carter Administration for not providing an adequate plan of relief. Consolidate Edison is subjected to further scrutiny. By the 21st, the Daily News turns to an analysis of the political and economic implications of the blackout. Consolidated Edison would have gone bankrupt had this blackout taken place in 1974 before the purchase of two new power plants and their investment in new equipment. The blackout's implication for the mayoral election was surfacing. Beame and the other candidates scrambled to give an impression of providing leadership. By July 22nd, Carter was reported to have related looting to the unemployment situation. Thus, the local picture was one of blame of utility as a villain, the minorities for having broken ranks and tarnishing the city's image, and the political exploitation of the situation, the local leadership with the exception of the SBA, the federal government was treated as too distant from the problem.

The Blackout As Drama Away From the Affected Area

Newspapers in five cities in various parts of the country were selected. These included the Chicago Tribune, in a midwestern city, but otherwise a large metropolis, much like New York City; the Boston Globe, in another large metropolis, but this time in New England; the Washington Post, in the city most concerned with federal governments; the Des Moines Register, to provide an example of a midwest agricultural center; and the Houston Post, to reflect the mood of a city closely bound to the energy industry. A pattern emerges in all five cities. The news is immediately

The July 14th Chicago Tribune carried a page one headline report on the blackout referring to the breakdowns in communication and transportation problems in hospitals and airports, and presents some technical reasons for the blackout. The report of the social response to the event begins with information on the activities of Mayor Beame and Governor Carey as they try to mobilize for the emergency. While mentioning looting in some areas, this issue of the Chicago Tribune generally reports a festive and cooperative atmosphere. The report includes a comment from Commonwealth Edison officials in Chicago saying that a comparable blackout was unlikely in Chicago.

The July 15th edition, while reporting the reestablishment of some transportation and some reopenings of business, elaborates on the social conflicts which begin to swirl around the blackout. President Carter, Mayor Beame and Governor Carey are calling for investigations into the reasons for the blackout. Reports of arrests for the looting and the costs to business are carried along with the note that looting was restricted to particular areas. They report that otherwise there was no panic in the city. The locational restriction is a code for telling the public that "minorities" are involved. At the same time, they play down the possibility of similar disorders in Chicago. With emergency generators in hospitals and prisons, Chicago is prepared to handle the problem at its inception at the technical level. By July 16, more detailed information on the technical causes was available, assessments of the economic costs of the blackout and of the looting were offered. The business section of the paper recorded shock wave effects on the midwest stock exchange. Since the midwest exchange is a dependent of the national brokerage houses headquartered in New York, loss of sales in that exchange were inevitable with the closing of the New York exchange. The editorial dwelt on the looting, comparing the present to the 1965 blackout. Permissive society was the culprit. By July 17, the blackout report was on page 34. The breakdown of public order was interpreted as a function of the nature of the nature and, thus, something peculiar to New York. It reported in some detail about costs of closings to restaurants and retail stores and recorded Mayor Beame's attack on the New York Edison company for gross negligence.

The Boston Globe of July 14th ran headlines on the technical reasons for the blackout and its effect transportation and entertainment. Reports of minor looting were carried. By July 15th, more analyses of the technical reasons for the outage were received, but the emphasis began to shift to assessing blame. The antagonists in the drama began to take shape. They reported calls for investigations of the causes, Consolidated Edison was blamed, the looters were blamed, why were some areas peaceful while others were areas of looting. On page 36, they wrote an article critical of ConEd for only having partially followed the recommendations for avoiding blackouts after 1965. They had placed some generators in hospitals and train stations and two-way radios on trains but had not enabled the airports to operate at night. The business section of the paper drew Chicago into the drama, reporting the attempt of the large brokerage houses in New York to force the Chicago board to close on Thursday by court action. They ran another article on the tax losses, advertising and insurance.

At this point, they examined the likelihood of a similar event in Boston, noting that larger cities are only possible with electricity and that blackouts are probable. The Boston Globe quotes Boston Edison officials as saying that such blackouts are unlikely in Boston because the city is served by diverse power lines--despite the fact that this flexibility did not help New York. The editorial launches a general critique of New York society. The vast majority of New Yorkers, they write, seemed able to adjust to and cope with the crisis. Yet, instead of paying utilities to improve or redesign the system, they would apparently rather pay as they did on Wednesday night.

