NEW YORK INDEPENDENT SYSTEM OPERATOR

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## Assessment of the Potential Impact of the Millennium Natural Gas Pipeline on the Consolidated Edison Right of Way South of the Millwood West Sub Station

## Voltage, Thermal & Dynamics Review

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**Prepared by the NYISO Transmission Planning Staff**

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# THERMAL AND VOLTAGE

## INTRODUCTION

The proposed Millennium natural gas pipeline project occupies 28 miles of Consolidated Edison's Right of Way (ROW) connecting the Buchanan substation to the Millwood West substation and the ROW connecting the Millwood West substation to the Sprain Brook substation. Transmission lines are located in close proximity to each other over much of these ROWs and the construction and possible explosion of the proposed pipeline represent a risk to these lines. Power flows on these lines can reach 4,000 to 5,000 MWs, which represents approximately 40% to 70% of Con Edison's total system load, depending on system conditions.

## BASE CASES

The base case used for this study was the base case used for Extreme Contingency Analysis in the 2000 Comprehensive Area Transmission Review. The base case contains a NYCA load level that is approximately 83 percent of the forecasted 2006 summer peak. The transfer levels in this case represent typical transfers. (Approximately the fifty percentile of the past four years' transfer levels). This case is typically referred to as the Normal Transfer Case. A sensitivity case was developed from this case with transfer levels on the Upny-Coned and Dunwoodie South interfaces increased to approximately the ninety percentile range of historical transfers. This case is referred to as the Heavy Transfer Case. Details of the base cases can be found in the Appendix.

## STUDY METHODOLOGY

This assessment focused on the section of ROW just south of the Millwood Substation. At this point there are six 345 kV transmission lines on three adjacent transmission towers. The assessment was done in two phases. The first phase involved the assessment of the loss of the four East View lines connecting Millwood, Sprain Brook, and Buchanan, resulting in the isolation of the underlying East View connections and resultant loss of load. The second phase of the analysis included the loss of the two additional circuits into Pleasantville that are parallel to the four East View circuits. Load flow and dynamic simulation analysis were performed to assess the impact of these contingencies on system voltages, thermal overloads and dynamic response.

