NORTHEAST POWER COORDINATING COUNCIL
201 Park Avenue South, New York, N. Y. 10003

Telephone 212-943-5420

September 21, 1966

Mr. F. Stewart Brown, Chief
Bureau of Power
Federal Power Commission
Washington, D. C. 20426

Dear Mr. Brown:

In accordance with our understanding as expressed in my letter of May 13, 1966, the Northeast Power Coordinating Council has completed studies under 1968 conditions to supplement the FPC SSG studies that had been conducted under 1966 conditions.

Enclosed is the report of our Task Force on System Studies entitled "A Study of the Effect of Possible, but Improbable Events on the Northeast Power Interconnected Systems under 1968 Conditions".

As indicated in my letter, the results of this series of tests show the effect of major generation and transmission additions, but do not include the effect of all other possible changes, as for example, in protective devices, that are under study and may be made prior to 1968.

We trust that this report will be of aid to the Commission in the preparation of its final report.

It is the purpose of the Council to promote maximum reliability and efficiency of electric service in the Northeast Power interconnected system by extending the coordination of system planning and operating procedures of its members. The Council is carrying on several studies in furtherance of this purpose and the enclosed study covers only one phase of these activities.

The Council has adopted a “Procedure for Action in a Major Emergency” as a first step in the development of coordinating load reduction procedures and is undertaking immediate studies of current load reduction techniques, including the application of automatic equipment, for further consideration of its membership.
Studies have been conducted to determine critical switching time in certain key areas and plans are underway to modify protective schemes to obtain faster backup clearing and to obtain isolation of the affected area to prevent the occurrence of widespread interruptions. We feel that each of these steps will further reduce the already low probability of occurrence of a widespread interruption from the "possible but improbable" events.

Yours sincerely,

Ernest R. Acker
Chairman
A Study of
The Effect of Possible, but Improbable Events
on the
Northeast Power Interconnected Systems under 1968 Conditions

by
Northeast Power Coordinating Council's
Task Force on System Studies

September 21, 1966
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10 - Generation Swing Curves - Case 8. 11  
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11 - Generation Swing Curves - Case 9.32  
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    (1966 System)

14 - Generation Swing Curves - Case 10. 11  
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Northeast Power Coordinating Council

Task Force on System Studies

<table>
<thead>
<tr>
<th>Members</th>
<th>Affiliation</th>
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</thead>
<tbody>
<tr>
<td>K. W. Amish, Chairman</td>
<td>Rochester Gas and Electric Corporation</td>
</tr>
<tr>
<td>W. J. Balet, Secretary</td>
<td>Consolidated Edison Company of New York, Inc.</td>
</tr>
<tr>
<td>P. L. Dandeno</td>
<td>The Hydro-Electric Power Commission of Ontario</td>
</tr>
<tr>
<td>Einar Greve</td>
<td>Power Authority of the State of New York (Represented by Uhl, Hall &amp; Rich)</td>
</tr>
<tr>
<td>H. E. Pierce, Jr.</td>
<td>New England Power Company</td>
</tr>
<tr>
<td>H. B. Smith</td>
<td>Niagara Mohawk Power Corporation</td>
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Assisted by the Working Group on 1968 Studies of Improbable Events

<table>
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<tr>
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<tr>
<td>H. B. Smith, Chairman</td>
<td>Niagara Mohawk Power Corporation</td>
</tr>
<tr>
<td>G. D. Garcy</td>
<td>Niagara Mohawk Power Corporation</td>
</tr>
<tr>
<td>J. R. Stewart</td>
<td>Niagara Mohawk Power Corporation</td>
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<tr>
<td>G. C. Loehr</td>
<td>Consolidated Edison Company of New York, Inc.</td>
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<tr>
<td>D. Hayward</td>
<td>New England Power Company</td>
</tr>
<tr>
<td>R. B. MacKenzie</td>
<td>New York State Electric and Gas Corporation</td>
</tr>
<tr>
<td>E. G. Neudorf</td>
<td>The Hydro-Electric Power Commission of Ontario</td>
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<tr>
<td>L. J. Rubino</td>
<td>The Hydro-Electric Power Commission of Ontario</td>
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Liaison

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<tr>
<td>C. R. Jacobsen</td>
<td>Federal Power Commission</td>
</tr>
</tbody>
</table>
NORTHEAST POWER COORDINATING COUNCIL  
284 South Avenue, Poughkeepsie, New York  