On July 16th, a power line came down, producing a five hour power interruption on the outer Cape which affected some 17,000 customers. A rather routine event, which might ordinarily have gone unreported in the Boston Globe, merited page one attention. It, too, was drawn into the drama. Mayor Beame was reported visiting the site of fires and looting and ordering an investigation into the blackout--but otherwise, the adaptation of the municipal government or its engagement with the state and federal authorities was not of central interest in Boston. An editorial interpreted looting in terms of the paper's social philosophy, attributing it to poverty and pointing out the need for better distribution of income. By July 17th, a staff article, on page 15 contemplates the prospect for Boston. The possibility of looting is accepted and dealt with in economic insurance terms. Boston merchants would not have coverage, particularly those in the poor areas, and Federal Crime Insurance programs are not well publicized.

The Washington Post, like the papers in the other cities opened its July 14th morning edition with a page 1 staff report referring to the technical causes of the blackout and the immediate impacts on transportation and entertainment. This paper carried the response of the police to disorder, the comments of the mayor on public order, but added that New Yorkers seem to be taking the blackout with good humor. On July 15th the page 1 story on the blackout concentrated on the issue of public order. The looting had occurred. The public order in in New York depended on where you were. Parts of the city had a holiday air, while others had the look of a war. They turned to the social economic effects and the government responses. The orders for an investigation by Carter and Beame were reported. Potomac Electric and Power Company assured Washingtonians that the possibility of a blackout in Washington was "very remote" because of power reserves and pooling and communication, but that if it were to occur, the police and fire departments have emergency generators. On July 16th, an editorial reflected on our dependence on electricity and what they called the love-hate relationship between New York City and Consolidated Edison. It can happen in Washington, they wrote, regardless of what Potomac Electric says. Their social interpretation involved an article on poor areas where the looting occured, interviews with poverty workers, police, and sociologists. The outcome was a general critique of New York City. The Washington Post wrote that New York revealed to the world Wednesday night that it is something less than a "wonderful town". The July 17th issue reported Mayor Beame's call for harsh penalties against looters. In a syndicated column, Kraft interpreted the looting as a sign that the poor areas in the cities cannot be ignored. By July 18th they were concentrating on the repressive activities of government, reporting that Mayor Beame and borough President Sutton were calling again for severe treatment of the looters. Thus while Boston builds a picture of economic disaster, Washington, as a government city and one that has had its share of civil disturbances, sees the blackout as a problem in social order.

The Des Moines Register, on July 14th, opened a front page story with the technical details of the causes and the effects on transportation and city services. They noted, though, that most residents remained calm in the darkness. More details on the technical problems appeared the next day, and then they began to report on the social conflict: reactions of outrage expressed by Federal Power Commission and by Mayor Beame, a rising tide of public indignation over the performance of the utility and individuals, business and government agencies that have suffered losses are bombarding the company with damage suits. They stress the paralyzing effects of loss of electricity on transportation, business and home activities. They published reassurances as they recalled that in 1962 and 1965 a blackout in the Midwest had resulted from failure of Fort Randall Dam Power Station on the Missouri River. Since then improvements in the power grid system have kept local power failures from spreading, so that no area-wide blackouts have occurred in the Midwest. On July 16th the blackout story appeared on page 8. Articles analyzed blame and cost and the looting. Inquiries instituted by the Federal Power Commission into the cause of the blackout were reported. The July 17th paper recorded the arrest and detention in the courts of several thousand looters. On July 18th in a page 4 article they asked what would happen in Iowa if citizens demanded more electricity than utility companies could come up with. Their conclusion was that the company would switch off customers. On July 19th they ran a story on page 28 as to whether Carter will declare New York City a disaster area -- a choice he later rejected.