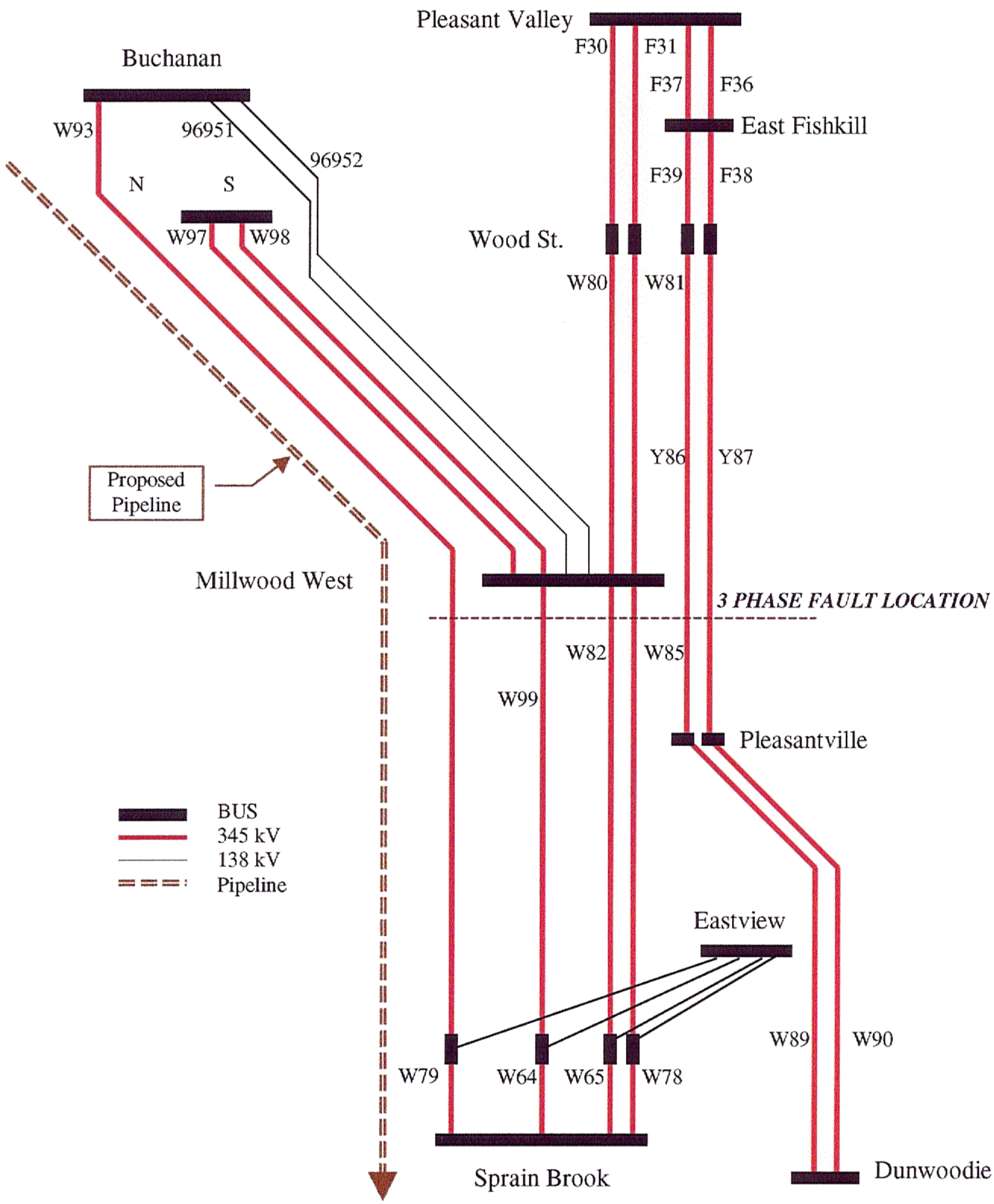
## FACILTIES IMPACTED

The circuits that make up the ROW south of Millwood are presented in Table [1]. Figure [1] shows a diagram of these circuits in relation to each other, the proposed pipeline route, and the location of the fault.

**TABLE 1** CIRCUITS IN THE RIGHT OF WAY

| Circuit Id | From | To | RATEA | RATEB | RATEC | Heavy Transfer Case MVA | Heavy Transfer Case MW |
|---|---|---|---|---|---|---|---|
| W93 | Buchanan North | East View 1 | 1720 | 1890 | 2401 | 1022 | 1009 |
| W99 | Millwood West | East View 2 | 2293 | 2708 | 3236 | 976 | 975 |
| W82 | Millwood West | East View 3 | 2293 | 2708 | 3236 | 926 | 925 |
| W85 | Millwood West | East View 4 | 2293 | 2708 | 3236 | 926 | 925 |
| Y86 | Fishkill | Pleasantville East | 1839 | 2605 | 3105 | 868 | 867 |
| Y87 | Wood A | Pleasantville West | 1839 | 2605 | 3105 | 840 | 840 |

**Figure 1** - Position of pipe line with respect to transmission circuits.



## THERMAL AND VOLTAGE STUDY RESULTS

The first phase assessed the impact of the loss of the right of way south of Millwood. This contingency involves the loss of the four East View lines connecting Millwood, Sprain Brook, and Buchanan, resulting in the isolation of the underlying East View connections and resultant loss of load. These are the first four lines in Table [1]. The impact of this extreme contingency resulted in no significant voltage deviations, and no thermal overloads (STE ratings) in the NYCA system for the Normal Transfer Case. Thermal overloads were observed in the PJM system in the northern New Jersey area. For the Heavy Transfer Case, no significant voltage deviations occurred, but some thermal overloads on the remaining NYCA circuits through to New York City occurred. The flows on the Hudson Farragut lines were at 110 and 112 percent STE rating, and the Waldwick to South Mahwah lines were at approximately 102 percent. Flows on circuits in northern New Jersey were up to 130 percent of rating, while flows on circuits in New England were up to 120 percent of rating. Stability analysis indicated that the system is stable for both levels of transfers.

Additional analysis was done to estimate the level of generation pickup, or load reduction, that would be required to reduce the flows on the overloaded circuits to a level below their LTE rating and Normal rating. Shift factors were calculated for a load drop in New York City, and from these results, a required generation pickup for rating relief was calculated. To reduce the line flows on the overloaded circuits to LTE ratings would require a generation pickup of approximately 1050 MW. To get to Normal ratings would require a generation pickup of approximately 2700 MW. This represents about a twelve percent and thirty percent reduction, respectively, in the NYC Zone load, which was about 9300 MWs.