Telephone 914-454-7980  

May 13, 1966

Mr. F. S. Brown, Chief  
Bureau of Power  
Federal Power Commission  
Washington, D. C. 20426

Dear Mr. Brown:

In accordance with our recent discussion in Washington, the Northeast Power Coordinating Council is initiating studies of the northeast interconnected systems to supplement the Phase I and Phase II studies of the FPC System Studies Group under 1966 conditions. The Council's studies will be conducted by its Task Force on System Studies with membership as follows:

<table>
<thead>
<tr>
<th>Name</th>
<th>Power System</th>
</tr>
</thead>
<tbody>
<tr>
<td>William J. Balet</td>
<td>Consolidated Edison</td>
</tr>
<tr>
<td>Paul L. Dandeno</td>
<td>Ontario Hydro</td>
</tr>
<tr>
<td>Halbert E. Pierce, Jr.</td>
<td>New England Power</td>
</tr>
<tr>
<td>Harry B. Smith</td>
<td>Niagara Mohawk</td>
</tr>
<tr>
<td>Einer Greve</td>
<td>Power Authority</td>
</tr>
<tr>
<td>Keith W. Amish, Chairman</td>
<td>Rochester G. &amp; E.</td>
</tr>
</tbody>
</table>

All of the members of this task force are members of the FPC System Studies Group. The Council studies will determine the effect of planned generation and transmission additions through 1968 on the most severe "improbable" cases analyzed by the FPC System Studies Group. The following cases are being considered:

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.71</td>
<td>Three phase fault on one Niagara-Rochester 345 Kv circuit with one breaker at Niagara failing to operate.</td>
</tr>
</tbody>
</table>
Case No. | Description
---|---
1.72 | Three phase fault involving both Niagara-Rochester 345 Kv circuits with unsuccessful reclosing.
8.11 | Three phase fault involving both Rochester-Clay 345 Kv circuits with unsuccessful reclosing.
9.32 | Three phase fault involving both Clay-Edit 345 Kv circuits with unsuccessful reclosing.
10.11 | Three phase fault causing loss of all transmission circuits from Brayton generating plant and breaker at Millbury failing to operate.
1.53 | Three phase fault on two Beck 230 Kv circuits and one breaker failing to operate, no delivery to Canada.

On Test 590-128, instability developed even though the power flow relays operated to separate Canada from New York. This case will be rerun with the fault detection relays at Packard and Niagara operating. A test under 1968 conditions is contingent on the outcome of this rerun.

2.11 | Three phase fault involving all three Saunders-Hinchinbrooke 230 Kv circuits. A test under 1968 conditions is contingent on the investigation of post-transient conditions under 1966 conditions by the systems involved.

While the results of this series of tests will show the effect of generation and transmission additions, they will not include the effect of other proposed changes, as for example, in protective devices, that are now under study and may be made by 1968.

The Council will from time to time advise the Commission as to the progress of these studies and upon their completion will submit a report to the Commission setting forth the results.

It is our understanding that you have designated Mr. Jerome K. Delson of your staff as your liaison representative for
this project and we assume that he will contact Mr. Amish for any information he may require in connection with this assignment.

With best regards,

Yours sincerely,

Ernest R. Acker
Chairman

ERA:la
PURPOSE OF STUDY

The study was conducted to examine the response of the Northeast Power interconnected systems following severe disturbances under 1968 system conditions. The 1968 system representation included all major generation and transmission additions planned for that time. Tests have been conducted similar to the severe “possible but improbable events” reported in Section IV of the report to the Federal Power Commission, “Studies Related to the Northeast Power Interruption” dated June 1, 1966. A comparison of matching tests indicates the effect of the scheduled additions on the system response.
INTRODUCTION

The System Studies Group appointed by the Federal Power Commission was assigned two jobs: (1) to attempt to reproduce the initial events of November 9, 1965 through the use of computer simulation, and (2) to examine the Northeast interconnected systems for other events that could lead to a similar widespread outage. The Federal Power Commission System Studies Group’s June 1, 1966 report discusses the studies and results of these assignments. In section IV of this report covering the analysis of postulated major disturbances referred to as “possible, but improbable events”, it was shown that in some cases these events caused no major problems; in others, the system was stable but overloads on underlying circuits might create a problem, and in some cases, instability could occur.

