Connecticut Cable Transient and Harmonic Study for Middletown to Norwalk Project

East Devon-Beseck 20-mile Cable Option (M/N-P2)

Final Report
December 2003

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Foreword

This document was prepared by General Electric International, Inc. (GEII) acting through its Power Systems Energy Consulting (PSEC) located in Schenectady, New York. It is submitted to Northeast Utilities (NU). Technical and commercial questions and any correspondence concerning this document should be referred to:

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Executive Summary

Study Objectives

GE Power Systems Energy Consulting (PSEC) has performed several switching transient and harmonic studies of the Northeast Utilities (NU) Bethel to Norwalk and Middletown to Norwalk 345 kV transmission cable projects that are proposed in southwestern Connecticut. In a recent study[1], harmonic and switching transient analyses were performed for the Middletown to Norwalk (M/N) project, with Devon-Beseck configured as a 33-mile overhead line. In another recent study[2], an alternate configuration was analyzed, with Devon-Beseck configured with 40-mile underground cables (three parallel cables). This is referred to as the "M/N-P1" configuration. It was found that this configuration resulted in a system driving-point impedance resonance at 2nd harmonic and was not recommended.

The focus of the study, documented in this report, is to further analyze switching transients and harmonic characteristics of the Middletown to Norwalk project with Devon-Beseck configured with two sets of 10-mile underground cables (each with three parallel cables), with 14 miles of overhead line in the middle. In this report, this is referred to as the "M/N-P2" configuration. This cable addition increases the total 345 kV cable charging capacitance from about 1500 MVAR (for Plumtree to Norwalk and Norwalk to East Devon cables) to about 2800 MVAR. The objective of the study is to investigate the harmonic impacts of this cable/overhead line option and evaluate switching transients with particular emphasis on equipment duty and power quality. This study was intended to investigate potential fatal flaws of the M/N-P2 configuration, rather than a more comprehensive study such as that which was recently performed for the M/N base configuration.

The study has been performed with the Electromagnetic Transients Program (ATP/EMTP), which is recognized as an industry standard for simulating the transient performance and frequency response of electric utility systems [www.emtp.org].

Conclusions and Recommendations

Evaluation of the M/N-P2 configuration did not identify any overtly fatal flaws, but did reveal significant risks that would require considerable limitations and restrictions on operating practices and future modifications of the system. Therefore, it is recommended that the M/N-P2 configuration be avoided.

These high risk areas include potentially damaging voltages on the cable system due to a resonance condition near 60 Hz, restrictions on cable energization and de-energization operations, high voltages across the series reactor, circuit breaker recovery voltages which exceed standard test values, and the potential for more severe sustained overvoltage

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[1] Final Report on M/N Project dated November 2003

[2] Final Report on M/N-P1 Project dated November 2003

situations due to driving-point impedance resonances near both 2nd and 3rd harmonics. These issues are described further below.

With the Beseck end open or with the overhead line out of service, the series reactor at Devon with the remaining cables can contribute to low-frequency oscillations in the system.[3] This phenomenon was observed in cable energization, transformer energization, and fault and clear simulations. Consequently, the Devon-Beseck cables could be energized only from the Beseck end, and not from the Devon end, with the last step to complete the path through the series reactor. Additionally, a redundant transfer trip scheme would be needed to trip the Devon end of the cables if the cables were in service through the series reactor at Devon without connection to the Beseck end. An alternate location for the series reactor, which could possibly mitigate some of the resonance issues identified in this study, could also be considered.

The addition of the Devon-Beseck cables together with the Devon series reactor makes the shunt reactors critical elements where a minimum amount of compensation must remain on when the cables are connected. For instance if for some unknown reason the Devon-Beseck cable system opened at Beseck and in the worst scenario all the shunt reactors tripped on the cables, then the cables would be series resonant with the Devon series reactor near 60 Hz creating very low impedance to the system and potentially damaging voltages on the cable system and across the series reactor.

Stub fault and clear simulations resulted in transient voltages of 700 kV across the Devon series reactor. The insulation coordination and equipment specification of the series reactor would require further evaluation in regard to its BIL rating and possible use of surge arresters across the reactor.

Critical fault clearing cases with sustained voltage across the breaker contacts above 750 kV exceed test values defined in ANSI C37.06 and would require review with the breaker manufacturer. These cases indicate the need for a higher temporary overvoltage and transient recovery voltage capability required for the breaker or could possibly be a driver for a higher circuit breaker voltage rating if the manufacturer cannot provide the capability with a 362 kV breaker.

High overvoltages were observed at some 115 kV capacitor bank locations, particularly at Rocky River during fault events. The natural-frequency oscillations of the 345 kV cable system due to application of a 345 kV system fault appear to interact with the resonance of the 115 kV capacitor banks, greatly amplifying the transient. In the actual system, surge arresters located on the 115 kV system will limit these overvoltages.[4] Fault clearing events also resulted in temporary overvoltages on the 115 kV system. It would be recommended that arrester energy and TOV duty be evaluated in the 115 kV system.

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3 Here low-frequency describes beat frequencies below 60Hz where there could be concerns besides power quality and temporary overvoltages. Issues may include: interaction with fast power control devices, torsional stimulus to turbine-generators, and voltage flicker.

4 Also, damping of the system at the relatively high frequency of this interaction (600 Hz – 1 kHz) may be greater than represented in the simulation model, due to skin effects in the transmission cables and overhead 1ines.

With regard to harmonic characteristics, the M/N-P2 configuration resulted in impedance resonances marginally above the 2^{nd} harmonic and marginally above the 3^{rd} harmonic. Changes in system configuration could easily move the resonances to 2^{nd} and 3^{rd} harmonics or below. In the M/N and M/N-P1 configurations, there was a single impedance resonance between 2^{nd} and 3^{rd} harmonics, but in the M/N-P2 configuration the addition of the series reactor with the cable system results in an additional resonance near 3^{rd} harmonic. Consequently, there are concerns regarding power system events involving transformer exciting current, such as energization and inrush due to fault clearing. With resonances near both 2^{nd} and 3^{rd} harmonics, the harmonic currents due to inrush could have an additive effect to produce more severe results than those with resonances at either harmonic.

Additional system contingencies could lead to more severe sustained overvoltage situations than observed in this study. A reasonable effort was made in this study to include first-contingency events likely to initiate a critical system response. However, higher-level contingencies, beyond routine planning criteria, may result in much more severe consequences to utility and consumer equipment. Extreme contingencies could result, for example, from a major regional disturbance such as a blackout. Equipment failures resulting from extreme resonant conditions during system breakup could greatly hinder power restoration efforts.

There are also concerns about being close to 2^{nd} harmonic. Although the resonance is above 2^{nd} harmonic, it is very close, and defining a design with a minimum safe margin above 2^{nd} harmonic is a subjective call. There is significant concern in regard to the harmonic characteristics of the M/N-P2 configuration.

In summary, with the M/N-P2 configuration, it is expected that the system would be very sensitive to future upgrades and would require careful engineering to study changes in the transmission system, even at somewhat remote areas. With resonances near both 2^{nd} and 3^{rd} harmonics, power system events involving transformer exciting current could be more severe with system configuration changes. Operation of the Devon-Beseck cables would require restrictions for energization and de-energization and transfer trip schemes that must be implemented to avoid low-frequency oscillations. Careful consideration would also be required for specifying equipment to withstand transient and temporary overvoltages observed during switching events. The shunt reactor protection scheme would need to ensure that a common response to a disturbance could not trip multiple reactors while leaving cable sections uncompensated. Due to the multiple significant risks and the complex system requirements needed to address them, it is recommended that the M/N-P2 configuration be avoided.

1. Introduction

GE Power Systems Energy Consulting (PSEC) has performed several switching transient and harmonic studies of the Northeast Utilities (NU) Bethel to Norwalk and Middletown to Norwalk 345 kV transmission cable projects that are proposed in southwestern Connecticut. In a recent study[1], harmonic and switching transient analyses were performed for the Middletown to Norwalk (M/N) project, with Devon-Beseck configured as a 33-mile overhead line. In another recent study[2], an alternate configuration was analyzed, with Devon-Beseck configured with 40-mile underground cables (three parallel cables). This is referred to as the "M/N-P1" configuration. It was found that this configuration resulted in a system driving-point impedance resonance at 2nd harmonic and was not recommended.

The focus of the study, documented in this report, is to further analyze switching transients and harmonic characteristics of the Middletown to Norwalk project with Devon-Beseck configured with two sets of 10-mile underground cables (each with three parallel cables), with 14 miles of overhead line in the middle. In this report, this is referred to as the "M/N-P2" configuration. This cable addition increases the total 345 kV cable charging capacitance from about 1500 MVAR (for Plumtree to Norwalk and Norwalk to East Devon cables) to about 2800 MVAR. The objective of the study is to investigate the harmonic impacts of this cable/overhead line option and evaluate switching transients with particular emphasis on equipment duty and power quality. This study was intended to investigate potential fatal flaws of the M/N-P2 configuration, rather than a more comprehensive study such as that which was recently performed for the M/N base configuration.

The study has been performed with the Electromagnetic Transients Program (ATP/EMTP), which is recognized as an industry standard for simulating the transient performance and frequency response of electric utility systems [www.emtp.org].

1 Final Report on M/N Project dated November 2003

2 Final Report on M/N-P1 Project dated November 2003

2. Study Approach

The study was organized into two tasks:

1. Harmonic Analysis
2. Switching Transient Analysis

Task 1. Harmonic Analysis

The large shunt charging capacitance of cables can significantly affect the harmonic frequency response of the system. Resonances in the low-order harmonic range can be expected. There is an ambient level of harmonic distortion in any power system, due to nonlinear loads and power electronic equipment distributed throughout the system. The resonances formed by the cable charging can potentially amplify the ambient distortion to unacceptable levels. Harmonic currents may also add to the heating of the cable, and potentially constrain cable loadability. Harmonic resonance concerns were addressed by performing harmonic screening simulations. Frequency-domain simulations were performed using the EMTP model[1] to calculate the positive-sequence driving-point impedance versus frequency at Plumtree, Norwalk, Southington, East Shore, Devon, Frostbridge, Glenbrook, Singer, Devon, and Beseck. Comparison cases were performed with variation of the 115 kV capacitor banks in the system.

A total of 39 cases were performed to calculate the positive-sequence driving-point impedance with the 20-mile cable option between Devon and Beseck. The results of the harmonic analysis are provided in Section 4.

Task 2. Switching Transient Analysis

The switching transient analysis simulations included energization, de-energization, transformer switching, and fault and clear cases to determine switching transient overvoltages and temporary overvoltages for evaluation of equipment duty and power quality. Equipment recommendations are focused on surge arresters and switchgear.

Except in the limited case of some recently introduced circuit breakers with synchronous switching, the timing of circuit breaker closing is essentially random with respect to the point on voltage wave. There is also typically a variation between the closing times of the individual breaker poles (phases). Some transient results are sensitive to the exact timing of switching. Because of the complexities involved, it is virtually impossible to precisely predict the breaker timing which produces the most severe transient results. For this reason, detailed design studies typically use extensive Monte Carlo analysis of randomly selected breaker timings. However, for the purpose of this study, breaker timing rules-of-thumb were utilized to produce results which roughly approach the worst-case results. Most energization cases were performed using fixed point-on-wave circuit breaker closing angles, e.g., closing

[1] The EMTP model is described in Section 3.

at voltage peaks or zeroes for cable energization cases, and voltage zeroes for transformer energization (to maximize inrush harmonics). Using fixed point-on-wave closing angles was sufficient to determine the switching transient issues associated with the cables and transformers. Circuit breakers were modeled with uncontrolled closing with closing angles adjusted based on the previous study experience, for comparison with the MN base configuration cases of the previous study. Selected cases were performed with pre-insertion resistors to analyze the mitigation of energization transients. Since this study was focused on fatal flaw analysis, statistical analysis was not performed, and it should be noted that actual transient overvoltages could be higher than those presented in this report. Variation of fault application and clearing times were also based on the experience of the previous studies for evaluation of temporary overvoltages.

Cable switching and faults can create transient oscillations which can potentially be magnified at buses with capacitor banks in the lower voltage systems interconnected with the cable transmission project. Voltage magnification can occur when resonances form between the 345 kV cable capacitance, 345 kV driving-point impedance, the 115 kV bank capacitance, and the impedance between them. Voltages at nearby capacitor installations were monitored during cable switching and fault simulations to screen for such magnification. This issue may require extensive analysis in any future design study.

More than 90 simulation cases were performed to complete this part of the study. The results of the transient analysis are provided in Section 5.

3. System Model

An extensive model of the NU system in southwestern Connecticut was developed in the previous studies, including explicit representation of the 345 kV transmission system as far as Pleasant Valley, Manchester, Card, and Montville and the 115 kV transmission system as far as Campville, Berlin, East Meriden, and Green Hill. The 138 kV undersea cables to Northport were also included in the model. The transmission system beyond the extent of the model was represented by equivalent sources at each point where the model interfaces with the external system. Capacitor banks and load transformers were modeled throughout the explicitly-represented 115 kV system.

The model of the Middletown to Norwalk project was refined in the M/N project study and included a 33.3-mile overhead line between East Devon and Beseck 345 kV. In this study, the overhead line was replaced by two sets of three parallel 345 kV cables each with a length of 10 miles, with 14 miles of overhead line in the middle, between East Devon and Beseck. This cable addition increases the total 345 kV cable charging capacitance from about 1500 MVAR (for Plumtree to Norwalk and Norwalk to East Devon cables) to about 2800 MVAR.

Figure 3-1 shows the one-line diagram of M/N-P2 configuration including the breaker arrangement, provided by NU. Figure 3-2 shows the configuration of cables, overhead line, and shunt reactors between East Devon and Beseck as modeled for this study. Circuit breakers indicated by lettered squares are used to describe the case simulation conditions. Note that the simulation model shown in Figure 3-2, while not identical in configuration to Figure 3-1, is functionally equivalent and fully adequate to model the switching operations of the 20-mile cable option. For example, breaker Z1A represents one of two breakers that could be used to energize a cable circuit from the Devon end. Each of the 12 variable (75-150 MVAR) shunt reactors on the 10-mile cables was modeled with tap settings at 100 MVAR as a default, with variation cases at 75 and 150 MVAR. Also, due to modified thermal requirements, the 7% (on 100 MVA base) series reactor at Devon 345 kV is normally inserted, as specified by NU. In the two previous studies of the M/N project and the M/N-P1 project, the series reactor was normally bypassed.