Phase two of the assessment evaluated the impact of the loss of all six of the circuits in this portion of the ROW. The impact was only evaluated for the Heavy Transfer Case. The impact of the loss of all six lines results in voltage collapse and system instabilities.

## SUMMARY

The results of this study demonstrate the significant adverse impacts that the loss of either four or six circuits in this ROW can have on the New York Bulk Power System, as well as neighboring systems. While the loss of four circuits for the Normal Transfer Case did not result in widespread significant adverse system impacts, it does result in the loss of local load in the Westchester area that is served from the Eastview substation. This loss of local load affects over 110,000 customers, and represents a peak load of over 600 MWs. The loss of four circuits for the Heavy Transfer Case results in the same loss of local load, and additionally, violations of thermal limits in the New York system as well as neighboring systems. The loss of all six circuits results in loss of local load, voltage collapse and first swing system instability.

## DYNAMICS

### Introduction

In an effort to assess the outcome of a catastrophic gas pipe failure followed by an explosion, a dynamic simulation was conducted. The circuits under investigation are electrically close to the Dunwoodie and Sprain Brook substations. Therefore, a three-phase fault is simultaneously applied at each of these stations along with a fault on midsection of the W93 line connecting North Buchanan with Sprain Brook. Figure [1] shows a diagram of the lines and fault placement. High Speed clearing (3.5 cyc) removes the circuits shown in table [1]. This assumes that lines are down and can not be restored with reclosing.

The dynamic simulation was performed using PTI's PSSE Dynamic Simulator. Figure [2] shows the PSAS Control Deck used to simulate a three-phase fault followed by line trips to clear the fault.

### Load Flow

The load flow was based on the summer 2006 load forecast and represents 90% of the summer peak. It is the same load flow base case presented in the 2000 Comprehensive Review of the New York Bulk Power System. Table [2] shows the interface flows prior to the fault.

**Table 2** – Interface flows.

| Interface | | MW | Mvar |
|---|---|---|---|
| Total East | | 3809 | 502 |
| Central East | | 1905 | -264 |
| UPNY-SENY | Open | 4638 | -113 |
| | Closed | 4677 | 559 |
| UPNY-ConEd | Open | 3994 | 17 |
| | Closed | 4993 | 323 |
| Millwood South | | 6525 | 392 |
| Dunwoodie South | Open | 4405 | -881 |
| | Closed | 5405 | -575 |

### Dynamics Results

The simulation was to be run out to 15 seconds, but it only made it to 5.5 seconds total,

0.1 seconds at steady state
3.5 seconds fault on
+ 1.9 seconds past fault clearing
5.5 seconds total

At that point the system was unstable. This is with no generator trips or other relay action besides that needed to trip the lines in table [1]. Plots of interface MW flows and the voltage and frequency at selected buses comfirm this.