This report by the Northeast Power Coordinating Council’s Task Force on System Studies covers the studies that have been made to determine the effect of scheduled major generation and transmission additions through 1968 on the response of the Northeast Power interconnected systems to the improbable events which had indicated severe problems under 1966 conditions.

The major additional facilities which have been included in this series of tests are tabulated on Table I.

It should be noted that substantial studies, planning and research are being conducted to develop improvements in protective schemes. In general, the benefits of these possibilities have not been included in the 1968 studies. However, a reduction in local breaker backup clearing time on the 345 Kv
Niagara bus and elimination of high speed reclosing after clearing a stuck breaker have been incorporated in the 1968 studies.

**ANALYSIS OF TESTS**

The stability tests are based on a load flow which represents a forecast 1968 summer peak load level. Deliveries from the Upstate New York area include 400 Mw to New England, 500 Mw to Southeast New York, and 77 Mw to PJM. Thus, the transmission system was tested under substantially the same condition of power delivery as in the 1966 study. Flows in major transmission circuits are indicated in Table II, and shown on Exhibit 1 (1966) and Exhibit 2 (1968) in the Appendix.

**Case 1.53**

Case 1.53 studied a three-phase fault on two 230 Kv Beck circuits, Q25BW and Q29BD, about 8 miles from Beck. Failure of one primary breaker at Beck was also assumed, requiring that the Beck-Allanburg-Buchanan 230 Kv circuit be tripped to clear the faulted circuit by local breaker back-up protection. Stability test 590-128 (1966 conditions) indicated unstable performance even though the United States and Canadian systems were separated in 33 cycles. Studies have shown that faster separation of the U. S. and Canadian systems will prevent a widespread outage from this type of disturbance, and the studies are being continued to determine the best method of accomplishing this objective. Using identical switching times as in test 590-128 but with a 1968 transmission arrangement, test 594-20 indicates stable performance.
Case 1.71

Case 1.71 involved a three-phase fault on one 345 Kv Niagara-Rochester circuit near the Niagara generating plant, with the further assumption that one of the primary circuit breakers failed to operate. The fault was cleared at Niagara by local breaker back-up tripping the circuit breakers on the 230 Kv side of the 230-345 Kv transformers. Stability test 590-126 (1966 conditions) indicated unstable performance. Stability test 594-15 (1968 summer conditions) indicates however that planned changes for 1968 will result in stable performance.

Case 1.72

Case 1.72 considered a three-phase fault near Niagara involving both Niagara-Rochester 345 Kv circuits. This fault was cleared by the primary breakers, followed by reclosing and clearing again at both ends of the two circuits. Stability test 590-111 (1966 conditions) indicated unstable performance. Stability test 594-16 (1968 summer conditions) indicates however that system changes planned for 1968 will result in stable performance. The L33P (St. Lawrence-Saunders) overload indicated on test 594-16 is such that the power directional overcurrent relays at Ontario Hydro’s St. Lawrence Generating Station will pick up. However, it is not likely that this would trip L33P since the pick-up value is only exceeded for 0.2 seconds during the 3 second period covered in this test.
Case 2. 11

Case 2. 11 concerned a three-phase fault involving all three Saunders-Hinchinbrooke circuits in Ontario. Test 590-118 indicated instability of the Saunders and Moses generating plants and the adjacent local area. Analysis of the post transient condition indicated that this might result in a loss of generation of about 1200 Mw in eastern Ontario and 200 Mw in eastern New York, and that the Niagara ties would be tripped by power relays. Tripping of these ties would reduce the loading on the New York-PJM ties and the outage would be restricted to portions of the Ontario system.

While instability of the Saunders and Moses generating plants may occur for the same disturbance on the 1968 system, the net loss of generation, based on Load Flow 594-10, would be limited to about 800 Mw in eastern Ontario and about 300 Mw in Eastern New York. The loss of this generation in Ontario should not cause tripping of the Niagara ties. Also, the total loss, which would largely appear on the NY-PJM ties should not cause tripping of any of these ties. For December, 1968 peak load and generation patterns, these figures would be reduced to 600 Mw net generation loss in eastern Ontario and 300 Mw in eastern New York.