The Houston Post reported on the public order issue in its first headline story on July 14th. They noted that Governor Carey had put the National Guard on the alert. They reported the conflict between Mayor Beame and Consolidated Edison. The public order issue remained central on July 15th, noting that most New Yorkers took it in stride while there was mass looting and that Consolidated Edison was criticized by the politicians. They quoted the Houston Lighting and Power Company spokesman to the effect that a blackout was unlikely in Houston since they have power reserve, have never had one, and have a smaller system. Power blackouts, they say, are more likely from hurricane than from power failure in Houston. On page 3 they quote a Houston psychologist who was in New York and said that people rose to the occasion because there was precedent for it. Everyone made an equal sacrifice. People acted decently. The Houston Post blamed the media for the high coverage of crime. This followed in a number of Associated Press stories about crime and the way New Yorkers were coping with it. On July 16th a short interruption of power in the Houston area, leaving 8,000 in Houston without electricity as lightning hit the lines and poles in the substation, merited page 1 presentation, They noted, though, that it was unlike the New York City blackout, since only a minor area was affected. On July 17th they ran an Associated Press story on page 2 about crowded jails of New York City, and on July 18th they ran a United Press International story on page 1, noting that 30,000 people in New York and New Jersey were affected by another power outage. They noted that the politicians responded to the blackout --Sutton, Javits, Beame --all condemning the looters.

Economic Impacts

Effects on certain aspects of the economy are indicated by stock exchange figures. We had hoped to obtain data on the clearing of bank checks payable to New York banks as a measure of business flow through New York, but that was not possible. The consolidated trading reports, however, for New York Stock Exchange issues and for the exchanges in Boston, Philadelphia, and the Pacific and the Midwest show the trend in securities. The exchanges out of New York are dependent on New York ones and therefore suffer shock wave type effect. Table 5 shows the level of trading in these various exchanges.

Table 5 shows the level of trading in these various exchanges.

TABLE 5

NEW YORK STOCK EXCHANGE ISSUES
Consolidated Trading
(in thousands)

	New York	Boston	Philadelphia	Pacific	Midwest	Total
July 11, Monday	19,790.	128.	422.	824.	854.	23,098.
July 12, Tuesday	22,470	118.	372.	1,452	1,952	27,584
July 13, Wednesday	23,160	238.	215.	966.	1,303	27,370
July 14, Thursday	Closed	Closed	Closed	569.	410.	N.I.
July 15, Friday	29,120.	386.	360.	1,212.	1,609.	34,494.

Sales on Friday, July 15th seem to compensate a bit for those lost during the closing of the exchange on July 14th, but not nearly to the expected level. Were Friday sales completely to include deferred Thursday sales, the total figure would have been some 20 million shares higher than it is. A technical reason for business not being handled by other exchanges on July 14th was that the largest brokers and national corporations used computers based in Manhatten and could not handle trading without that equipment. Also, since most trading occurs through the New York exchange, the proper opening prices for stock could not be fixed when it closed on the 14th. Brokers went to federal court to keep the

Pacific and Midwest branches from opening, but late in the day the court ruled they could be opened --in effect, leaving some trading time for the Pacific and Midwest exchanges. The Boston and Philadelphia never did open. Doubtless, ramifying effects on the overseas exchanges were also experienced, but data on their trading is not available.

Impacts on Health Organizations

Some of the effects on health, particularly mortality and morbidity, are available from hospital and city statistics. Interruption of health maintaining equipment for those not in hospital settings, such as those on renal dialysis units where there was no auxilliary generator, would be the most serious. Only a few people could have been caught in the circumstances and we have no records of them. There could have been deaths attributable to the difficulty of bringing aid to victims, but we have no figures on that either. The social strain of suddenly losing social support as the role system is suspended, the physical strains incurred by people who walked up many stairs or people with respiratory problems finding themselves in closed buildings without adequate air conditioning, are all increasingly exposed to mortal danger. Daily mortality rate figures are given in Table 6 along with temperature data -- generally positively associated with mortality.

TABLE 6

NEW YORK CITY DEPARTMENT OF PUBLIC HEALTH

July 1977 Date	Mortality Rate	Day's High Temperature
1, Friday	193	87
2, Saturday	204	86
3, Sunday	188	84
4, Monday	202	88
5, Tuesday	228	95
6, Wednesday	223	85
7, Thursday	222	76
8, Friday	190	88
9, Saturday	187	89
10, Sunday	184	85
11, Monday	161	81
12, Tuesday	212	76
13, Wednesday	180	
14, Thursday	257	92
15, Friday	210	96
16, Saturday	202	98
17, Sunday	197	97
18, Monday	243	100
19, Tuesday	273	102
20, Wednesday	283	92
21, Thursday	298	104
22, Friday	291	88
23, Saturday	208	87
24, Sunday	198	90
25, Monday	227	78
26, Tuesday	185	82
27, Wednesday	173	81
28, Thursday	197	80
29, Friday	179	82
30, Saturday	182	82
31, Sunday	219	88