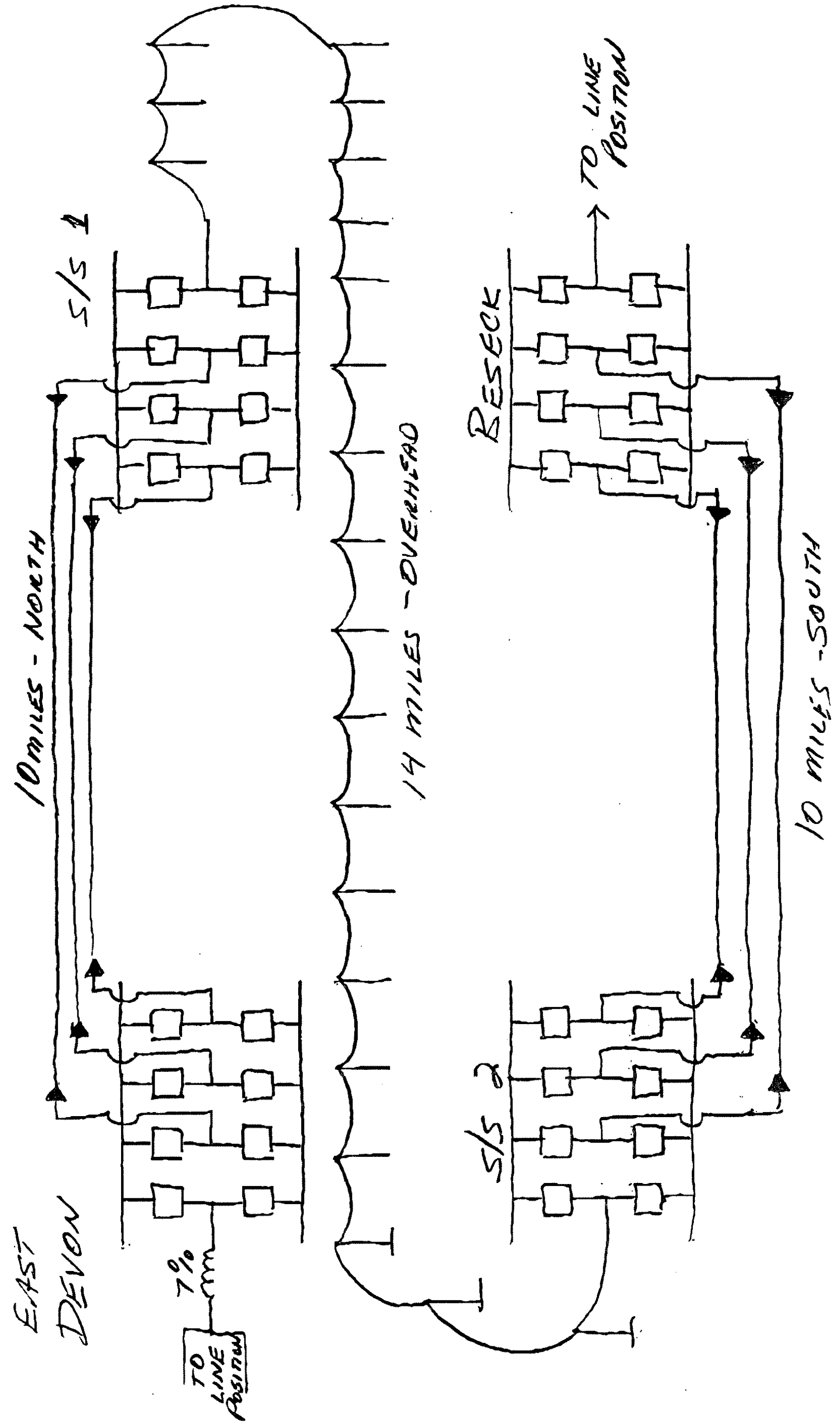


Figure 3-1. M/N-P1 One-Line Diagram with Breaker Arrangement

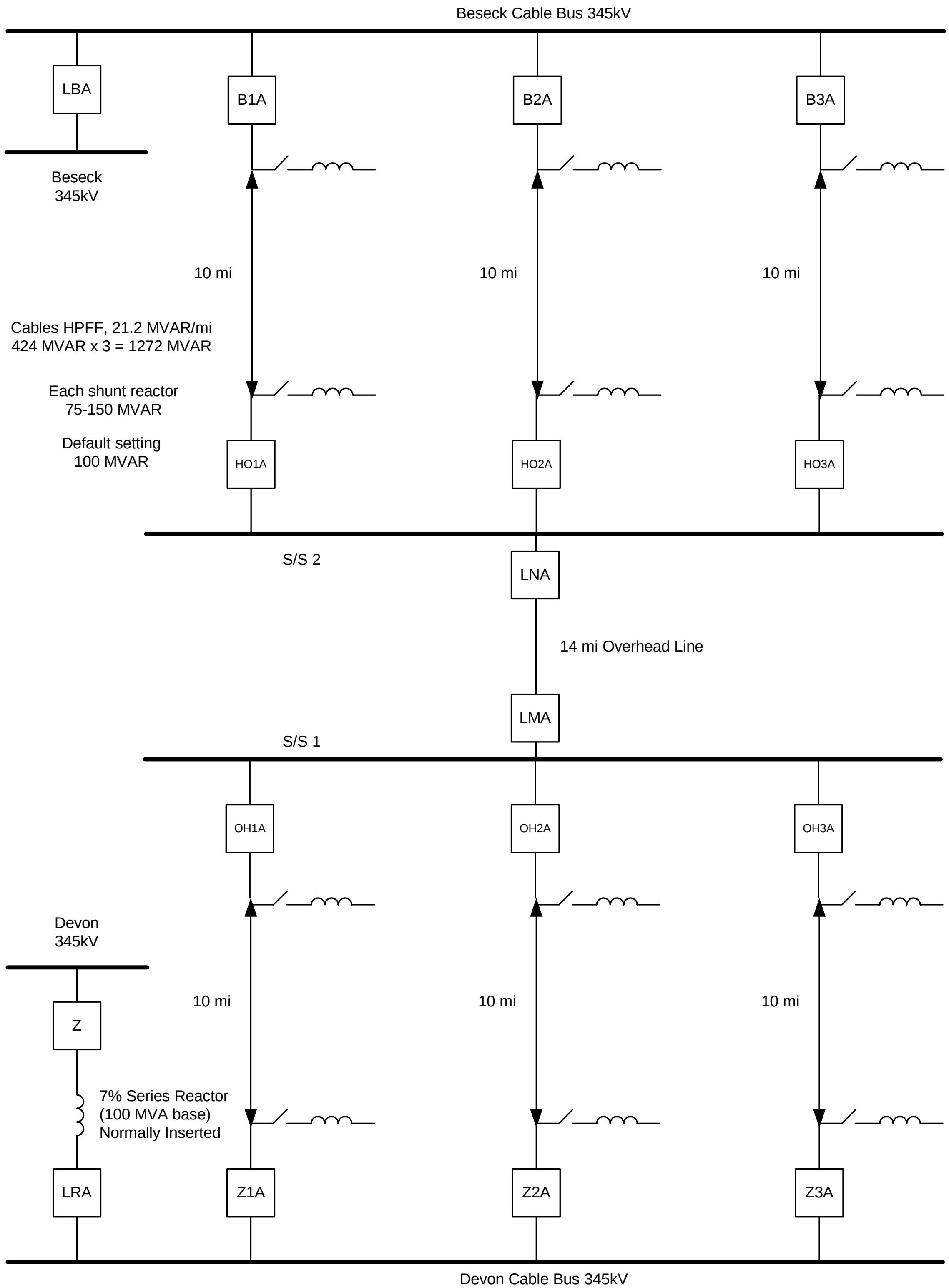


Figure 3-2. System Model One-Line Diagram of Devon-Beseck 20-mile Cable Option

4. Harmonic Analysis

The harmonic impact of the Devon-Beseck 20-mile cable option was analyzed by evaluating the driving-point impedance versus frequency at various locations.

Driving-Point Impedance

Harmonic screening simulations were performed to calculate the positive-sequence driving-point impedance versus frequency at the Plumtree, Norwalk, Singer, Devon, Beseck, Southington, and East Shore 345 kV buses and at the Plumtree, Norwalk, Southington, Devon, Frost Bridge and Glenbrook 115 kV buses. Cases were performed for the M/N-P2 configuration with various capacitor bank allocations. Table 4-1 shows the cases that were performed for the M/N-P2 configuration and the resonant frequencies that were observed along with the corresponding impedance value at those frequencies. The resonant frequency is indicated by its harmonic number (HN), in per unit of 60 Hz, and impedance magnitude is in ohms. For comparison purposes, the M/N base configuration cases from a previous study are shown in Table 4-2. The driving-point impedance plots for M/N-P2 are provided in Appendix A.

Table 4-1. Driving-Point Impedance Cases for M/N-P2 Configuration

			Resonant Frequency & Impedance (pu of 60Hz, Ohm)					
			Low		Middle		High	
Case	Location	Capacitor Banks	HN	Z(Ω)	HN	Z(Ω)	HN	Z(Ω)
M/N-P2_1A	Plumtree 345 kV	Light Load	2.4	156	3.3	141	10.4	478
M/N-P2_1B	Plumtree 345 kV	All in Service	2.2	122	3.2	80	11.2	681
M/N-P2_1C	Plumtree 345 kV	All Out of Service	2.4	157	3.3	140	10.4	478
M/N-P2_2A	Plumtree 115 kV	Light Load	2.4	16			10.4 13.8	96 106
M/N-P2_2B	Plumtree 115 kV	All in Service	2.1	16	6.7	71	9.5 11.3	57 38
M/N-P2_2C	Plumtree 115 kV	All Out of Service	2.4	16			10.4 13.8	96 106
M/N-P2_3A	Norwalk 345 kV	Light Load	2.4	200	3.3	224		
M/N-P2_3B	Norwalk 345 kV	All in Service	2.2	147	3.2	126		
M/N-P2_3C	Norwalk 345 kV	All Out of Service	2.4	201	3.3	223		
M/N-P2_4A	Norwalk 115 kV	Light Load	2.4	13	3.3	12	7.9	24
M/N-P2_4B	Norwalk 115 kV	All in Service	2.1	13	3.1 4.9	14 21	15.6	181
M/N-P2_4C	Norwalk 115 kV	All Out of Service	2.4	13	3.3	12	7.9	24
M/N-P2_5A	Southington 345 kV	Light Load	2.4	81	3.3	93	7.2	243
M/N-P2_5B	Southington 345 kV	All in Service	2.2	71	3.2	95	7.6	77
M/N-P2_5C	Southington 345 kV	All Out of Service	2.4	81	3.3	94	7.2	243
M/N-P2_6A	Southington 115 kV	Light Load	2.4	8			7.1	22
M/N-P2_6B	Southington 115 kV	All in Service	2.1	9	5.4	45	9.5	137
M/N-P2_6C	Southington 115 kV	All Out of Service	2.4	8			7.1	22
M/N-P2_7A	East Shore 345 kV	Light Load	2.4	56	4.8	156	7.1 14.7	122 335

			Resonant Frequency & Impedance (pu of 60Hz, Ohm)					
Case	Location	Capacitor Banks	Low		Middle		High	
			HN	Z(Ω)	HN	Z(Ω)	HN	Z(Ω)
M/N-P2_7B	East Shore 345 kV	All in Service	2.1	51	4.6	156	7.1 14.1	187 774
M/N-P2_7C	East Shore 345 kV	All Out of Service	2.4	54			7.1 14.6	148 370
M/N-P2_8A	Devon 115 kV	Light Load	2.4	11				
M/N-P2_8B	Devon 115 kV	All in Service	2.1	11				
M/N-P2_8C	Devon 115 kV	All Out of Service	2.4	12				
M/N-P2_9A	Frost Bridge 115 kV	Light Load	2.4	10				
M/N-P2_9B	Frost Bridge 115 kV	All in Service	2.1	13	4.8	59	8.7	26
M/N-P2_9C	Frost Bridge 115 kV	All Out of Service	2.4	10				
M/N-P2_10A	Glenbrook 115 kV	Light Load	2.4	12	3.3	11	8.0 16.0	42 56
M/N-P2_10B	Glenbrook 115 kV	All in Service	2.1	13	3.1	16	4.9	49
M/N-P2_10C	Glenbrook 115 kV	All Out of Service	2.4	12	3.3	11	8.0 16.0	42 56
M/N-P2_11A	Singer 345 kV	Light Load	2.4	203	3.3	221	10.5	141
M/N-P2_11B	Singer 345 kV	All in Service	2.2	148	3.2 4.9	122 57	11.2	252
M/N-P2_11C	Singer 345 kV	All Out of Service	2.4	205	3.3	220	10.5	141
M/N-P2_12A	Devon 345 kV	Light Load	2.4	203	3.3	209	10.4	182
M/N-P2_12B	Devon 345 kV	All in Service	2.2	148	3.2 4.9	115 55	11.2	347
M/N-P2_12C	Devon 345 kV	All Out of Service	2.4	205	3.3	208	10.4	182
M/N-P2_13A	Beseck 345 kV	Light Load	2.4	108	3.3	239	7.2	380
M/N-P2_13B	Beseck 345 kV	All in Service	2.2	79	3.2	185	7.6	211
M/N-P2_13C	Beseck 345 kV	All Out of Service	2.4	108	3.3	242	7.2	360

Table 4-2. Driving-Point Impedance Cases for M/N Base Configuration

			Resonant Frequency & Impedance (pu of 60Hz, Ohm)					
Case	Location	Capacitor Banks	Low		Middle		High	
			HN	Z(Ω)	HN	Z(Ω)	HN	Z(Ω)
PH2_1A	Plumtree 345 kV	Light Load	2.8	192			10.5	449
PH2_1B	Plumtree 345 kV	All in Service	2.4	128			11.3	620
PH2_1C	Plumtree 345 kV	All Out of Service	2.8	194			10.5	445
PH2_2A	Plumtree 115 kV	Light Load	2.8	19	10.5	93	13.9	109
PH2_2B	Plumtree 115 kV	All in Service	2.4	17	6.6	70		
PH2_2C	Plumtree 115 kV	All Out of Service	2.8	19	10.5	93	13.9	109
PH2_3A	Norwalk 345 kV	Light Load	2.8	243				
PH2_3B	Norwalk 345 kV	All in Service	2.4	149	5.0	70		
PH2_3C	Norwalk 345 kV	All Out of Service	2.8	245				
PH2_4A	Norwalk 115 kV	Light Load	2.8	16	7.9	24		
PH2_4B	Norwalk 115 kV	All in Service	2.4	15	5.0	18	15.6	181
PH2_4C	Norwalk 115 kV	All Out of Service	2.8	16	7.9	24		
PH2_5A	Southington 345 kV	Light Load	2.8	60			10.4	259
PH2_5B	Southington 345 kV	All in Service	2.4	61	4.3	81	8.2	88
PH2_5C	Southington 345 kV	All Out of Service	2.8	60			10.3	250
PH2_6A	Southington 115 kV	Light Load					10.2	29

			Resonant Frequency & Impedance (pu of 60Hz, Ohm)					
Case	Location	Capacitor Banks	Low		Middle		High	
			HN	Z(Ω)	HN	Z(Ω)	HN	Z(Ω)
PH2_6B	Southington 115 kV	All in Service	4.3	26	5.4	38	11.3	126
PH2_6C	Southington 115 kV	All Out of Service					10.1	28
PH2_7A	East Shore 345 kV	Light Load	4.7	167			10.2	212
PH2_7B	East Shore 345 kV	All in Service	4.3	111	7.2	188	12.5 14.6	261 519
PH2_7C	East Shore 345 kV	All Out of Service					10.1	239
PH2_8A	Devon 115 kV	Light Load	2.8	13				
PH2_8B	Devon 115 kV	All in Service	2.4	11				
PH2_8C	Devon 115 kV	All Out of Service	2.8	13				
PH2_9A	Frost Bridge 115 kV	Light Load	2.8	11			10.4	30
PH2_9B	Frost Bridge 115 kV	All in Service	2.4	14	4.3 5.4	31 40	8.3	34
PH2_9C	Frost Bridge 115 kV	All Out of Service	2.8	11			10.4	29
PH2_10A	Glenbrook 115 kV	Light Load	2.8	14	8	42	16.0	56
PH2_10B	Glenbrook 115 kV	All in Service	2.4	15	5.0	45		
PH2_10C	Glenbrook 115 kV	All Out of Service	2.8	14	8	42	16.0	56
PH2_11A	Singer 345 kV	Light Load	2.8	237			10.5	136
PH2_11B	Singer 345 kV	All in Service	2.4	144	5.0	74	11.3	231
PH2_11C	Singer 345 kV	All Out of Service	2.8	239			10.5	135
PH2_12A	Devon 345 kV	Light Load	2.8	228			10.5	173
PH2_12B	Devon 345 kV	All in Service	2.4	139	5.0	67	11.3	318
PH2_12C	Devon 345 kV	All Out of Service	2.8	230			10.5	171
PH2_13A	Beseck 345 kV	Light Load	2.8	67			10.4	280
PH2_13B	Beseck 345 kV	All in Service	2.4	57			12.5	277
PH2_13C	Beseck 345 kV	All Out of Service	2.8	67			10.4	270

Comparison of the driving-point impedance results of the M/N-P2 configuration with the M/N configuration indicate that with the 20-mile cable option, the lowest-frequency impedance resonance shifts down close to 2nd harmonic (from 2.4 to 2.1-2.2), with all capacitor banks in service. The series reactor at Devon 345 kV was inserted in the M/N-P2 cases, which causes some weakening of the system in this area. The results also indicate an additional resonance slightly above 3rd harmonic with the M/N-P2 configuration. These resonances near 2nd and 3rd harmonics are observed throughout the Bethel to Norwalk and Middletown to Norwalk cable region. In these cases, the light load capacitor bank configuration is similar to the configuration with all capacitors out of service, except that the filter banks are in service at Cross Sound.