Case 8. 11

Case 8. 11 studied a three-phase fault involving both Rochester-Clay 345 Kv circuits near Rochester. The fault was cleared by the primary breakers followed by reclosing and clearing again at both ends of the two circuits. Transient test 590-1 19 (1966 conditions) indicated stability during this
disturbance, but that heavy loading occurs on the remaining transmission system perhaps resulting in the St. Lawrence-Saunders tie tripping on transformer overload protection. Test 594-17 (1968 summer conditions) also indicates stability on the basis of machine angles. Loading on the St Lawrence-Saunders tie and other underlying transmission is reduced below levels which could initiate relay operation.

Case 9.32

Case 9.32 considered a three-phase fault involving both Clay-Edit 345 Kv circuits near Edic. The faults were cleared by primary breakers followed by reclosing and clearing at both ends of the two circuits. Transient test 590-120 (1966 conditions) indicated that the system remains stable during this disturbance. The test also indicated that heavy loading is experienced on the remaining transmission, and some underlying 115 Kv circuits may open perhaps resulting in instability and separation of the system. Transient test 594-18 (1968 summer conditions) also indicates stability on the basis of machine angles with heavy loading on the underlying transmission which could result in circuits opening and separation of the system.

Case 10.11

Case 10.11 considered a multiple-line three-phase fault near the Brayton Generating Plant in Massachusetts, resulting in loss of 530 Mw of generation. It was also assumed that a tie breaker at Millbury failed to
open. Test 590-130 (1966 conditions) indicated that the eastern portion of Massachusetts and Rhode Island would become unstable and separate from the rest of the system. Western Massachusetts and Connecticut remained stable and interconnected with New York. Test 594-19 (1968 summer conditions) indicates that planned system changes by 1968 will result in stable performance with no system separation.
**SUMMARY OF RESULTS**

The tests that have been conducted for scheduled 1968 conditions have paralleled as closely as possible the tests under 1966 conditions conducted by the Federal Power Commission System Studies Group. Comparison of the results of these tests are shown on Table III. These 1968 tests indicate that the possibilities of a widespread interruption that were found in the 1966 tests of improbable events, will be substantially reduced by the scheduled additions and changes.

**CONCLUSIONS**

The studies conducted by the Federal Power Commission System Studies Group and the further studies by the Northeast Power Coordinating Council Task Force on System Studies have focused attention on and created an increased awareness of the effect of "possible, but improbable events" on the Northeast Power interconnected systems. While this study has shown that the adverse effects of this series of postulated events will be substantially mitigated by the scheduled additional facilities, the possibility, remote as it may be, of some unlikely event or series of events, causing a major separation continues to exist. In order that a major separation will not cause a widespread interruption, it is essential to rapidly reestablish a balance between load and generation in any "island" that might be formed.
TABLE I

SCHEDULED MAJOR GENERATION AND TRANSMISSION
ADDITIONS INCLUDED IN 1968 TESTS

A. Within Northeast Power Coordinating Council:

1. Major Generation

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Capacity (Mw)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canal # 1, NEGEA</td>
<td>560</td>
</tr>
<tr>
<td>Haddam Neck, Conn. Yankee</td>
<td>463</td>
</tr>
<tr>
<td>Merrimack #2, PS of NH</td>
<td>350</td>
</tr>
<tr>
<td>New Boston #2, Boston Edison</td>
<td>400</td>
</tr>
<tr>
<td>Bridgeport Harbor #3, U. I.</td>
<td>400</td>
</tr>
<tr>
<td>Lakeview, O. H. (4 units)</td>
<td>1250</td>
</tr>
<tr>
<td>Douglas Point, O. H.</td>
<td>200</td>
</tr>
<tr>
<td>Kipling, O. H.</td>
<td>135</td>
</tr>
<tr>
<td>Mountain Chute, O. H.</td>
<td>165</td>
</tr>
<tr>
<td>Barrett Chute Extension, O. H.</td>
<td>117</td>
</tr>
<tr>
<td>Arthur Kill #3, Con. Ed.</td>
<td>515</td>
</tr>
<tr>
<td>Danskammer #4, C. H.</td>
<td>230</td>
</tr>
<tr>
<td>Northport, L. I. (2 units)</td>
<td>760</td>
</tr>
<tr>
<td>Lovett #4, O&amp;R</td>
<td>170</td>
</tr>
<tr>
<td>Nine Mile Point, N. M.</td>
<td>500</td>
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2. Major Transmission