**Figure 2** - PSSE PSAS control deck.

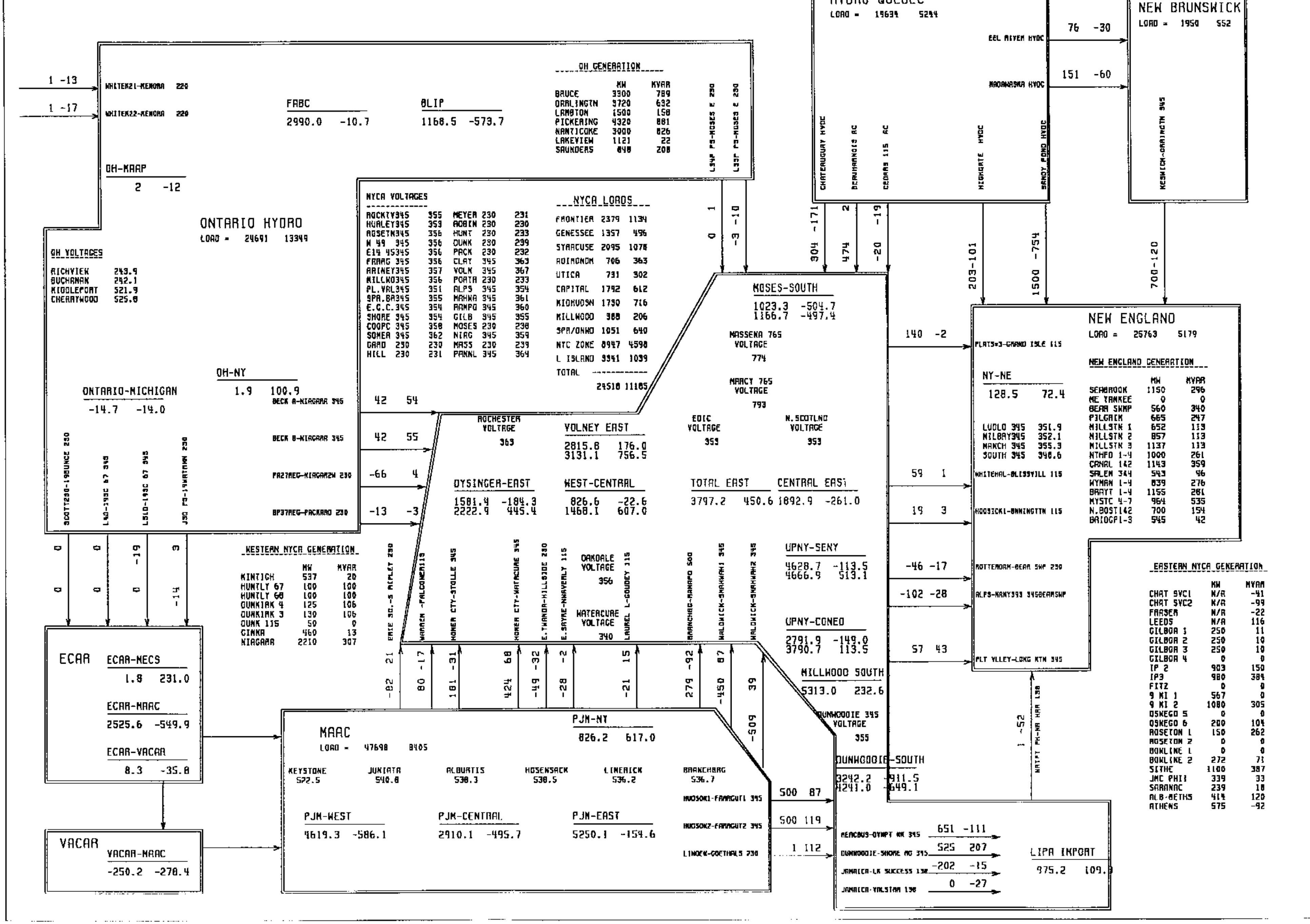
```
RUN TO .1 SECOND PRINT 120 PLOT 3 CRTPLT 0
  APPLY FAULT AT 3PHFLT BUS 9999
  APPLY FAULT AT MILLWOOD W BUS 74341
  APPLY FAULT AT PLESANTVILLE BUS 74342
  APPLY FAULT AT PLESANTVILLE BUS 74343
RUN FOR 3.5 CYCLES PRINT 120 PLOT 3 CRTPLT 0
  CLEAR FAULT
  TRIP LINE FROM PLEASANT VALLEY BUS 74343 TO WOOD A BUS 74355 CKT 1
  TRIP LINE FROM FISHKILL BUS 74331 TO PLEASANTVILLE BUS 74342 CKT 1
  DISCONNECT  BUS  74317 / E VIEW 345
  DISCONNECT  BUS  74318 / E VIEW2 345
  DISCONNECT  BUS  74319 / E VIEW3 345
  DISCONNECT  BUS  74320 / E VIEW4 345
  DISCONNECT  BUS  74428 / EASTVIEW 138
  DISCONNECT  BUS  74430 / ELMSFD1E 138
  DISCONNECT  BUS  74431 / ELMSFD1W 138
  DISCONNECT  BUS  74432 / ELMSFD2E 138
  DISCONNECT  BUS  74433 / ELMSFD2W 138
  DISCONNECT  BUS  74489 / HARRSN-1 138
  DISCONNECT  BUS  74490 / HARRSN-2 138
  DISCONNECT  BUS  74491 / HARRSN-3 138
  DISCONNECT  BUS  74569 / WHIT PL6 138
  DISCONNECT  BUS  74572 / WP5/HAR3 138
  DISCONNECT  BUS  74573 / WP7/HAR2 138
  DISCONNECT  BUS  74574 / WP8/HAR1 138
  DISCONNECT  BUS  74741 / ELMSFD#2 13.6
  DISCONNECT  BUS  74744 / HARRSON 13.6
  DISCONNECT  BUS  74748 / WH PLNS 13.6
  DISCONNECT  BUS  74749 / WHPL-1R 13.6
  DISCONNECT  BUS  74750 / WHPL-2R 13.6
RUN FOR 2 SECONDS PRINT 120 PLOT 5 CRTPLT 0
RUN TO 15 SECONDS PRINT 480 PLOT 7 CRTPLT 0
END
```