Resonances are also appearing locally near 5th, 7th, and 11th harmonics with the 20-mile cable option in the M/N-P2 configuration. The resonant peak magnitudes at 5th harmonic are higher at some locations and lower at other locations. Resonances at 7th harmonic are appearing at more locations. The 5th and 7th harmonic resonances appear to be more dependent on local conditions. The 11th harmonic resonances are generally higher in magnitude with the M/N-P2 configuration.

Comparisons of harmonic resonance characteristics at 345 kV can be examined at Plumtree and Norwalk with different cable project configurations, and additionally with the existing system at Plumtree in the base system before the 345 kV cable additions. Figure 4-1 shows the driving-point impedance vs. frequency at Plumtree 345 kV with the existing system, with the Bethel to Norwalk project, with the Middletown to Norwalk project base configuration, with the M/N-P1 configuration, and with the M/N-P2 configuration, with all capacitor banks in service. With the addition of each cable project, the resonances move from 3rd harmonic to 2nd harmonic, and with the M/N-P2 configuration another resonance is observed near 3rd harmonic. The magnitude is higher with the B/N project but is lower with the M/N project due to the increased strength with the 345 kV loop. The impedance resonances with the M/N-P2 configuration are tuned just above 2nd harmonic and just above 3rd harmonic, with magnitudes similar to that of the existing system at 3rd harmonic.

Figure 4-2 shows the driving-point impedance vs. frequency at Norwalk 345 kV with the B/N project, with the M/N project base configuration, with the M/N-P1 configuration, and with the M/N-P2 configuration, with all capacitor banks in service. The impedance resonance characteristics at Norwalk 345 kV are similar to those at Plumtree 345 kV, except that the 5th harmonic resonance is more pronounced at Norwalk and the 11th harmonic resonance is much higher at Plumtree. At both Plumtree and Norwalk, the harmonic resonance characteristics of the M/N-P2 configuration are similar to the M/N configuration above 5th harmonic.

Figure 4-3 shows the driving-point impedance vs. frequency at Devon 345 kV with the M/N project base configuration, with the M/N-P1 configuration, and with the M/N-P2 configuration, with all capacitor banks in service and with all capacitor banks out of service. The plot indicates the additional resonance near 3rd harmonic with M/N-P2 and an increased magnitude of the 11th harmonic resonance. At Devon, the harmonic resonance characteristics of the M/N-P2 configuration are similar to the M/N configuration above 5th harmonic, and at Beseck they are much different, as shown in Figure 4-4. With the M/N-P2 configuration, the resonance near 3rd harmonic is higher in magnitude than the resonance near 2nd harmonic, and the resonance near 7th harmonic is much higher in magnitude.

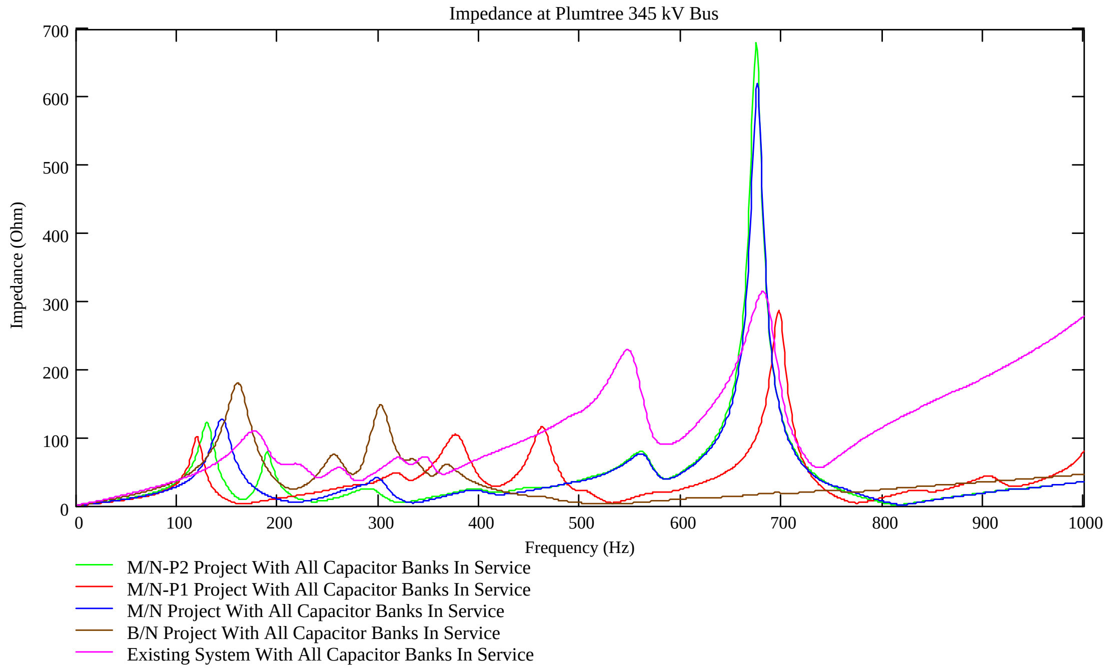


Figure 4-1. Impedance vs. Frequency at Plumtree 345 kV

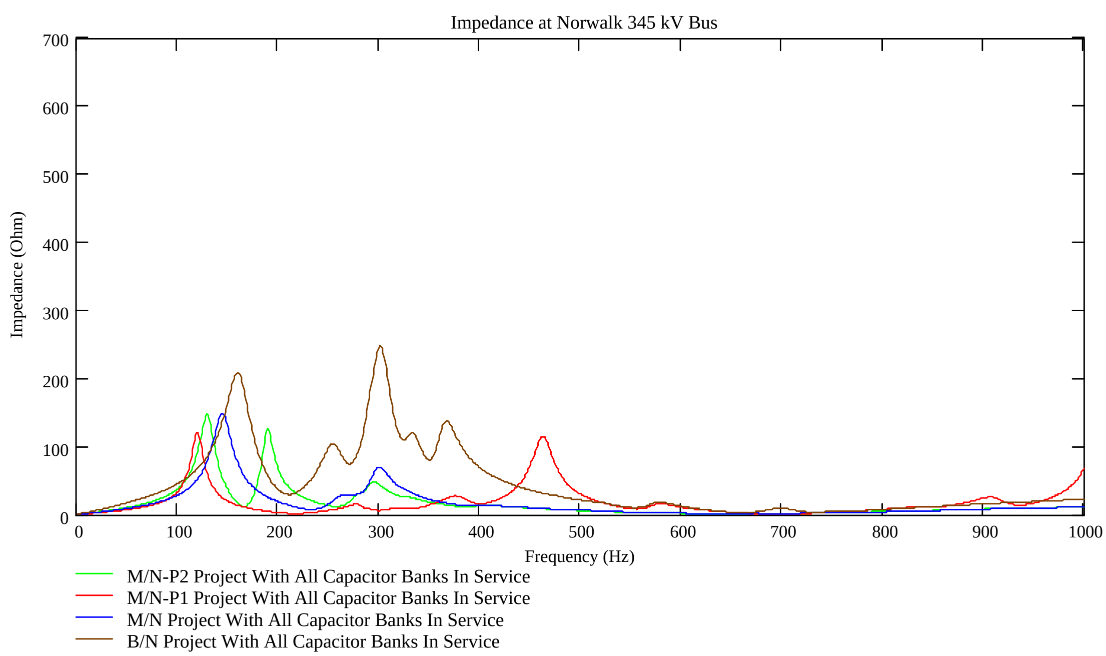


Figure 4-2. Impedance vs. Frequency at Norwalk 345 kV

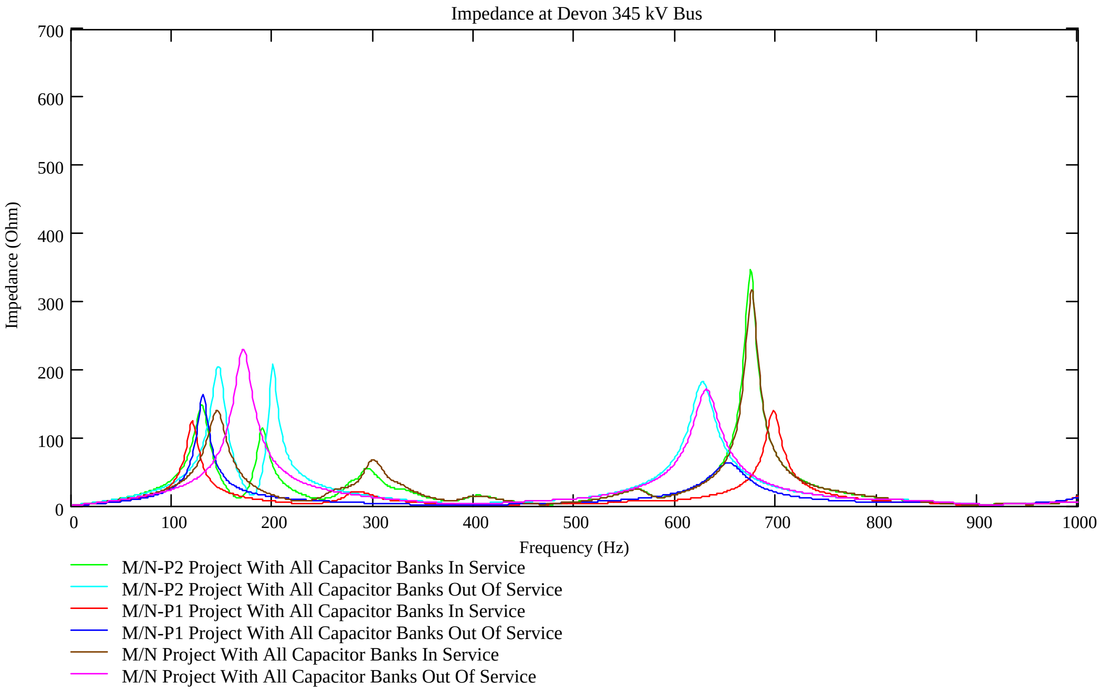


Figure 4-3. Impedance vs. Frequency at Devon 345 kV

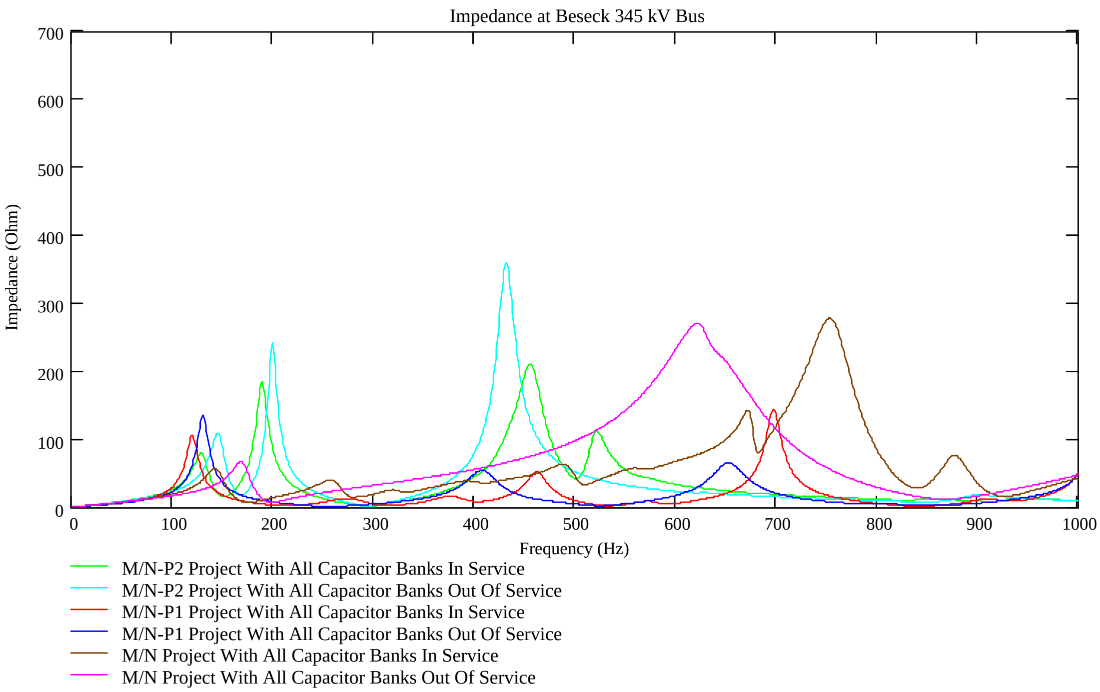


Figure 4-4. Impedance vs. Frequency at Beseck 345 kV

Second Harmonic Resonance Risk Evaluation

The M/N-P2 configuration, with 20 miles of cable and with the series reactor inserted at Devon 345 kV, resulted in an impedance resonance marginally above the 2^{nd} harmonic. Changes in system configuration could easily move the resonance to 2^{nd} harmonic or below. Consequently, there are similar concerns with this configuration as there were for the M/N-P1 configuration with 40 miles of cable, which had an impedance resonance at 2^{nd} harmonic.

Under normal circumstances, there is little stimulus of the 2^{nd} harmonic because most nonlinear loads produce virtually all of their current distortion in the odd-order harmonics (exceptions are arc furnaces, lamp dimmers, and some consumer-device half-wave dc power supplies). However, there are a number of circumstances where substantial 2^{nd} harmonic stimulus can take place. Existence of system driving point impedance resonances near the 2^{nd} harmonic increase the risk of severe distortion and consequent elevated peak overvoltages and complex control and protection interactions. Designing a system configuration which results in an impedance resonance at 2^{nd} harmonic is potentially very risky and is not recommended.