<table>
<thead>
<tr>
<th>Transmission</th>
<th>Voltage (Kv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southington-Haddam Neck-Manchester</td>
<td>345</td>
</tr>
<tr>
<td>Manchester-Carpenter Hill-W. Medway</td>
<td>345</td>
</tr>
<tr>
<td>W. Medway-Canal</td>
<td>345</td>
</tr>
<tr>
<td>W. Medway-Sudbury</td>
<td>230</td>
</tr>
<tr>
<td>Merrimack Station-Dunbarton</td>
<td>230</td>
</tr>
<tr>
<td>Linden-Goethels-Farragut</td>
<td>230 &amp; 345</td>
</tr>
<tr>
<td>Suffern-Millwood</td>
<td>345</td>
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B. Immediately adjacent to Northeast Power Coordinating Council:

1. Major Generation

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Capacity (Mw)</th>
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</thead>
<tbody>
<tr>
<td>Wagner #3, BG&amp;E</td>
<td>319</td>
</tr>
<tr>
<td>Keystone (2 units)</td>
<td>1800</td>
</tr>
<tr>
<td>Oyster Creek, JCP&amp;L</td>
<td>640</td>
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</table>
1. Major Generation cont’d.

Brunner Island #3, PP&L
Muddy Run, PE (8 units)
Hudson #2, PSE&G
Campbell #2, Consumers
St. Clair #7, D. E.
Trenton Channel #9, D. E.

2. Major Transmission

Keystone- Juniata (2 circuits)
Juniata-Peach Bottom-Whitpain
Juniata-Branchburg-Suffern
Keystone-Yukon-Kammer
# TABLE II

## COMPARISON OF BASE LOAD FLOWS

<table>
<thead>
<tr>
<th></th>
<th>West to Central (U.S.)</th>
<th>Saunders to St. Lawrence</th>
<th>Central to East</th>
<th>Linden to Fresh Kill</th>
<th>Branchburg to Millwood</th>
<th>UPNY to SENY</th>
<th>UPNY to New England</th>
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<tr>
<td>System Studies Group</td>
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<tr>
<td>1966 Load Flow (590-105)</td>
<td>1221 Mw</td>
<td>216 Mw</td>
<td>1212 Mw</td>
<td>34 Mw</td>
<td>(Not in)</td>
<td>500 Mw</td>
<td>400 Mw</td>
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<td>NPCC- 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1968 Summer Load Flow</td>
<td>810 Mw</td>
<td>222 Mw</td>
<td>1160 Mw</td>
<td>-18 Mw</td>
<td>237 Mw</td>
<td>500 Mw</td>
<td>400 Mw</td>
</tr>
<tr>
<td>594-9 *</td>
<td>a39</td>
<td>232</td>
<td>1227</td>
<td>146</td>
<td>(Not in)</td>
<td>500</td>
<td>400</td>
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*Used for Case 10-11 with expanded New England representation*
TABLE III
COMPARISON OF TRANSIENT STABILITY TESTS

<table>
<thead>
<tr>
<th>Case</th>
<th>Description</th>
<th>SYSTEM STUDIES GROUP (1966 conditions)</th>
<th>NPCC-1 (1968 conditions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.53</td>
<td>3-phase fault on 2 Beck circuits stuck breaker</td>
<td>590-128 Unstable</td>
<td>594-20 Stable</td>
</tr>
<tr>
<td>1.71</td>
<td>3-phase fault at Niagara 345 Kv stuck breaker</td>
<td>590-126 Unstable</td>
<td>594-15 Stable</td>
</tr>
<tr>
<td>1.72</td>
<td>3-phase fault at Niagara on both Niagara-Rochester 345 Kv</td>
<td>590-111 Unstable</td>
<td>594-16 Stable</td>
</tr>
<tr>
<td>8.11</td>
<td>3-phase fault at Rochester on both Rochester-Clay 345 Kv</td>
<td>590-119 Stable *</td>
<td>594-17 Stable</td>
</tr>
<tr>
<td>9.32</td>
<td>3-phase fault at Edic on both Clay-Edit 345 Kv</td>
<td>590-120 Stable *</td>
<td>594-18 Stable *</td>
</tr>
<tr>
<td>10.11</td>
<td>3-phase fault on all lines at Brayton - stuck breaker at Millbury</td>
<td>590-130 Unstable</td>
<td>594-19 Stable</td>
</tr>
</tbody>
</table>

* Underlying transmission may trip from overload.
NOTE:

FOR CONVENIENCE, SOME STATIONS ARE SHOWN IN ADJACENT AREAS
NOTE:
FOR CONVENIENCE, SOME STATIONS ARE SHOWN IN ADJACENT AREAS.
CASE 1.53
TEST 590-120;

THREE PHASE FAULT 8 MILES FROM BECK
ON TWO BECK-TORONTO 230 KV CIRCUITS
STUCK BREAKER AT BECK CLEARED
BY BACKUP

BASE LOAD FLOW 590-105 (1965/1966 HEAVY LOAD)
(LOAD REPRESENTATION = CONSTANT 1 FOR MW)

INITIAL INTERCHANGE:
UPNY to N-E = 400 Mw
UPNY to SENY = 500 Mw
UPNY to HEPC = 0 MW
UPNY to PJM = 26 MW

FLOW WEST to CENTRAL = 1221 MW
FLOW CENTRAL to EAST = 1212 MW

RAVENSWOOD (BUS 211)
CASE 1.53
TEST 594-20

THREE PHASE FAULT 8 MILES FROM BECK
ON TWO BECK-TORONTO 230 KV CIRCUITS
STUCK BREAKER AT BECK CLEARED
BY BACKUP

BASE LOAD FLOW 594-10 (1968 SUMMER PEAK LOAD)
(LOAD REPRESENTATION = CONSTANT I FOR MW)
INITIAL INTERCHANGE:
UPNY to NE = 400 MW
UPNY to SENY = 500 MW
UPNY to HEPC = 0 MW
UPNY to PJM = 77 MW
FLOW WEST to CENTRAL = 810 MW
FLOW CENTRAL to EAST = 1160 MW
CASE 1.71
TEST 500-126
THREE-PHASE FAULT AT NIAGARA ON ONE NIAGARA-ROCHESTER 345 KV CIRCUIT
STUCK BREAKER AT NIAGARA CLEARED BY BACKUP

INITIAL INTERCHANGE:
- UPNY to NE = 400 MW
- UPNY to SENY = 500 MW
- UPNY to HEPC = 0 MW
- UPNY to PJM = 26 MW
- FLOW WEST to CENTRAL = 1221 MW
- FLOW CENTRAL to EAST = 1212 MW

BASE LOAD FLOW 590-105 (1965/1966 HEAVY LOAD)
(LOAD REPRESENTATION = CONSTANT I FOR MW)
CASE 1.71
TEST 594-15

THREE PHASE FAULT AT NIAGARA ON ONE NIAGARA-ROCHESTER 345 KV CIRCUIT
STUCK BREAKER AT NIAGARA CLEARED BY BACKUP

BASE LOAD FLOW 594-10 (1968 SUMMER PEAK LOAD)
(LOAD REPRESENTATION = CONSTANT I FOR MW)
INITIAL INTERCHANGE:

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>UPNY</td>
<td>NE</td>
<td>400</td>
</tr>
<tr>
<td>UPNY</td>
<td>SENY</td>
<td>500</td>
</tr>
<tr>
<td>UPNY</td>
<td>HPG</td>
<td>0</td>
</tr>
<tr>
<td>UPNY</td>
<td>PJM</td>
<td>77</td>
</tr>
<tr>
<td>WEST</td>
<td>CENTRAL</td>
<td>810</td>
</tr>
<tr>
<td>CENTRAL</td>
<td>EAST</td>
<td>1160</td>
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TIME (SECONDS) 0.5 1.0 15
THREE PHASE FAULT AT NIAGARA ON BOTH NIAGARA-ROCHESTER 345 KV CIRCUITS UNSUCCESSFUL RECLOSURE ON BOTH CIRCUITS

BASE LOAD FLOW 590-105 (1965/1966 HEAVY LOAD) (LOAD REPRESENTATION = CONSTANT 1 FOR MW)

INITIAL INTERCHANGE:
- UPNY to NE = 400 MW
- UPNY to SENY = 500 MW
- UPNY to HEPC = 0 MW
- UPNY to PJM = 26 MW

FLOW WEST to CENTRAL = 1221 MW
FLOW CENTRAL to EAST = 1212 MW

TIME (SECONDS) 0 0.5 1.0 1.5
CASE 1/2
TEST 594-16

THREE PHASE FAULT AT NIAGARA ON BOTH NIAGARA-ROCHESTER 345 KV CIRCUITS UNSUCCESSFUL RECLOSURE ON BOTH CIRCUITS

BASE LOAD FLOW 594-10 (1968 SUMMER PEAK LOAD)
(LOAD REPRESENTATION = CONSTANT I FOR MW)