## APPENDIX - Study Data

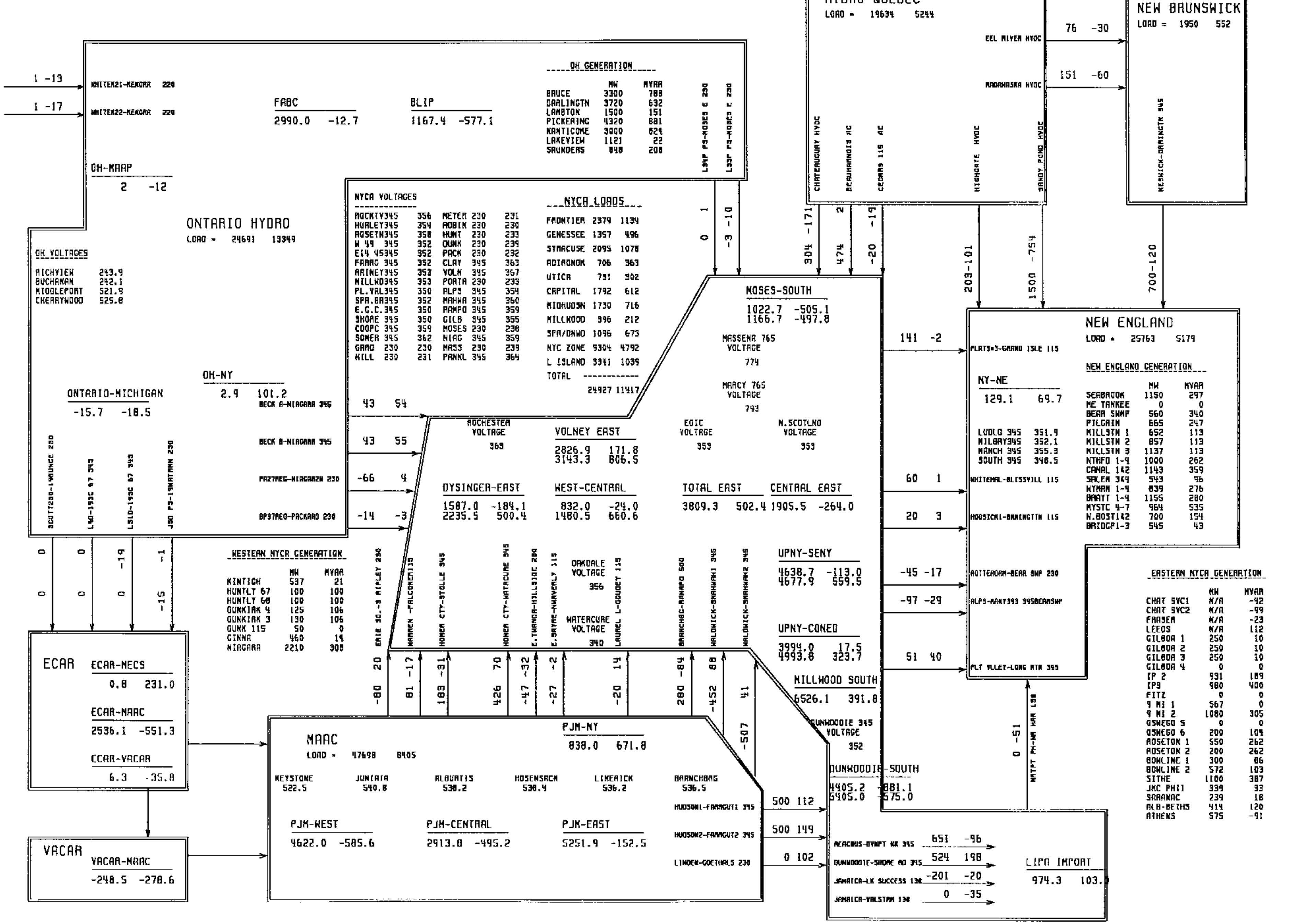
Load Flow Data
Post fault Interface flows
Post fault voltages
Post fault frequency