The most significant source for 2^{nd} harmonic stimulus in a power system is transformer exciting current. Transformer exciting current is very highly distorted, and is composed almost entirely of odd-order harmonics during normal excitation. With asymmetric (i.e., offset) saturation, both even- and odd-order harmonics are produced, which tend to decrease as a function of 1/(HN). Thus, transformers characteristically produce large 2^{nd} harmonic components during offset saturation. Large-scale injection of these current harmonics in a system resonant in the same frequency range can result in severe voltage distortion and elevated peak voltages.

Asymmetric transformer saturation is usually the result of flux offsets due to transformer energization and fault clearing. Inrush can persist for many seconds. Another source of asymmetric saturation is geomagnetic disturbances, which can be present for periods of several days. Severe geomagnetic disturbances, resulting from solar storms, can cause currents at very low frequency (or quasi-dc currents) to flow in the earth. These currents are known as geomagnetically-induced currents (GIC) which can flow into the power system through grounded-wye transformers and can cause asymmetric transformer saturation throughout the power system. The resulting transformer exciting currents, rich in 2^{nd} harmonic, can result in severe and persistent voltage distortion.[1] A blackout of Hydro-Quebec in 1989 has been attributed to second harmonic distortion due to GIC interacting with a protective scheme. GIC issues have been frequently observed in the Hudson Valley region of New York, and in New Jersey where large GSU transformers were destroyed at a nuclear power plant (not due to harmonic distortion, however this indicates that GIC is present in the Northeast).

[1] R. A. Walling, A. H. Khan, "Characteristics of Transformer Exciting-Current During Geomagnetic Disturbances," IEEE Transactions on Power Delivery, Vol. 6, No. 4, October 1991, pp.1707-1713.

Severe distortion at a particular harmonic, resulting from asymmetric transformer saturation, often occurs when the system is resonant just below that harmonic. This was observed in the study of the M/N project, in which the system was tuned below 3rd harmonic (between 2.4 and 2.8). When a system is resonant below the given harmonic, the system impedance is inherently capacitive at that harmonic (which can be seen as impedance decreasing with frequency at that harmonic; i.e., negative slope). The capacitive nature of the system forms a resonance with the non-linear inductance of the transformer, which can result in severe voltage distortion during inrush situations, such as energization or inrush following fault clearing.

The same relationship applies to a system that is resonant at 2nd harmonic. However, the severity of the distortion would be expected to be even more severe since the 2nd harmonic currents are about 1.5 times higher than 3rd harmonic currents. In the M/N-P2 configuration, it was found that the system is resonant just above 2nd harmonic, with all cables and lines in service and all 115 kV capacitor banks in service. Changes in system configuration could easily move the resonance to 2nd harmonic or below, such as loss of lines or generators or addition of cables or capacitor banks at 115 kV. All of these examples, which could weaken the system or add capacitance, could occur either during normal operation or in planned upgrades to the NU system.

In a system that is resonant at 2nd harmonic, the potential for control interactions of certain power electronic equipment is increased. These include HVDC converter terminals, Statcoms, Static Var Compensators (SVCs), and drive system loads. Complex interactions between conventional HVDC systems and system 2nd harmonic resonance, resulting in system instability, have been documented. The HVDC terminal at nearby Cross Sound is a voltage-source-inverter-based converter. The vulnerability of this new technology to 2nd harmonic interactions has not been reported in the literature. A Statcom is currently in the plans for installation at Glenbrook 115 kV, which is very close to Norwalk. The potential for interaction between this Statcom and system 2nd harmonic resonance is also not known. Control schemes should be evaluated with the expected impedance resonance characteristics in a cycle-by-cycle transient analysis. Controls for drive system loads could also be affected by a 2nd harmonic resonance in the system. The potential effects of a 2nd harmonic resonance on control interactions could be widely distributed, and vulnerable locations could be difficult to identify.

The potential for misoperation of particular protection schemes can be increased in a system that is resonant at 2nd harmonic. For example, schemes that are based on phase comparison or that monitor zero crossings could be prone to misoperation if currents have a high harmonic content.

While not as severe an issue as distortion driven by transformer saturation, a resonance at 2nd harmonic will tend to aggravate the issue of steady-state even-order harmonic distortion caused by the minority of loads injecting even harmonics. Some suggest that current guidelines for 2nd harmonic distortion current injection are too high.[2] Existence of a system

[2] Orr, J.A.; Emanuel, A.E., "On the need for strict second harmonic limits," Proceedings of 8th International Conference on Harmonics and Quality of Power, 1998, Vol. 1, Oct. 1998, pp. 176 –181.

resonance at 2nd harmonic has the same impact on voltage distortion as a large increase in harmonic current injection.

Summary

The M/N-P2 configuration resulted in impedance resonances marginally above the 2nd harmonic and marginally above the 3rd harmonic. Changes in system configuration could easily move the resonances to 2nd and 3rd harmonics or below. Consequently, there are concerns regarding power system events involving transformer exciting current, such as energization and inrush due to fault clearing. With resonances near both 2nd and 3rd harmonics, the harmonic currents due to inrush could have an additive effect to produce more severe results than those with resonances at either harmonic. There are also concerns, as discussed above, about being close to 2nd harmonic. Although the resonance is above 2nd harmonic, it is very close, and defining a design with a minimum safe margin above 2nd harmonic is a subjective call. There is significant concern in regard to the harmonic characteristics of the M/N-P2 configuration.

5. Switching Transient Analysis

The critical issues that were examined in regard to switching cables and transformers, and clearing faults, in the M/N-P2 configuration were power quality and equipment duty. Different criteria were applied for evaluation of transient and temporary overvoltages and distortion resulting from routine switching operations, and results from contingencies such as faults and equipment failures. Sustained and distorted overvoltages, resulting from routine cable and transformer switching, are not acceptable when considering power quality throughout the system. For fault and equipment failure events, avoidance of consequential equipment damage was the driving criterion. Equipment must be able to withstand temporary overvoltages, and circuit breakers must be capable of successfully interrupting under these conditions. In this fatal flaw analysis of the M/N-P2 configuration, selected cases were simulated to evaluate routine switching operations and to investigate scenarios where the impedance resonances near 2^{nd} and 3^{rd} harmonics could adversely impact the switching transient and temporary overvoltages.

Table 5-1 provides a case list of the switching transient simulations that were performed and includes the operating breaker, open breakers, fault type and location, shunt reactor settings, capacitor bank dispatch, switch timing, and other system conditions. The corresponding simulation case plots can be found in Appendix B. Eight pages of plots for each case are included in the Appendix, and the complete set of plots is included separately on a CD. The first two pages are summary pages for the Devon-Beseck cables and the Norwalk-Singer and Singer-Devon cables, including cable end voltages, surge arrester energies, and circuit breaker voltages. Quantities at each cable end are superposed on each plot. The next two pages show the voltages and currents for each of the six cables between Devon and Beseck. Two pages of 345 kV bus voltages and two pages of 115 kV bus voltages are also included.

With the series reactor at Devon 345 kV always inserted, several scenarios were investigated where cables between Devon and Beseck were in service, but the cable system was isolated either by opening the Beseck end or removing the overhead line. The series reactor together with the shunt-compensated cables are similar to a filter circuit, having a series resonance dependent on the natural frequency of the inductive and capacitive components. Depending on the number of cables in service, the frequency of the series resonance can vary from about 160 Hz down to about 80 Hz, as indicated in Figure 5-1 and Table 5-2, which was calculated with 75 MVAR shunt reactors. With the Beseck end open or with the overhead line out of service, the series reactor with the remaining cables can contribute to low-frequency oscillations in the system. This phenomenon was observed in cable energization, transformer energization, and fault and clear simulations.

Energization Strategy

Several cases were simulated to energize each of the six 10-mile cables from each end with uncontrolled closing, and selected cases were performed with pre-insertion resistors. Case scenarios were simulated energizing the cables starting from the Devon end and starting from the Beseck end. Figure 5-2 shows the energization of the third cable from the Devon end. A

Table 5-1. Switching Transient Simulation Case List

Switching Cases: Devon-Beseck modeled as 2 sets of 10-mile cables, 14-mile overhead line (M/N-P2)

Shunt Reactor Settings (MVAR)

Case #	Operation	Operating Breaker	Open Breakers	Fault Type	Fault Location	Dev-Bes (6 Cables) Setting of each of 12 reactors	Nor-Sng1 Nor	Nor-Sng1 Sng	Nor-Sng2 Nor	Nor-Sng2 Sng	Sng-Dev1 Sng	Sng-Dev1 Dev	Sng-Dev2 Sng	Sng-Dev2 Dev	Plum-Norw Plm	Plum-Norw Nor1	Plum-Norw Nor2	Arresters	Pre-Ins Resistor	Cap Banks	Switch Timing	System Conditions
Energize Cable Devon to Beseck FIRST TIME starting from Devon																						
FED 1	Energize	Z1A	Z2A,Z3A,OH1A,OH2A,OH3A,HOA1,HOA2,HOA3,B1A,B2A,B3A			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FED 1A	Energize	Z1A	Z2A,Z3A,OH1A,OH2A,OH3A,HOA1,HOA2,HOA3,B1A,B2A,B3A			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	
FED 1R	Energize	Z1A	Z2A,Z3A,OH1A,OH2A,OH3A,HOA1,HOA2,HOA3,B1A,B2A,B3A			100	100	100	100	100	75	75	75	75	75	150	75	IN	350Ω	Pk. Load	Vpeak-all	
FED 2	Energize	Z2A	Z3A,OH2A,OH3A,HOA1,HOA2,HOA3,B1A,B2A,B3A,LMA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FED 3	Energize	Z3A	OH3A,HOA1,HOA2,HOA3,B1A,B2A,B3A,LMA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FED 3R	Energize	Z3A	OH3A,HOA1,HOA2,HOA3,B1A,B2A,B3A,LMA			100	100	100	100	100	75	75	75	75	75	150	75	IN	350Ω	Pk. Load	Vpeak-all	
FED 4	Energize	LMA	HOA1,HOA2,HOA3,B1A,B2A,B3A			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FED 5	Energize	HO1A	HOA2,HOA3,B1A,B2A,B3A ,LBA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FED 5R	Energize	HO1A	HOA2,HOA3,B1A,B2A,B3A ,LBA			100	100	100	100	100	75	75	75	75	75	150	75	IN	350Ω	Pk. Load	Vpeak-all	
FED 6	Energize	HO2A	HOA3,B2A,B3A,LBA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FED 7	Energize	HO3A	B3A,LBA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FED 8	Energize	Z1A	Z2A,Z3A,OH1A,OH2A,OH3A,HOA1,HOA2,HOA3,B1A,B2A,B3A,X2,Y2			150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-PhA	Singer-Devon cable out
FED 9	Energize	Z1A	Z2A,Z3A,OH1A,OH2A,OH3A,HOA1,HOA2,HOA3,B1A,B2A,B3A,X2,Y2			150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-PhA	S-D cable out, 7% reactor bypassed
FED 9A	Energize	Z1A	Z2A,Z3A,OH1A,OH2A,OH3A,HOA1,HOA2,HOA3,B1A,B2A,B3A,X2,Y2			150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	S-D cable out, 7% reactor bypassed
FED 10	Energize	Z	LBA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	
FED 10A	Energize	Z	LBA	B-g	D-B OH Line 345 kV	100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	
FED 10R	Energize	Z	LBA			100	100	100	100	100	75	75	75	75	75	150	75	IN	350Ω	Pk. Load	Vzero-all	
FED 11	Energize	LRA	LBA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	
FED 11A	Energize	LRA	LBA	B-g	D-B OH Line 345 kV	100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	
FED 12	Energize	Z	Z3A,OH1A,OH2A,OH3A,LBA			75	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-PhA	series reactor and 2 cables together
FED 12A	Energize	Z	Z3A,OH1A,OH2A,OH3A,LBA	B-g	Devon Cable Ckt 1	75	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	series reactor and 2 cables together
Energize Cable Devon to Beseck FIRST TIME starting from Beseck																						
FEB 1	Energize	B1A	Z1A,Z2A,Z3A,OH1A,OH2A,OH3A,HOA1,HOA2,HOA3,B2A,B3A			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-PhA	
FEB 2	Energize	B2A	Z1A,Z2A,Z3A,OH1A,OH2A,OH3A,HOA2,HOA3,B3A,LNA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FEB 3	Energize	B3A	Z1A,Z2A,Z3A,OH1A,OH2A,OH3A,HOA3,LNA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FEB 4	Energize	LNA	Z1A,Z2A,Z3A,OH1A,OH2A,OH3A			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FEB 5	Energize	OH1A	Z1A,Z2A,Z3A,OH2A,OH3A			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FEB 6	Energize	OH2A	Z2A,Z3A,OH3A,LRA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FEB 7	Energize	OH3A	Z3A,LRA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vpeak-all	
FEB 8	Energize	LBA	Z			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	
FEB 8A	Energize	LBA	Z	B-g	D-B OH Line 345 kV	100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	
Energize Norwalk Transformer																						
N 1	Energize	N	O			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	
N 1R	Energize	N	O			100	100	100	100	100	75	75	75	75	75	150	75	IN	350Ω	Pk. Load	Vzero-all	
N 2	Energize	N	O			100	100	100	100	100	75	75	75	75	75	150	75	IN		Lt. Load	Vzero-all	light load cap bank condition
N 3	Energize	N	O,V1,W1			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	Norwalk-Singer cable out
N 4	Energize	N	O,R,S			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	345/115 Norwalk transformer out
N 5	Energize	N	O,X1,Y1			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	Singer-Devon cable out
Energize Singer/Pequonnock Transformer																						
2 1	Energize	2	3			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	
2 1A	Energize	2	3,LBA			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	
2 2	Energize	2	3			100	100	100	100	100	75	75	75	75	75	150	75	IN		Lt. Load	Vzero-all	light load cap bank condition
2 3	Energize	2	3,V1,W1			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	Norwalk-Singer cable out
2 4	Energize	2	3,4,5			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	345/115 Singer/BrgEnergy transformer out
2 5	Energize	2	3,X1,Y1			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	Singer-Devon cable out
Energize Devon Transformer																						
6 1	Energize	6	7			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	
6 2	Energize	6	7			100	100	100	100	100	75	75	75	75	75	150	75	IN		Lt. Load	Vzero-all	light load cap bank condition
6 3	Energize	6	7,X1,Y1			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	Singer-Devon cable out
6 4	Energize	6	7,2,3			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	345/115 Pequonnock transformer out
6 5	Energize	6	7,V1,W1,V2,W2			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	Norwalk-Singer cables out
6 5R	Energize	6	7,V1,W1,V2,W2			100	100	100	100	100	75	75	75	75	75	150	75	IN	350Ω	Pk. Load	Vzero-all	Norwalk-Singer cables out
6 6	Energize	6	7,X1,Y1,X2,Y2			100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load	Vzero-all	Singer-Devon cables out
Fault and Clear (apply fault at 1 cy)																						
DBF 1	Cable Fault & Clear	HO1A, B1A		B-g	Beseck end	100	100	100	100	100	75	75	75	75	75	150	75	IN		Lt. Load		open t=5,11cy
DBF 2	Cable Fault & Clear	HO1A, B1A		B-g	Beseck end	75	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy

Table 5-1. Switching Transient Simulation Case List

Switching Cases: Devon-Beseck modeled as 2 sets of 10-mile cables, 14-mile overhead line (M/N-P2)