INITIAL INTERCHANGE:
UPNY to NE = 400 MW
UPNY to SENY = 500 MW
UPNY to HEPC = 0 MW
UPNY to PJM = 77 MW
FLOW WEST to CENTRAL = 810 MW
FLOW CENTRAL to EAST = 1160 MW

0 TIME (SECONDS) 0.5 1.0 1.5
THREE PHASE FAULT AT ROCHESTER ON BOTH ROCHESTER-CLAY 345 KV CIRCUITS
UNSUCCESSFUL RECLOSURE ON BOTH CIRCUITS

CASE 8.11
TEST 594-17

BASE LOAD FLOW 594-10 (1968 SUMMER PEAK LOAD)
(LOAD REPRESENTATION = CONSTANT I FOR MW)
INITIAL INTERCHANGE:
UPNY to NE = 400 Mw
UPNY to SENY = 500 Mw
UPNY to HEPC = 0 Mw
UPNY to PJM = 77 Mw
FLOW WEST to CENTRAL = 810 Mw
FLOW CENTRAL to EAST = 1160 Mw
CASE 9.32
TEST 590-120;

THREE PHASE FAULT AT EDIC ON
BOTH CLAY-EDIC 345 KV CIRCUITS
UNSUCCESSFUL RECLOSURE ON BOTH CIRCUITS

BASE LOAD FLOW 590-105 (1965/1966 HEAVY LOAD)
(Load representation = constant 1 for MW)

Initial interchange:
- UPNY to NE = 400 MW
- UPNY to SENEY = 500 MW
- UPNY to HEPC = 0 MW
- UPNY to PJM = 26 MW

Flow:
- WEST to CENTRAL = 1221 MW
- FLOW CENTRAL to EAST = 1212 MW
THREE PHASE FAULT AT EDIC ON BOTH CLAY-EDIC 345 KV CIRCUITS
UNSUCCESSFUL RECLOSURE ON BOTH CIRCUITS

BASE LOAD FLOW 594-10 (1968 SUMMER PEAK LOAD)
(LOAD REPRESENTATION = CONSTANT I FOR MW)
INITIAL INTERCHANGE:
- UPNY to NE = 400 Mw
- UPNY to SENY = 500 Mw
- UPNY to HEPC = 0 MW
- UPNY to PJM = 77 Mw
FLOW WEST to CENTRAL = 810 MW
FLOW CENTRAL to EAST = 1160 MW
CASE 10.11
TEST 590-130;

THREE PHASE FAULT AT BRAYTON ON
THREE 115 KV CIRCUITS
STUCK BREAKER AT MILLBURY CLEARED
BY BACKUP

BASE LOAD FLOW 590-125 (1965/1966 HEAVY LOAD)
(LOAD REPRESENTATION = CONSTANT I FOR MW)

INITIAL INTERCHANGE:

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<thead>
<tr>
<th>Source</th>
<th>Destination</th>
<th>MW</th>
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<tbody>
<tr>
<td>UPNY</td>
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<td>HEPC</td>
<td>0</td>
</tr>
<tr>
<td>UPNY</td>
<td>PJM</td>
<td>26</td>
</tr>
<tr>
<td>FLOW WEST</td>
<td>CENTRAL</td>
<td>1193</td>
</tr>
<tr>
<td>FLOW CENTRAL</td>
<td>EAST</td>
<td>1221</td>
</tr>
</tbody>
</table>

0 TIME (SECONDS) 0.5 1.0 1.5
THREE PHASE FAULT AT BRAYTON ON THREE 115 KV CIRCUITS
STUCK BREAKER AT MILLBURY CLEARED BY BACKUP

CASE 10.11
TEST-594-19

EXHIBIT 14

INITIAL INTERCHANGE:
- UPNY to NE = 400 Mw
- UPNY to SENY = 500 Mw
- UPNY to HEPC = 0 Mw
- UPNY to PJM = 77 Mw
- FLOW WEST to CENTRAL = 839 MW
- FLOW CENTRAL to EAST = 1227 MW

BASE LOAD FLOW 594-9 (1968 SUMMER PEAK LOAD)
(LOAD REPRESENTATION = CONSTANT I FOR MW)