# 2006 EXTREME BASE CASE NY TRIENNIAL REVIEW

DYNM BASE CE MS 1POLE

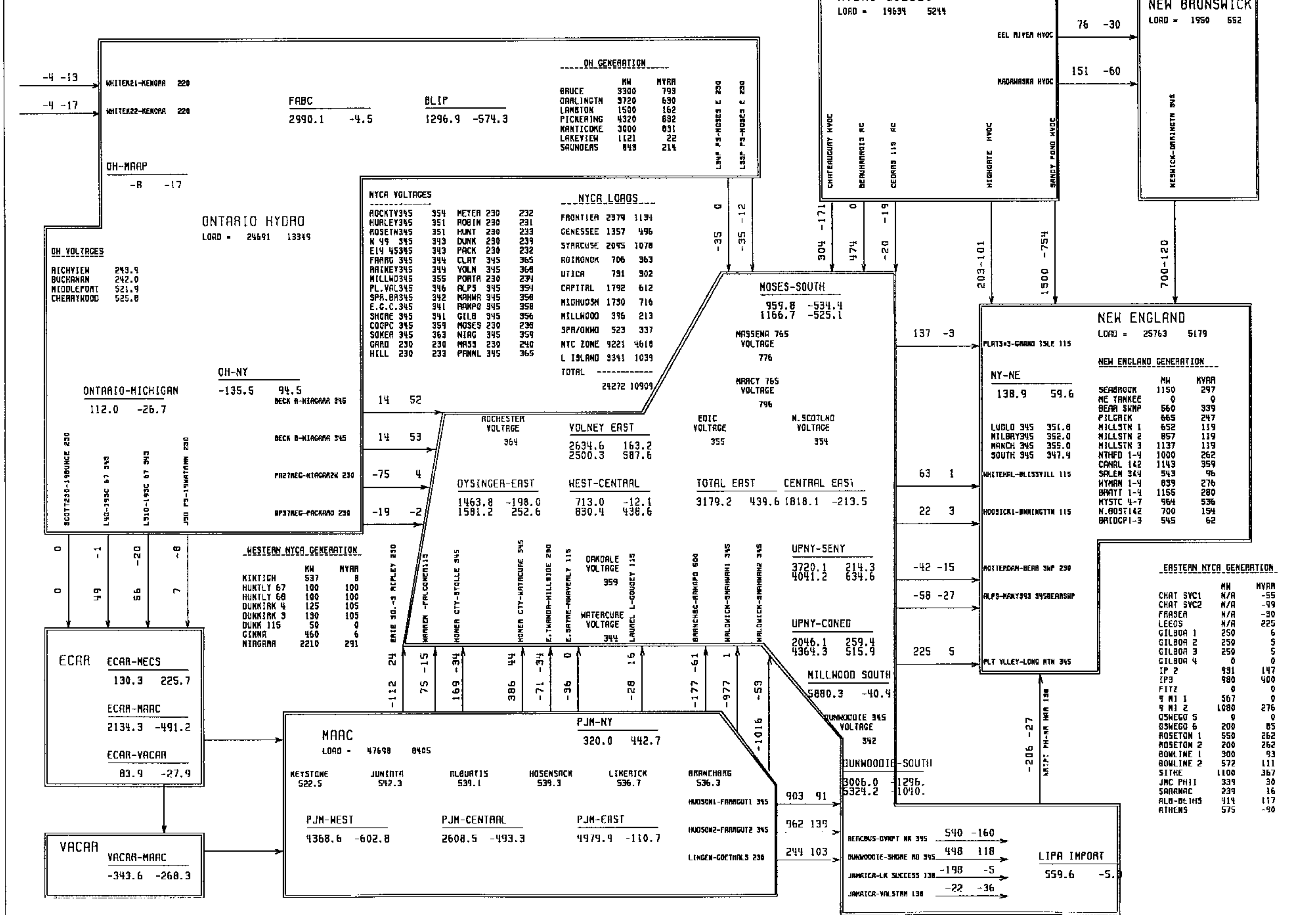


## 2006 EXTREME BASE CASE NY TRIENNIAL REVIEW
## DYNM BASE MODIFIED TO 90TH PERCENTILE



# 2006 EXTREME 90 