Case #	Operation	Operating Breaker	Open Breakers	Fault Type	Fault Location	Dev-Bes (6 Cables) Setting of each of 12 reactors	Nor-Sng1 Nor	Nor-Sng1 Sng	Nor-Sng2 Nor	Nor-Sng2 Sng	Sng-Dev1 Sng	Sng-Dev1 Dev	Sng-Dev2 Sng	Sng-Dev2 Dev	Plum-Norw Plm	Plum-Norw Nor1	Plum-Norw Nor2	Arresters	Pre-Ins Resistor	Cap Banks	Switch Timing	System Conditions
						Shunt Reactor Settings (MVAR)																
DBF 2A	Cable Fault & Clear	HO1A, B1A	Beseck reactor out	B-g	Beseck end	75	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 3	Line Fault & Clear	LMA,LNA		B-g	Beseck end	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 4	Line Fault & Clear	LMA,LNA		B-g	Devon end	100	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 5	Line Fault & Clear	LMA,LNA		B-g	Devon end	75	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 6	Line Fault & Clear	LMA,LNA		ABC-g	Beseck end	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 7	Line Fault & Clear	LMA,LNA		ABC-g	Devon end	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 8	Stub Fault & Clr	Fault		ABC-g	Devon 345 kV	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 9	Stub Fault & Clr	Fault		ABC-g	Devon 345 kV	75	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 10	Stub Fault & Clr	Fault		ABC-g	Beseck 345 kV	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 11	Stub Fault & Clr	Fault		ABC-g	Beseck 345 kV	75	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 12	Stub Fault & Clr	Fault		ABC-g	Singer 345 kV	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 12A	Stub Fault & Clr	Fault	LBA	ABC-g	Singer 345 kV	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 13	Stub Fault & Clr	Fault		ABC-g	Singer 345 kV	75	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 14	Stub Fault & Clr	Fault		ABC-g	Norwalk 345 kV	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 15	Stub Fault & Clr	Fault		ABC-g	Norwalk 345 kV	75	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 16	Stub Fault & Clr	Fault		ABC-g	D-B OH Line 345 kV	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 17	Stub Fault & Clr	Fault		ABC-g	D-B OH Line 345 kV	75	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 18	Stub Fault & Clr	Fault		ABC-g	Norwalk 345 kV	0	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 19	Bus Fault & Clr	OH1,OH2,OH3,LMA	Y1,Y2	ABC-g	D-B S/S 1	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 20	Bus Fault & Clr	HO1A,HO2A,HO3A,LNA	Y1,Y2	ABC-g	D-B S/S 2	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 21	Bus Fault & Clr	HO1A,HO2A,HO3A,LNA		ABC-g	D-B S/S 2	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 22	Bus Fault & Clr	HO1A,HO2A,HO3A,LNA	Y1,Y2, Z2A, Z3A	ABC-g	D-B S/S 2	150	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
DBF 23	Cable Fault & Clear	HO1A, B1A	RESTRIKE HO1A PHASE > 550 Kv	B-g	Beseck end	75	100	100	100	100	75	75	75	75	75	150	75	IN		Pk. Load		open t=5,11cy
Fault and Clear Norwalk-Singer-Devon Cables (apply fault at 1 cy)																						
NSF 1	Cable Fault & Clear	V1,W1	S1	B-g	Singer end	100	75	0	75	75	75	75	75	75	75	150	75	IN		Pk. Load	Bkr W1 last	open t=5,11cy
SDF 1	Cable Fault & Clear	X1,Y1	D1	B-g	Singer end	100	75	75	75	75	75	0	75	75	75	150	75	IN		Pk. Load	Bkr Y1 last	open t=5,11cy

capacitive switching transient is observed in addition to a low-frequency oscillation having a beating effect of the 60 Hz system with the series reactor and the three cables tuned at about 100 Hz. Figure 5-3 shows that the use of a pre-insertion resistor in the same case mitigates the capacitive switching transient but does not remedy the low-frequency oscillation. Figure 5-4 indicates the presence of a 20 Hz modulation in the highly distorted cable voltages when energizing all six cables together from the Devon end, with a pre-insertion resistor. This modulation is the result of beating between 80 Hz and the 60 Hz voltage components. The series reactor with six cables has a resonant frequency near 80 Hz, which beats against the 60 Hz system. Energizing all six cables together is not recommended, and these results further support the need for intermediate switching stations. Alternately, Figure 5-5 shows the energization of the third cable from the Beseck end. A capacitive switching transient is observed, but there is no low-frequency oscillation. The Devon-Beseck cables should be energized only from the Beseck end, and not from the Devon end, with the last step to complete the path through the series reactor.

Energization of the 14-mile overhead line between Devon and Beseck was performed without line-end arresters and with uncontrolled closing, and it resulted in high transient voltages. Line-end arresters and/or controlled closing should be used for line energization, and further study is recommended to evaluate line terminal and substation equipment with regard to insulation coordination.

Transformer energization scenarios were also examined. Figure 5-6 shows the energization of the Devon 345/115 kV transformer without pre-insertion resistors and with the Norwalk-Singer cables out of service, and it indicates a severely distorted voltage with a high temporary overvoltage magnitude near 2 pu. Figure 5-7 indicates that the use of a pre-insertion resistor in the same case greatly improves the temporary overvoltage distortion due to inrush. Figure 5-8 shows the energization of the Singer transformer without pre-insertion resistors and with the LBA breaker open at the Beseck end of the cables. The simulation indicates that transformer energization can initiate low-frequency oscillations with an 80 Hz component, producing current amplitude modulation at 20 Hz, when the series reactor and cables are connected at the Devon end with the Beseck end open. This condition should be avoided.

Equipment Specification Issues

Various fault and clear scenarios were also studied. In Figures 5-9 and 5-10, the 14-mile overhead line between Devon and Beseck is faulted and removed from service with delayed breaker opening. After the LMA breaker opens, an oscillatory temporary overvoltage (TOV) appears on the three Devon cables, which are isolated with the series reactor at Devon. After the LNA breaker opens, a trapped charge is left on the unfaulted phases of the overhead line. The trapped charge on the line results in a dc offset in the circuit breaker transient recovery voltages (TRVs). The oscillatory TOV on the cables contributes to the TRV across the breaker which is nearly 800 kV. This exceeds the TRV capability defined for 362 kV breakers in ANSI C37.06. Recovery voltages of about 750 kV were also observed in cable fault clearing cases. Higher test voltages or breaker ratings could be required and should be reviewed by the breaker manufacturer.

In Figures 5-11 and 5-12, a three-phase-to-ground fault is applied and removed at Singer 345 kV, with the LBA breaker open at the Beseck end of the cables. The simulation indicates that a stub fault clearing can initiate severe oscillations on the Devon-Beseck cables when the series reactor and cables are connected at the Devon end with the Beseck end open. In this case, the effects of the 80 Hz series resonance of the series reactor and cables and the inrush from multiple transformers are combined and resulted in highly distorted overvoltages. This condition should be avoided.

Study results indicate that with the Beseck end open or with the overhead line out of service, the series reactor with the remaining cables can contribute to low-frequency oscillations in the system. A redundant transfer trip scheme is recommended to trip the Devon end of the cables if the cables are in service through the series reactor at Devon without connection to the Beseck end. An alternate location for the series reactor, which could possibly mitigate some of the resonance issues identified in this study, could also be considered.

Stub fault and clear simulations resulted in transient voltages of 700 kV across the Devon series reactor. The insulation coordination and equipment specification of the series reactor should be further evaluated in regard to its BIL rating and possible use of surge arresters across the reactor.

A detailed TRV study is recommended for the circuit breaker in series with the series reactor. Clearing a fault on the cable side of the reactor is a critical case for the TRV of the breaker adjacent to the reactor and requires a high-frequency model of the exact hardware and stray capacitances of the associated equipment. If TRV limits are exceeded, a shunt capacitance (such as a CVT) could be added between the breaker and series reactor to remedy the situation. This type of microsecond-level TRV analysis was not within the scope of this study, but should be considered particularly for this series reactor configuration.

115 kV Equipment Considerations

High transient voltages at 115 kV buses were observed in various cases primarily at Rocky River, as in previous studies. For example, with a stub fault and clear at Singer, a transient voltage of 2.4 pu was observed at Rocky River 115 kV. There is a widely-documented phenomenon, called voltage magnification, where oscillations between two coupled resonant circuits can result in magnified voltage oscillations in the second circuit due to oscillations in the first. Magnification is most severe when the driving circuit (the 345 kV system in this case) has a much larger capacitance than the driven system (115 kV capacitor bank). This phenomenon is most commonly reported as the result of switching a large capacitor bank in the vicinity of a smaller capacitor bank nearby on a lower-voltage system. However, in the case of the M/N and M/N-P2 configurations, the 345 kV fault oscillations appear to instigate this magnification phenomenon. A surge arrester at Rocky River would limit the transient voltage, but would discharge significant current in this case. Fault clearing events also resulted in temporary overvoltages on the 115 kV system. It is recommended that arrester energy and TOV duty be evaluated in the 115 kV system.

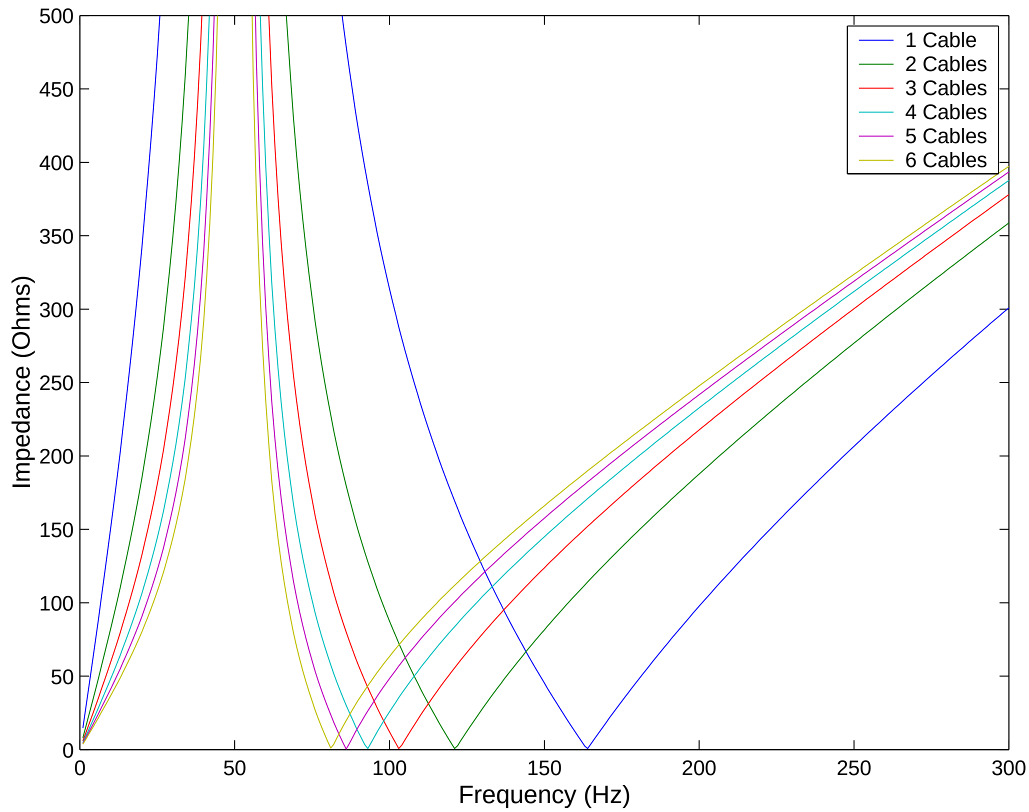


Figure 5-1. Impedance of Series Reactor with Shunt-Compensated Cables

Table 5-2. Frequency of Series Resonance of Series Reactor with Shunt-Compensated Cables

# Cables (10 mi)	# Shunt Reactors (75 MVAR)	Frequency of Series Resonance (Hz)	Harmonic Number (HN) (pu of 60 Hz)
1	2	164	2.73
2	4	121	2.02
3	6	103	1.72
4	8	93	1.55
5	10	86	1.43
6	12	81	1.35

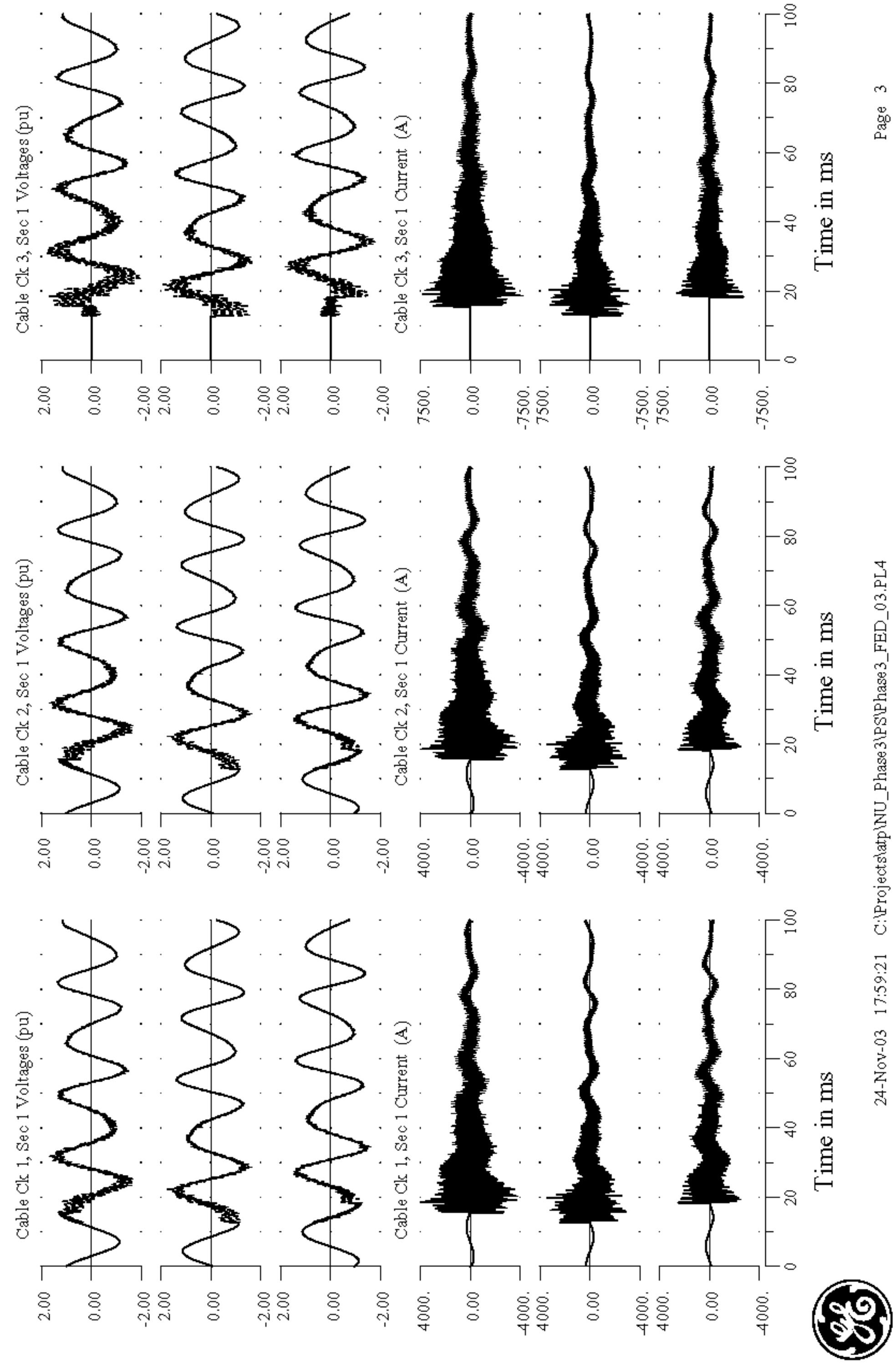


Figure 5-2. Energization of 3rd Cable at Devon (Case FED-3)