Then the blackout period from the 14th to the 16th of July, mortality was a bit higher than during the period immediately preceding it. Temperatures were in the 90's throughout those days. On the other hand, other periods, for example the 5th through the 7th of July, also had moderately high temperatures and high mortality. And the period of the 18th to the 22nd of July was one of very high temperature and an even higher mortality. Now, given the drop in industrial activity and the use of transportation, mortality should have dropped during the blackout period. Deaths attributable to work and traffic accidents should have been nil -- almost as if it had been a Sunday. The issue is clarified in part by examining mortality rates by cause of death. The 13th, 14th, and 15th might be compared with the previous Wednesday, Thursday, Friday sequence, and the two Wednesday, Thursday, Friday sequences following the blackout. There does not seem to be much difference between the Wednesday and Thursday-Friday death rates in those comparison weeks, at least,nothing comparable to the jump of fifty-seven cases, almost thirty percent over the Wednesday figure experienced on the first day of the blackout. Table 7 compares deaths on these days by the age of the deceased and causes of death.

TABLE 7

CAUSE OF DEATH ON JULY 13, 14 AND 15, 1977*
(in percents)

		Total			Respiratory			Cardiovascular Renal			Homicide			Other		
Date		13	14	15	13	14	15	13	14	15	13	14	15	13	14	15
Age	64-	41	33	33	30	43	40	32	20	19	--	--	--	51	47	48
	65+	59	67	67	70	57	60	68	80	81	1	--	--	49	53	52
TOTAL	N=	(176)	(234)	(207)	(20)	(26)	(20)	(75)	(123)	(107)	(4)	(6)	(5)	(77)	(79)	(75)

*Source: New York City Department of Public Health, Office of Vital Statistics

Looking across the bottom line an immediate jump is apparent on the first day of the blackout in deaths due to respiratory failures. By the second day of the blackout, the numbers return to the level of the previous day. In cardiovascular-renal deaths there was also a jump, in fact an increase of nearly two-thirds on the first day of the blackout with the high rate continued on the second day. There may also have been an increase in homicides, but the numbers are so small that the amount of variation from day to day is not a reliable gauge. There was no change in deaths due to all the other causes, such as cancer deaths, accident deaths.

Examining the age distribution it appears that blackout social conditions increase the probability of death among those sixty-five and over. However, the probability of death from respiratory failure was higher for those under sixty-five, while for the cardiovascular-renal, it was higher for those over sixty-five. The homicides were all under sixty-five, with one exception. No difference by age appears for all other causes of death.

Short of mortality it is believed that the blackout led to a number of personal injuries, people hurt in the melèe of the looting or other accidents in the dark. This may be assessed from records of emergency room and clinic visits in hospitals in the areas in which disturbances occurred. Table 8 shows the adult, child, and psychiatric emergency room visits on July 14th, the first day of the blackout, compared with the previous Thursday, July 7th. The table also shows the record of ambulance calls and visits to the clinic.

TABLE 8

NEW YORK CITY
HEALTH AND HOSPITAL CORPORATION
EMERGENCY AND CLINIC VISITS*

July 1977	Adult Emergency Room 7	Adult Emergency Room 14	Child Emergency Room 7	Child Emergency Room 14	Psychiatric Emergency Room 7	Psychiatric Emergency Room 14	Ambulance Runs 7	Ambulance Runs 14	Clinic Visits 7	Clinic Visits 14	Totals 7	Totals 14
Manhatten												
1. Bellevue	110	113	54	40	34	21	28	10	1552	12	1778	196
2. Gouverneur	NA	NA	NA	NA	NA	NA	NA	NA	950	136	950	136
3. Harlem	222	314	66	80	8	--	NI	NI	904	25	1200	419
4. Metropolitan	NI	NI	NI	NI	NI	NI	NI	NI	500	---	NI	NI
5. Sydenham	56	107	7	20	NI	NI	NI	NI	361	16	425	143
Bronx												
6. Bronx Municipal	237	304	208	190	24	20	NI	NI	1588	157	1634	671
7. Lincoln	179	388	21	127	25	15	21	7	1477	66	1723	603
8. N.C. Bronx	116	NI	26	NI	NI	NI	30	NI	449	NI	621	NI
Brooklyn												
9. Coney Island	208	242	49	56	12	3	11	16	716	271	996	588
10. Cumberland	156	178	102	91	NI	NI	36	10	576	56	870	335
11. Greenpoint	116	177	43	76	NI	NI	NI	NI	557	47	716	300
12. Kings	556	547	246	174	NI	NI	NI	NI	1144	92	1946	813
Queens												
13. Elmhurst	159	189	27	19	NI	NI	6	5	1217	720	1409	934
14. Queens	170	127	66	60	6	6	2	7	756	480	1000	680