PERCENT CASE NY TRIENNIAL REVIEW

## CNTG26 - LOSS OF ROW SOUTH OF MILLWOOD



2006 EXTREME BASE CASE NY TRIENNIAL REVIEW
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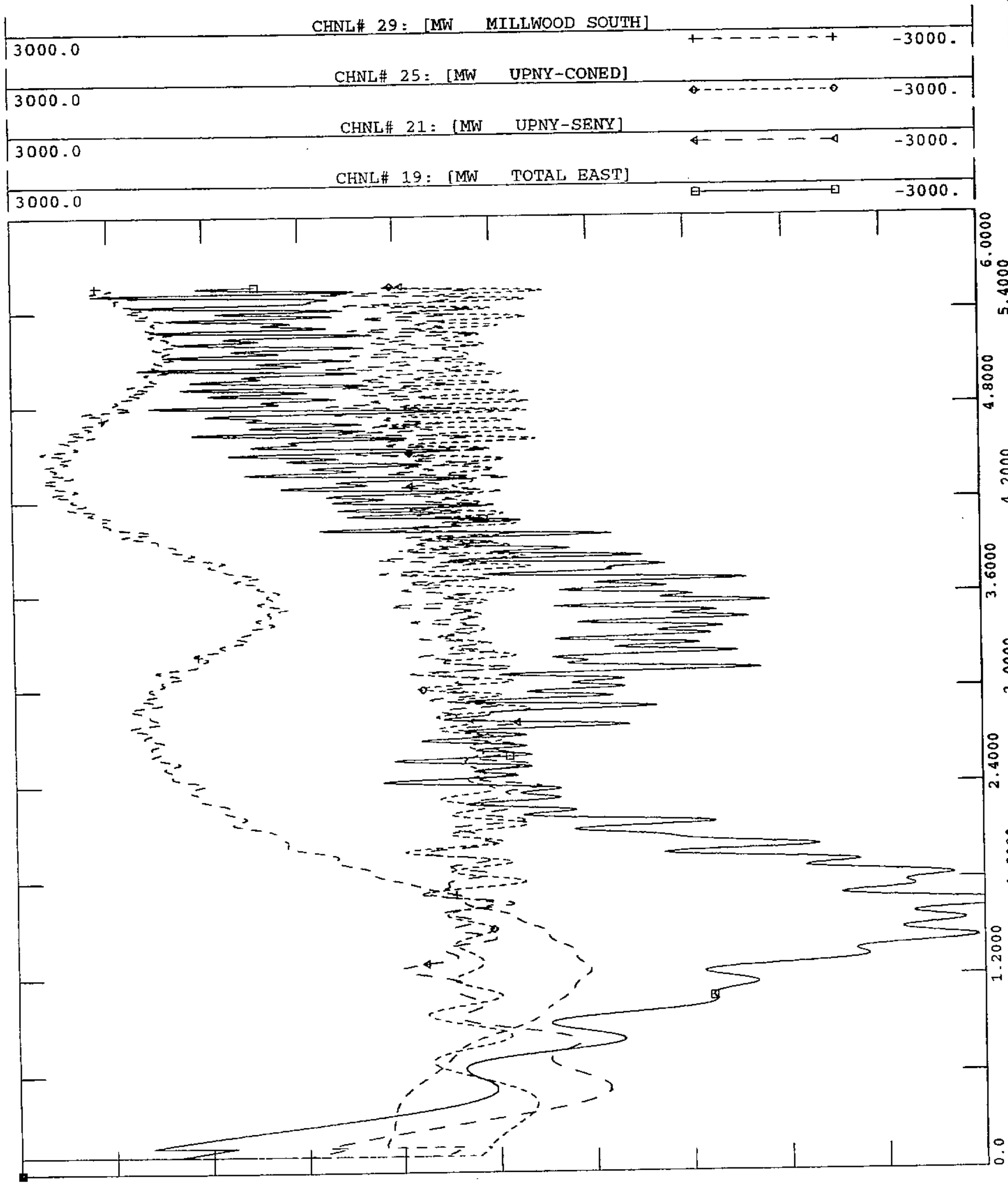