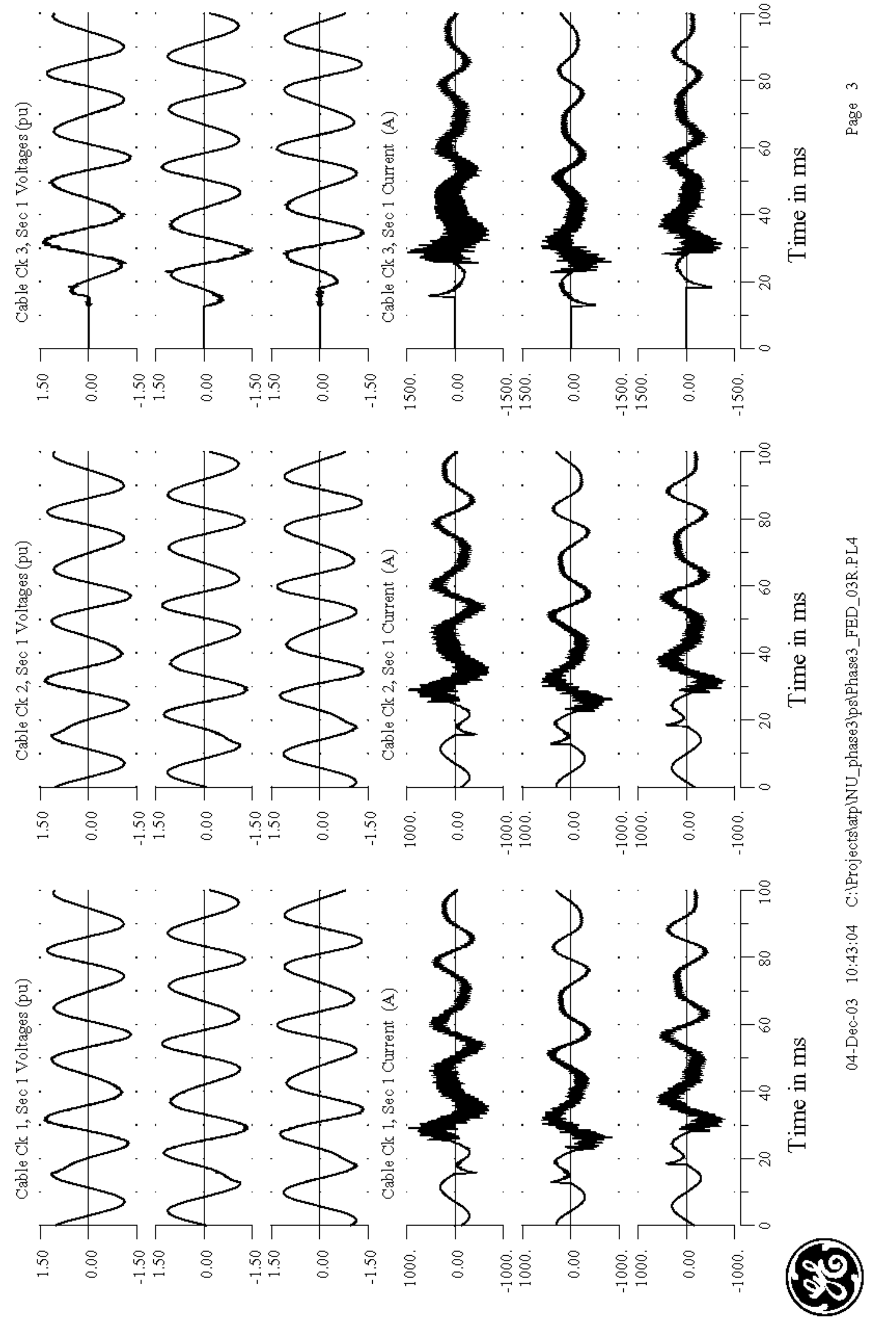


Figure 5-3. Energization of 3rd Cable at Devon, with Pre-Insertion Resistor (Case FED-3R)

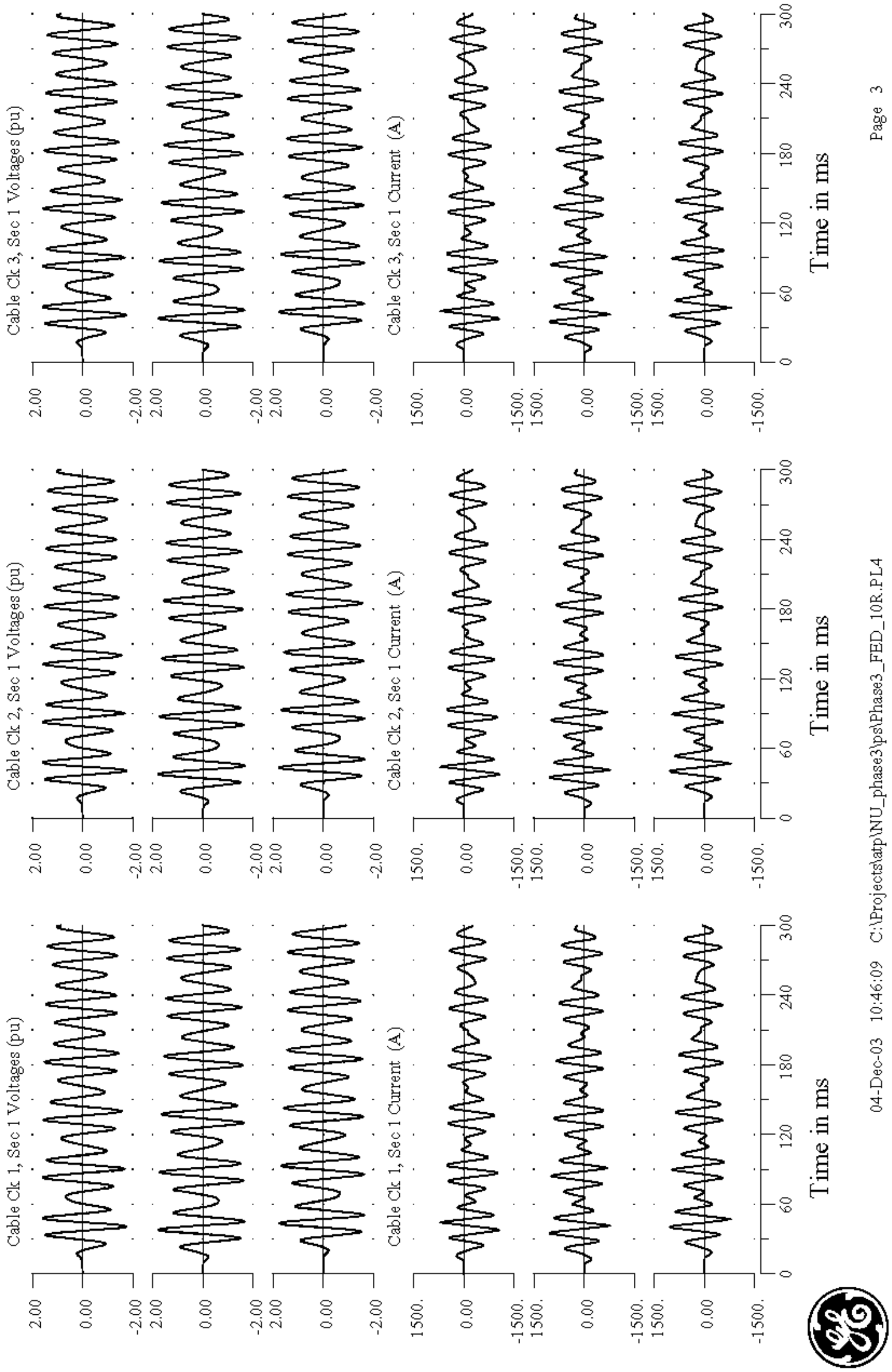


Figure 5-4. Energization of 6 Cables from Devon, with PIR (Case FED-10R)

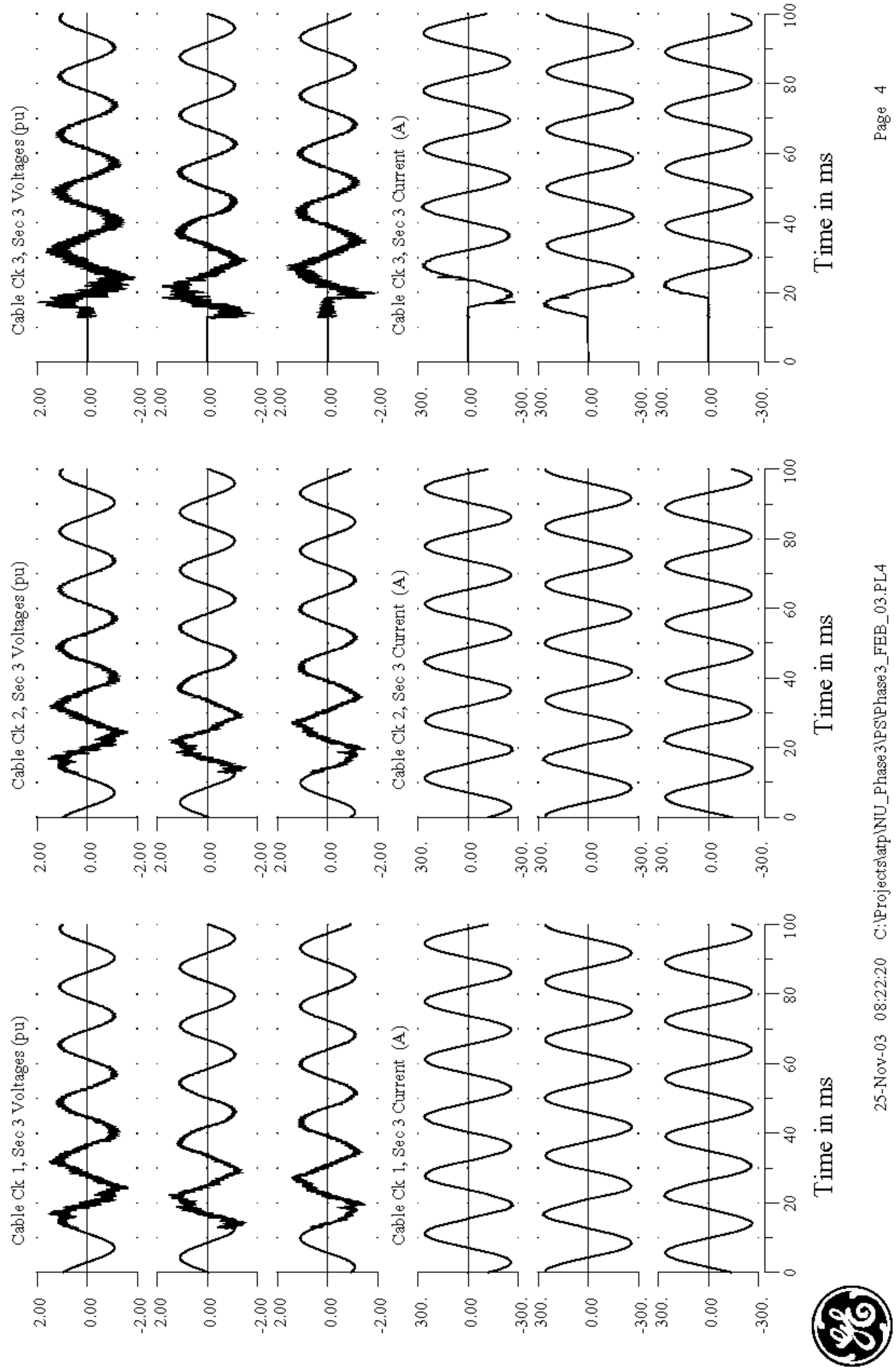


Figure 5-5. Energization of 3rd Cable at Beseck (Case FEB-3)

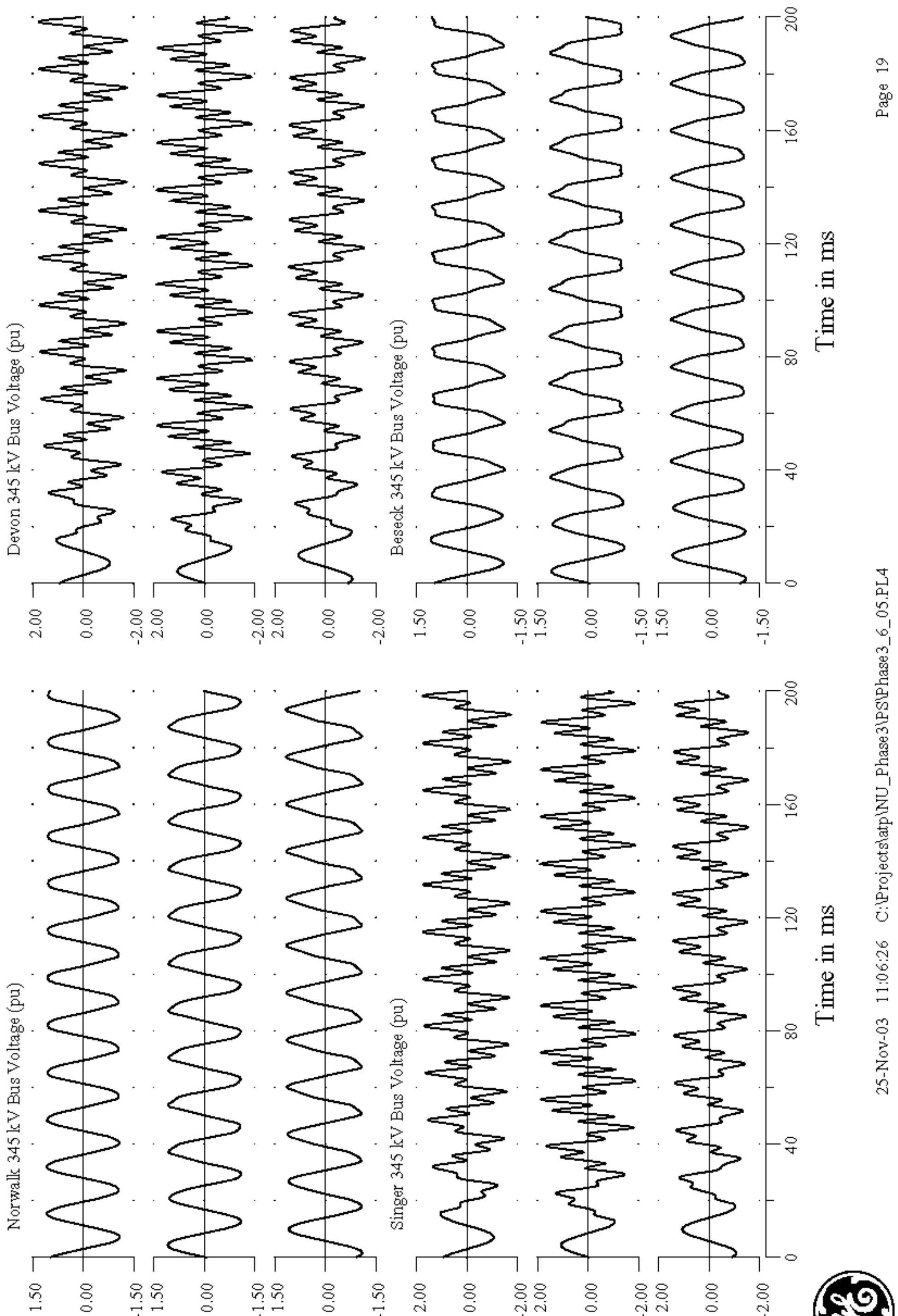


Figure 5-6. Energization of Devon Transformer, with Norwalk-Singer Open (Case 6-5)