*Source: Health and Hospital Corporation, Systems Development and Operations Office.
Metropolitan and N.C.B. excluded from total as insufficient information
NI= No Information Available
NA= Not Applicable

The Civil Disorder

In exploring the response of the various aspects of the criminal justice system to the illegal activities occuring during the blackout, a distinction must first be made between the perception of the situation and the reality. The initial reaction of the police and the courts was to respond to the looters as though the blackout were a disaster. The alternative, which in retrospect was closer to reality, was to view the looting behavior as that found during civil disturbances.

Research studies of disasters by such authors as Fritz and Mathewson and Diggory and Pepitone have noted the general dearth of looting behavior following disasters. When found, though, looters have been dealt with harshly. Following the San Francisco earthquake of 1906, the Army shot sixteen looters who were found robbing the dead. Dynes and Quarantelli, while agreeing with the findings have noted some exceptions. During times of disaster the looting of such "necessities" as food, flashlights, cots, and medical supplies is not viewed as criminal. The uathors see this as a result of a redefinition of property rights. During severe disasters there is general agreement among community members that the resources of individuals become community property. Individual property rights are suspended, so appropriation of private resources, which would normally be considered looting, is temporarily condoned.

While stealing for personal ends is rarely committed during disasters, Dynes and Quarantelli describe the characteristics of such theft. During disaster situations, looting, when it occurs, is generally the undertaking of a handful of individuals in the general population. Most often the looting is committed by non-local persons who venture into the impact community. In some cases, they have even been part of the security forces sent in from the outside to prevent such behavior. The main characteristics are the individualness and secretiveness of the activities. Similar conclusions were drawn by Siman in her study of the aftermath of the Wilkes-Barre flood of 1972.

One thing is clear. The blackout is associated with increased trading in the stock. During the week of the blackout, as well as the week following, the sales volume increased sharply.

The process may be examined on a day by day basis. This is shown in Table 10, which presents the same information for the week ending July 15th.

TABLE 10

CONSOLIDATED EDISON STOCK
WEEK ENDING JULY 15
(in hundreds)

Date	Volume	High	Low	Last	Change
July 11	459	24 3/8	24 1/4	24 3/8	
July 12	420	24 3/4	24 3/8	24 3/4	+ 3/8
July 13	1076	25 1/8	24 1/8	25	+ 1/4
July 14		--	--		--
July 15	4998	23 3/4	23 1/4	23 3/4	-1 1/4

The day before was a heavy day. Sales doubled, reaching just about 10,000 shares. The market closed on the 14th. On the 15th nearly 50,000 Consolidated Edison shares were traded. Presumably the pressure to sell was a bit greater than the demand. The value of the stock dipped to 23 1/4, the lowest value it had for some time, a closing value loss of 1 1/4 at the end of a week which had begun with increasing values. Everything considered, these losses were not as catastrophic as some might have expected. The stock value remained relatively stable after the blackout.

at Kings). There is no increase in Queens. The Bronx increase is almost entirely accounted for by admissions to Lincoln Medical Center in the South Bronx. In that particular neighborhood children may have participated in the riots more than in other neighborhoods. It is more likely, however, that this reflects a drop in the rigidity of child care and protection, in general, along with the release from public role obligations. The impact on parental behavior of the blackout should be further examined. The low clinic figure for Bellevue could be due to cessation of activity in the new building at Bellevue when the generators did not work.

Interestingly, the report on the blackout of LeRoy Carmichael, Executive Vice President for Operations of the New York City Health and Hospitals Corporation, reports an increase in the volume of ambulance calls. He relates this to a higher percentage of crime related emergencies such as stabbings, shootings, and cuts with broken glass. These data show a decrease in ambulance runs. The police data above also do not indicate an increase in patrol car runs such as might be associated with crimes against persons.

The Organizational Credibility of Consolidated Edison

The impact of the blackout and its related events on the value of Consolidated Edison stock is an economic effect which reflects the confidence of the public in that company. Table 9 shows the volume sales and the highest and lowest selling prices per share in each of the weeks in July.