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MILLENIUM GAS PIPE INTERF

2006 EXTREME BASE CASE NY TRIENNIAL REVIEW
DYNM BASE MODIFIED TO 90TH PERCENTILE

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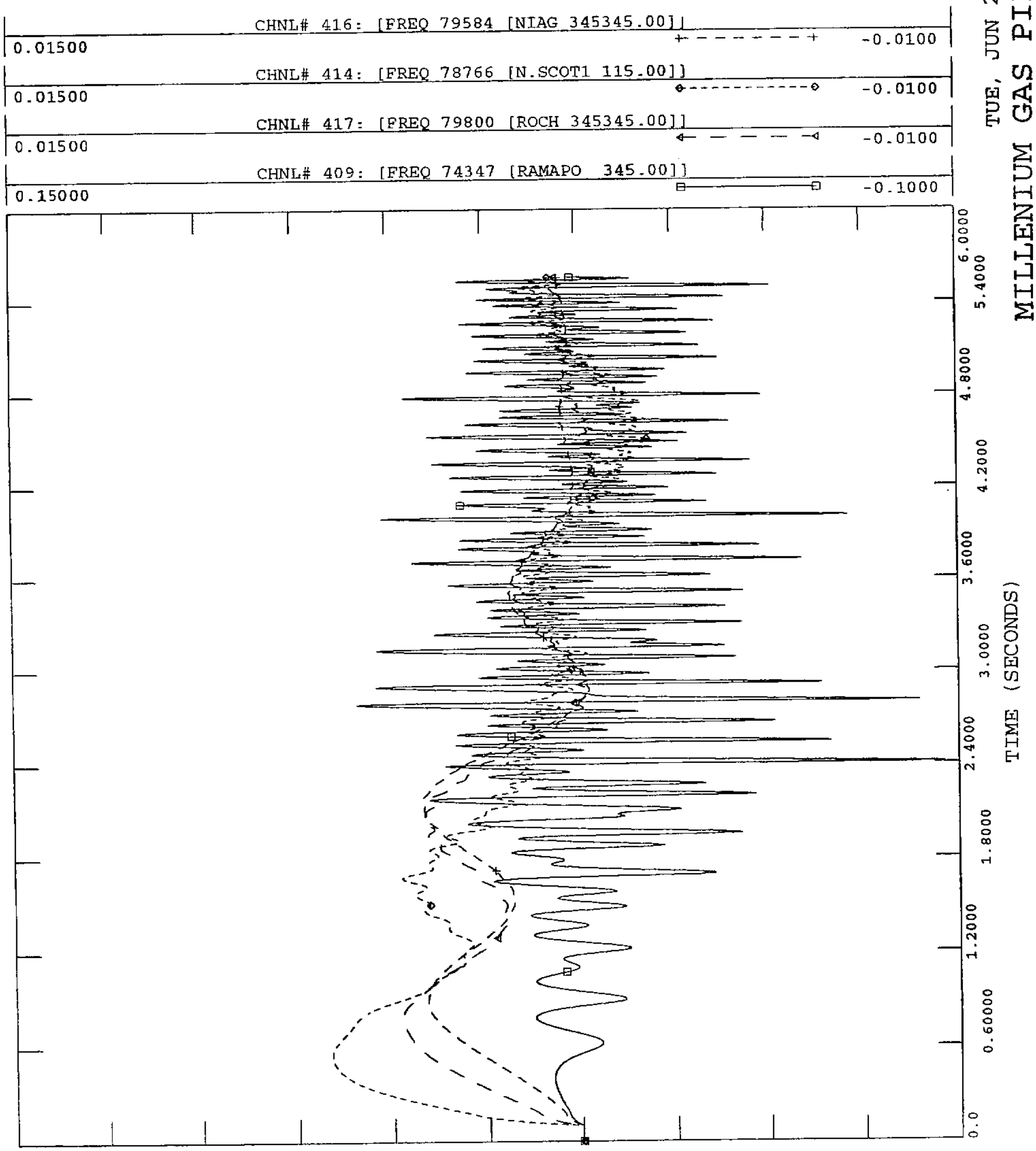

2006 EXTREME BASE CASE NY TRIENNIAL REVIEW
DYNM BASE MODIFIED TO 90TH PERCENTILE

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