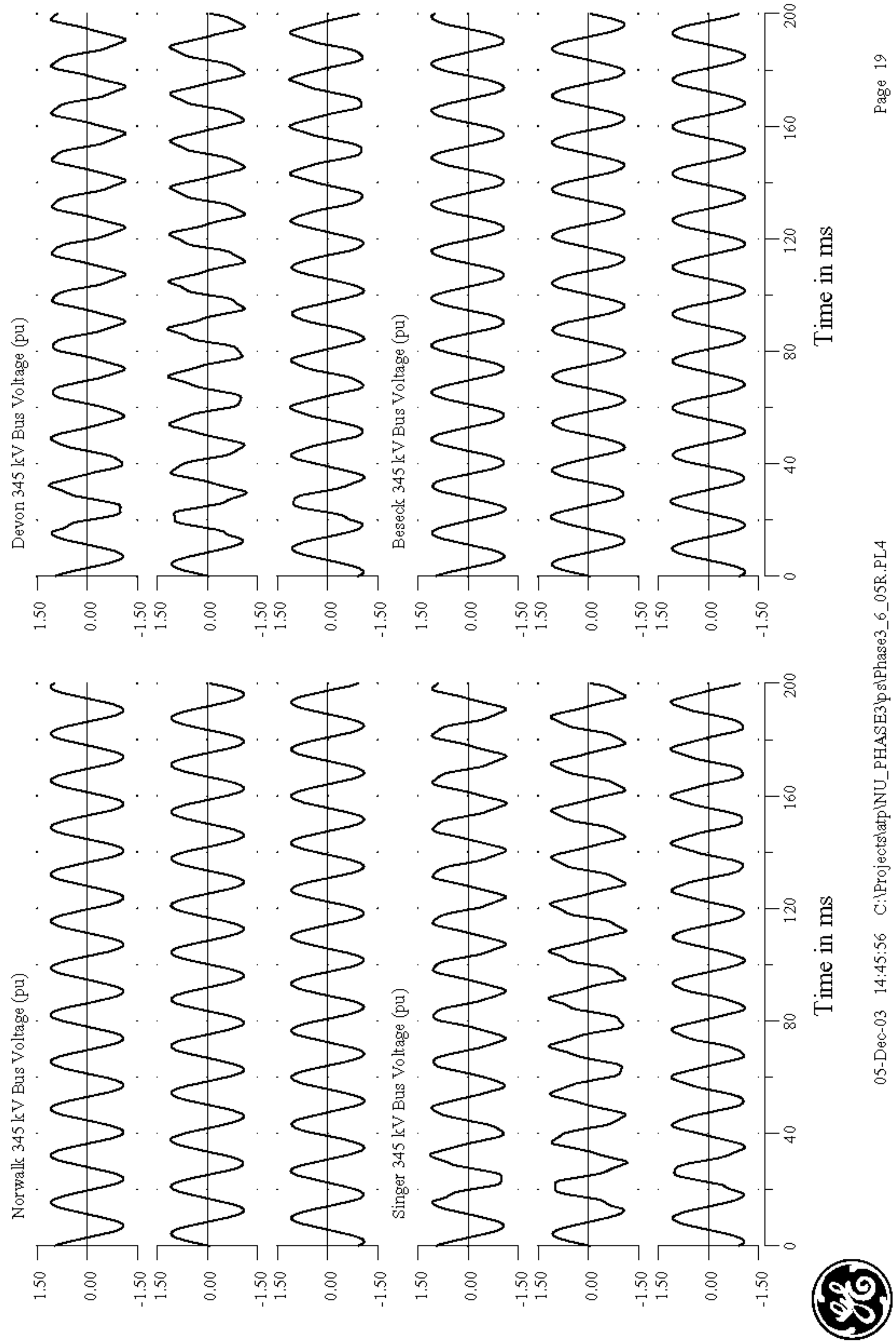


Figure 5-7. Energization of Devon Transformer, with Norwalk-Singer Open and with PIR (Case 6-5R)

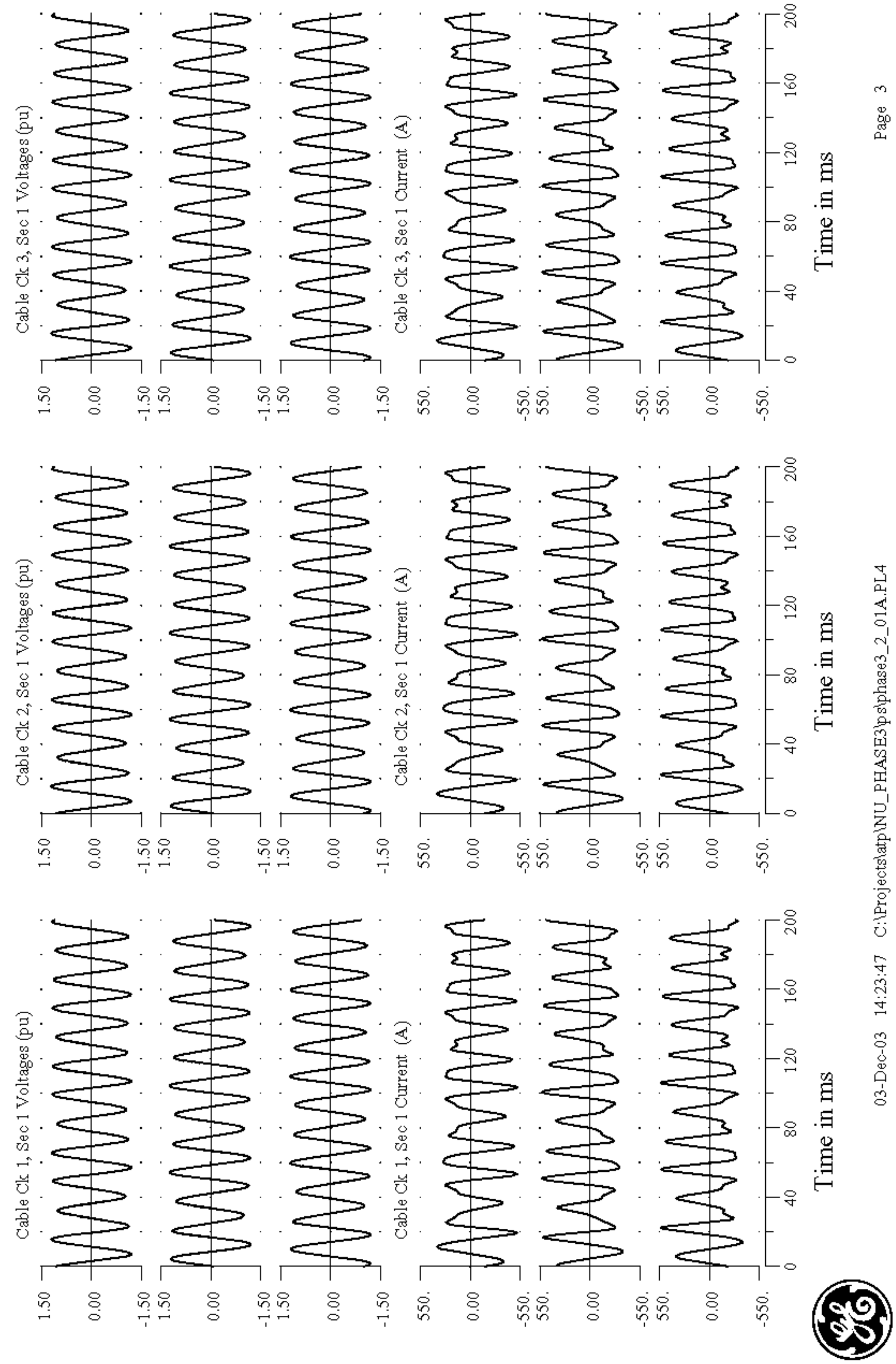


Figure 5-8. Energization of Singer Transformer, with Beseck Open (Case 2-1A)

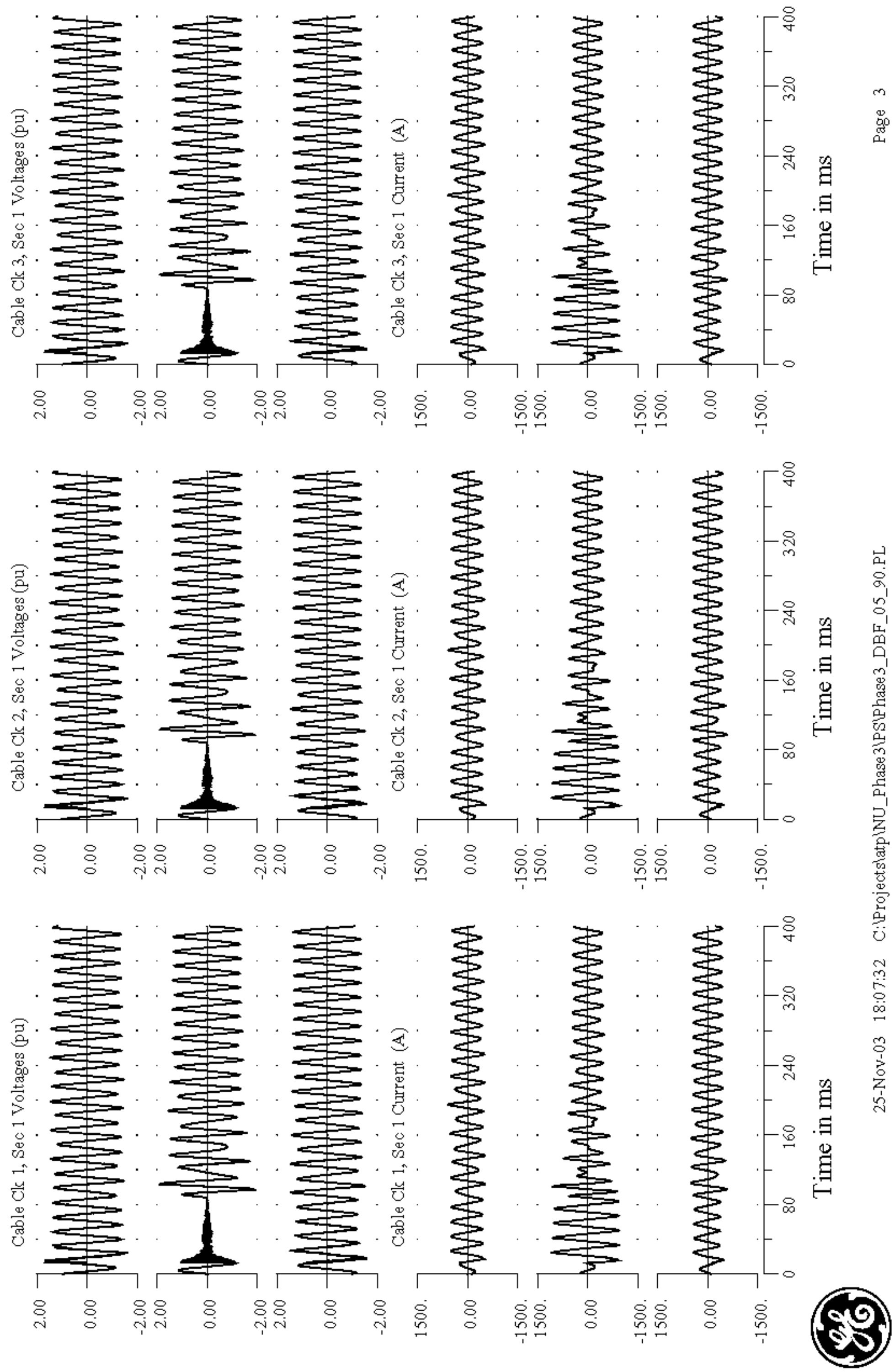


Figure 5-9. Fault & Clear Devon-Beseck Overhead Line (Case DBF-5-90)

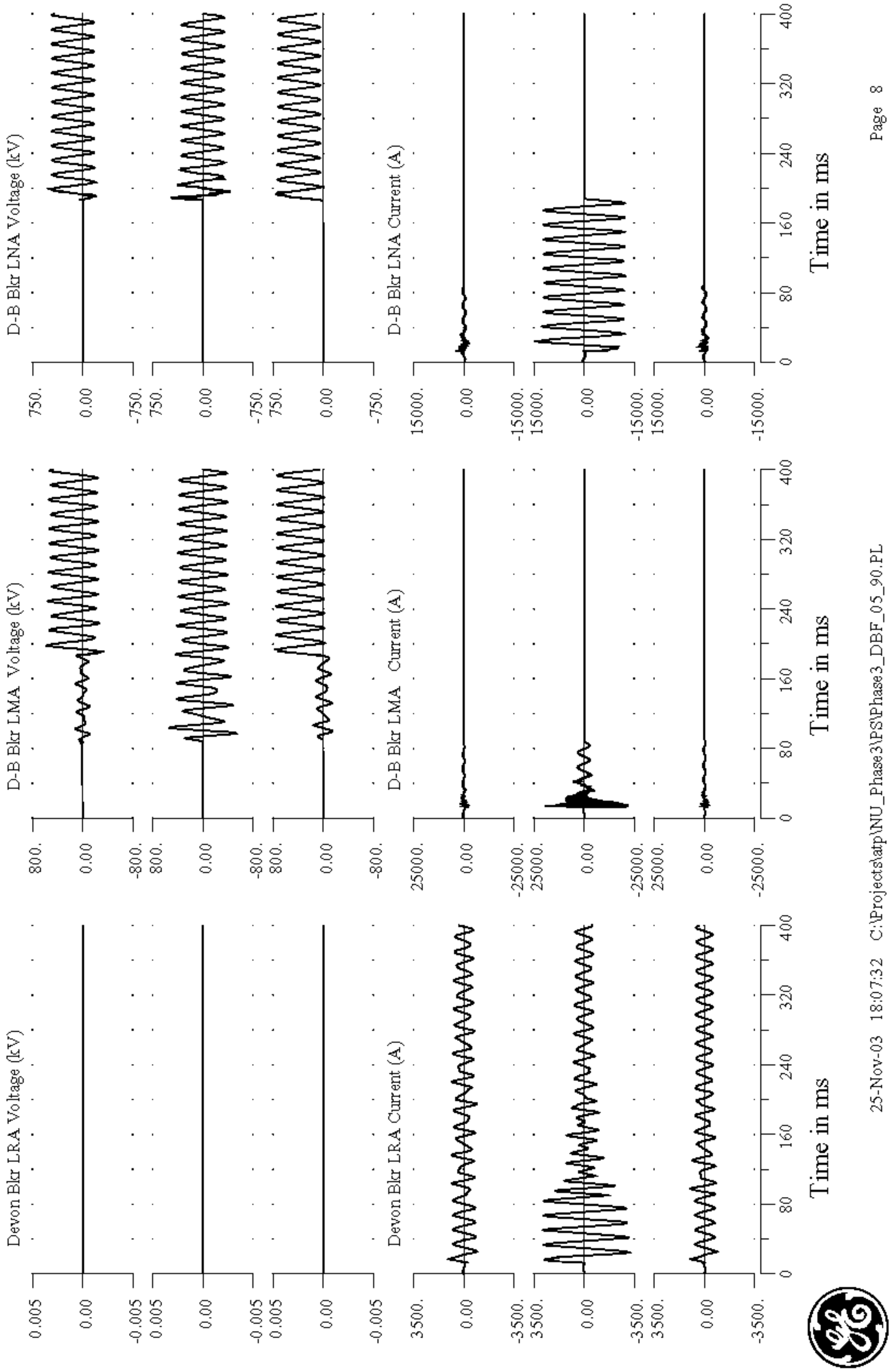


Figure 5-10. Fault & Clear Devon-Beseck Overhead Line – Breaker Voltages (Case DBF-5-90)