TABLE 9

CONSOLIDATED EDISON STOCK WEEK ENDING JULY 15
~~(in hundreds)~~

Week Ending	Volume	High	Low	Last	Change
July 1	2,231	24 3/4	23 3/4	24 1/4	+3/8
July 8	1,356	24 1/2	24 1/4	24 3/8	+1/8
July 15	6,953	25 1/8	23 1/4	23 3/4	-5/8
July 22	10,301	24	22 5/8	24	+1/4

The total figures indicate that adults using the emergency room increased significantly on the day of the blackout, the number of children slightly. The number of psychiatric cases and ambulance runs declined precipitously, as did the clinic usage. Clinic usage is for regular medical care. Some of the clinics, such as that at Bellevue, closed during the blackout. Further, people ordinarily arrive at clinics by subway. Some of the more pressing "clinic" cases may have been shifted to the emergency room and, thus, it would be difficult to know how much should be attributed to injuries related to the disorders. The disorders which occurred in the vicinity of these hospitals constitute an increasingly intense form of social activity and should have generated more ambulance runs. However, even this intense activity was episodic. On the whole, the blackout meant a decrease in social activity, even in the riot areas. Thus, overall ambulance runs are down. Apparently the focus of social activity of the looting amounted to less activity, on the whole, than would have occurred in the areas without the blackout. Emergency room admissions do not seem to increase in Manhatten, only slightly increase in Elmhurst, but decrease in the Queens Hospital Center in Queens. In Brooklyn, however, there was an increase in adult emergency room admissions by some ten to fifteen percent and by thirty to forty percent in the Bronx. We do not know the proportion of the Brooklyn and Bronx admissions attributable to the rioting, but one may suppose that the figures reflect a general increase in injury producing social activity -- perhaps, just from the general relaxation of role obligations. Some of these admissions may have been shifted from the clinics. Also, the hospitals in Brooklyn and Queens may have been more accessible by foot from the residential areas. An inspection of actual clinic records could help solve some of this puzzle.

A slight increase in child admissions to the emergency room appears in Manhatten and perhaps in Brooklyn (or perhaps a decrease considering the drop

The initial reaction of the police and court systems was to treat the blackout as though it were a disaster and respond to looting activities accordingly. The police at first sent large forces to guard the major expensive shopping areas of downtown Manhattan and left the smaller local shopping areas with little or no protection. When the looting went rampant in some local sections of the city, the media labeled the perpetrators as "savages" and "animals" and demanded maximum court action.

The characteristics of the looting which occurred during the blackout were far more similar to that experienced during civil disorders. This behavior, according to Quarantelli and Dunes, is generally collective in nature. The looters tend to come from all segments of the community, cutting across age, sex and class lines. Looters often work together in pairs, small groups and even family units. "The collective nature of massive looting is also manifest in its selective nature in civil disorders compared with its situational nature in disasters." The prime targets tend to be grocery, furniture, clothing and liquor stores. Looting of this nature further tends to be a very public act, rather secretive in nature.

As in disasters, there is also a redefinition of property rights.

> The looting undertaken is likewise a temporary manifestation of a new group norm, in which the right to use of available resources becomes problematical. If property is thought of as the shared understanding of who can do what with the valued resources within a community, in civil disorders we see a breakdown in that understanding. What was previously taken for granted and widely shared become a matter of dispute among certain segments of the general population.
>
> Viewed in this way, much of the pattern of looting in civil disturbances...makes sense. At the height of such situations, plundering becomes the normative, the socially accepted thing to do. Far from being deviant, it become the conforming behavior in the situation.

Like most other social institutions, the entire criminal justice system was toatlly unprepared for the impact of the blackout. According to the media reports, the police department was slow in responding and when a response was made if often proved ineffectual in many areas of the city. The lack of any standardized emergency procedures produced further backups in the system when prisoners were left unprocessed in the various station houses. The loss of electricity was directly responsible for much of the backlog when the fingerprint identification hook-up with the state capitol was inoperable. The overcrowded conditions in the detention facilities became intolerable with the lack of lighting and cooling systems. It was remarked that conditions in many holding areas approached those of "cruel and unusual punishment." The great influx of defendants also caught the judicial system unprepared and hearings were delayed days beyond normal expectations.

With this material as background, it is now apprpriate to examine the actual looting that occurred following the power outage. According to the Report to the Select Committee on Criminal Justice Emergency Preparedness there were 3076 arrests made for blackout related looting. It should be further noted that this number would represent a conservative estimate of all those who engaged in looting activities. On any measure of looting behavior during a disaster, this would represent an extremely large number of individuals, even for New York.

A profile of some characteristics of the blackout related defendants, reported in the New York Times of 14 August 1977, is presented in Table 11.

A randomly selected sample ot defendants arraigned between June 6 and July 12, 1977 is also presented for comparison. While none of the differences is statistically significant it is notable that the blackout related group of defendants tended to be younger, more predominantly male, less likely to have a prior arrest record, and generally of a higher employment status. These facts were explained away by Nicholas Scoppetta, Deputy Mayor for Criminal Justice, when he noted that "the looting involved a lot of people with prior arrest records. And we know that a lot of people just joined in when they knew they could."

Table 11

Profile of Blackout Related Defendants vs. A Comparison Sample (in percents)

Characteristics	Blackout Related	Comparison
Employment Status		
Employed	45	30
Student	14	13
On Welfare	10	16
Other Unemployed	30	42
Age		
16-20	33.8	28.0
21-25	26.9	28.4
26-30	14.3	18.2
31-40	17.8	16.9
41 and older	7.2	8.4
Sex		
Male	93.3	83.4
Female	6.7	16.6
Prior Arrest Record	64.4	69.4

These characteristics of the looters combined with their inordinately large number lend credence to the contention that the looters were acting within the framework of a civil disturbance rather than a disaster.

The courts, though, took a much harsher reaction to the looters. As indicated in Table 12, the initial court dispositions of the blackout related defendants were more severe than those received by the comparison sample. Twenty five percent of the blackout cases were sent to the Grand Jury as compared to only five percent in the comparison group. In normal conditions, 32% of all burglary cases could be expected to be dismissed in Criminal Court. This was initially true for 14% of the blackout cases.

Table 12

Case Dispositions-Blackout Related Defendants vs. Comparison Group*
(in percents)

Case Status	Blackout	Comparison
Held for Grand Jury	25	5
Dismissed	11	9
Adjourned in Contemplation of Dismissal	3	23
Transferred to Family Court	0	1
Bench Warrants	5	5
Adjourned	8	0
Pled Guilty, Pending Sentence	5	0
Pled Guilty, Sentenced	40	2
Youthful Offender	3	51
Other	0	0
Acquitted	0	4
Convicted After Trial	0	0
TOTAL N=	(3,076)	(3.054)

* Comparison group is composed of defendants charged with this offense. This is composed of every seventh burglary related case docketed from January to June 1977.

Similar courst harshness was evident in the sentencing process. Table 13 reveals that a considerably higher proportion of blackout defendants received some jail time compared with non-blackout cases. But, it should be noted that with the elimination of the tiem served category, the intergroup differences disappear. Now, only 20% of the blackout group was given additional jail time as contrasted with 24% of the burglary comparison group.

Table 13

Sentences - Blackout Related Defendants vs. Comparison Group
(in percents)

Sentences		Blackout	Comparison
Time SErved		34	7
30 Days		10	11
60 Days		3	4
90 Days		3	4
91-180 Days		2	2
Over 180 Days		1	1
One Year		1	2
Total Jail Time	N=	(711)	(485)
Jail Time Other Than Time Served	N=	(268)	(376)
Unconditional Discharge		1	0
Conditional Discharge		20	20
Fine		3	2
Fine/Imprisonment		16	42
Probation		6	5
Total No Jail Time	N=	(600)	(1,088)
TOTAL SENTENCED	N=	(1,311)	(1,573)

The State Division of Criminal Justice Services noted in their November 1977 Report:

> Although the sentences meted out in the weeks immediately following the blackout were harsher than usual, the sentences given since then have been considerably more lenient, reducing the overall differences. For example, as of Labor Day (1977), 60% of the blackout defendants sentenced in Manhattan had been given some jail time (including time served) and 40% of the defendants had received no jail time. As of October 25, 1977, the figures have changed to 36% jail time (including time served) and 64% no jail time.

Thus, with the passage of time and the calming of tempers, the New York City Courts tended to treat the blackout looters no differently than any other defendants.

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