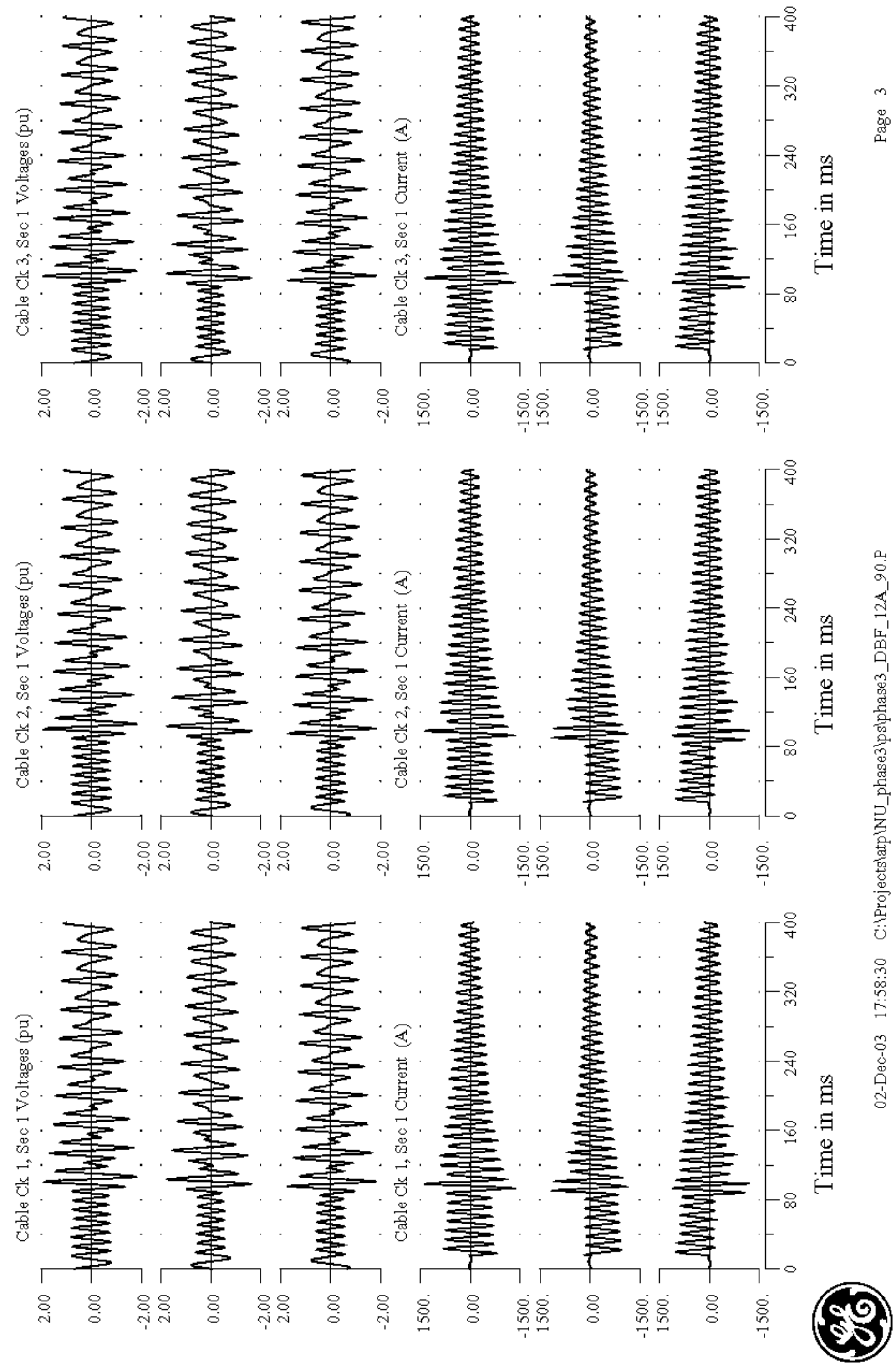


Figure 5-11. Stub Fault & Clear at Singer, with Beseck Open (Case DBF-12A-90)

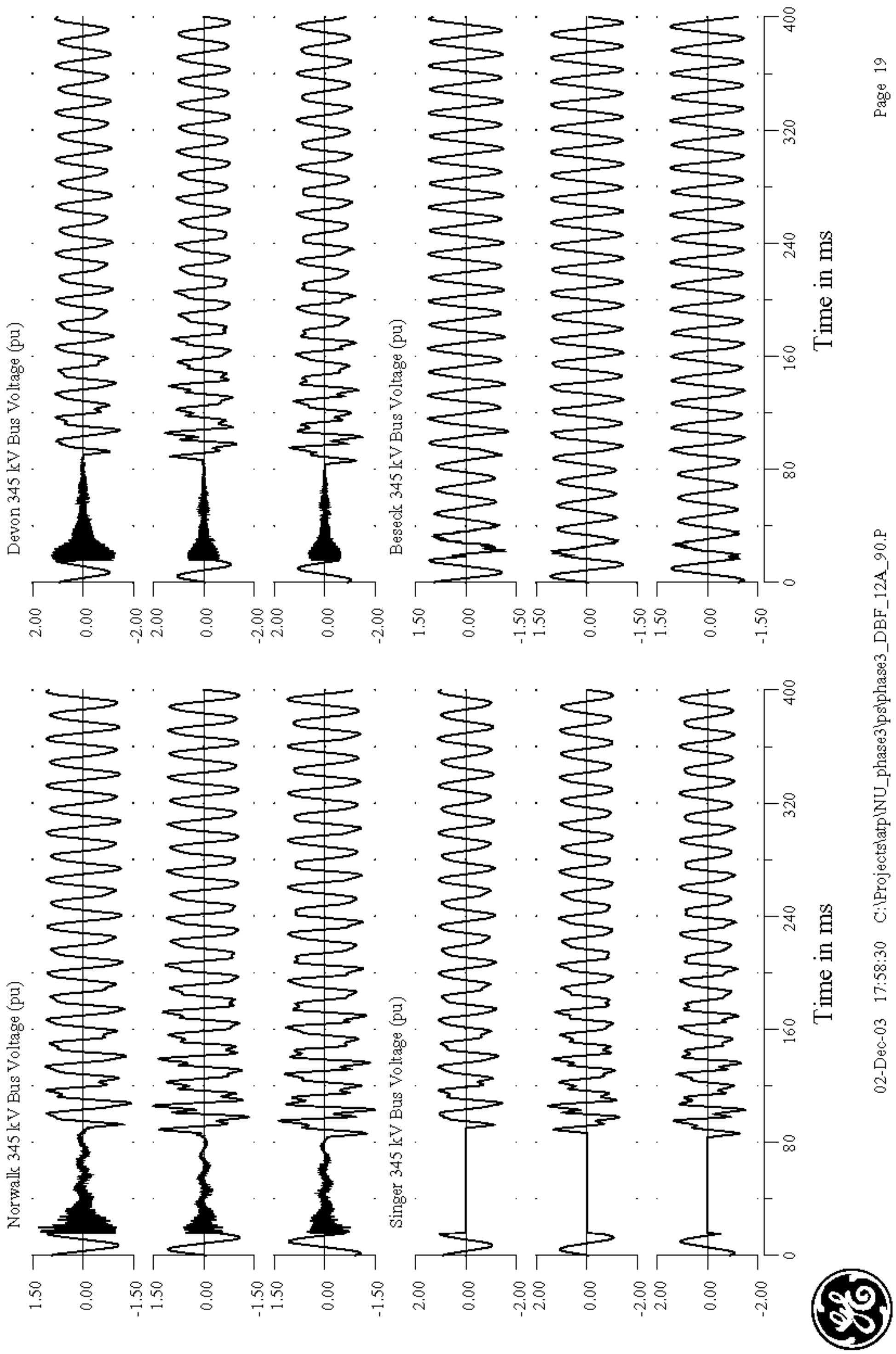


Figure 5-12. Stub Fault & Clear at Singer, with Beseck Open – Bus Voltages (Case DBF-12A-90)

6. Conclusions and Recommendations

Evaluation of the M/N-P2 configuration did not identify any overtly fatal flaws, but did reveal significant risks that would require considerable limitations and restrictions on operating practices and future modifications of the system. Therefore, it is recommended that the M/N-P2 configuration be avoided.

These high risk areas include potentially damaging voltages on the cable system due to a resonance condition near 60 Hz, restrictions on cable energization and de-energization operations, high voltages across the series reactor, circuit breaker recovery voltages which exceed standard test values, and the potential for more severe sustained overvoltage situations due to driving-point impedance resonances near both 2nd and 3rd harmonics. These issues are described further below.

With the Beseck end open or with the overhead line out of service, the series reactor at Devon with the remaining cables can contribute to low-frequency oscillations in the system.[1] This phenomenon was observed in cable energization, transformer energization, and fault and clear simulations. Consequently, the Devon-Beseck cables could be energized only from the Beseck end, and not from the Devon end, with the last step to complete the path through the series reactor. Additionally, a redundant transfer trip scheme would be needed to trip the Devon end of the cables if the cables were in service through the series reactor at Devon without connection to the Beseck end. An alternate location for the series reactor, which could possibly mitigate some of the resonance issues identified in this study, could also be considered.

The addition of the Devon-Beseck cables together with the Devon series reactor makes the shunt reactors critical elements where a minimum amount of compensation must remain on when the cables are connected. For instance if for some unknown reason the Devon-Beseck cable system opened at Beseck and in the worst scenario all the shunt reactors tripped on the cables, then the cables would be series resonant with the Devon series reactor near 60 Hz creating very low impedance to the system and potentially damaging voltages on the cable system and across the series reactor.

Stub fault and clear simulations resulted in transient voltages of 700 kV across the Devon series reactor. The insulation coordination and equipment specification of the series reactor would require further evaluation in regard to its BIL rating and possible use of surge arresters across the reactor.

Critical fault clearing cases with sustained voltage across the breaker contacts above 750 kV exceed test values defined in ANSI C37.06 and would require review with the breaker manufacturer. These cases indicate the need for a higher temporary overvoltage and transient recovery voltage capability required for the breaker or could possibly be a driver for a higher

[1] Here low-frequency describes beat frequencies below 60Hz where there could be concerns besides power quality and temporary overvoltages. Issues may include: interaction with fast power control devices, torsional stimulus to turbine-generators, and voltage flicker.

circuit breaker voltage rating if the manufacturer cannot provide the capability with a 362 kV breaker.

High overvoltages were observed at some 115 kV capacitor bank locations, particularly at Rocky River during fault events. The natural-frequency oscillations of the 345 kV cable system due to application of a 345 kV system fault appear to interact with the resonance of the 115 kV capacitor banks, greatly amplifying the transient. In the actual system, surge arresters located on the 115 kV system will limit these overvoltages.[2] Fault clearing events also resulted in temporary overvoltages on the 115 kV system. It would be recommended that arrester energy and TOV duty be evaluated in the 115 kV system.

With regard to harmonic characteristics, the M/N-P2 configuration resulted in impedance resonances marginally above the 2nd harmonic and marginally above the 3rd harmonic. Changes in system configuration could easily move the resonances to 2nd and 3rd harmonics or below. In the M/N and M/N-P1 configurations, there was a single impedance resonance between 2nd and 3rd harmonics, but in the M/N-P2 configuration the addition of the series reactor with the cable system results in an additional resonance near 3rd harmonic. Consequently, there are concerns regarding power system events involving transformer exciting current, such as energization and inrush due to fault clearing. With resonances near both 2nd and 3rd harmonics, the harmonic currents due to inrush could have an additive effect to produce more severe results than those with resonances at either harmonic.

Additional system contingencies could lead to more severe sustained overvoltage situations than observed in this study. A reasonable effort was made in this study to include first-contingency events likely to initiate a critical system response. However, higher-level contingencies, beyond routine planning criteria, may result in much more severe consequences to utility and consumer equipment. Extreme contingencies could result, for example, from a major regional disturbance such as a blackout. Equipment failures resulting from extreme resonant conditions during system breakup could greatly hinder power restoration efforts.

There are also concerns about being close to 2nd harmonic. Although the resonance is above 2nd harmonic, it is very close, and defining a design with a minimum safe margin above 2nd harmonic is a subjective call. There is significant concern in regard to the harmonic characteristics of the M/N-P2 configuration.

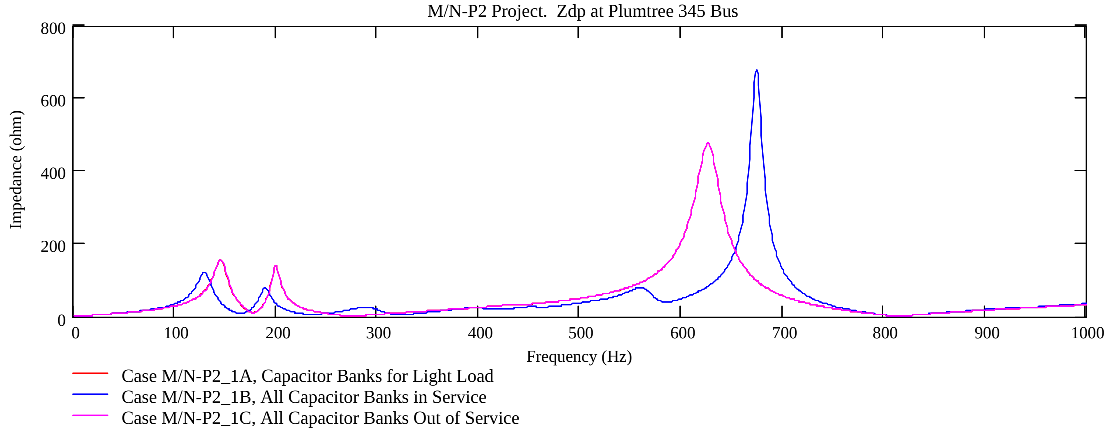
In summary, with the M/N-P2 configuration, it is expected that the system would be very sensitive to future upgrades and would require careful engineering to study changes in the transmission system, even at somewhat remote areas. With resonances near both 2nd and 3rd harmonics, power system events involving transformer exciting current could be more severe with system configuration changes. Operation of the Devon-Beseck cables would require restrictions for energization and de-energization and transfer trip schemes that must be implemented to avoid low-frequency oscillations. Careful consideration would also be required for specifying equipment to withstand transient and temporary overvoltages

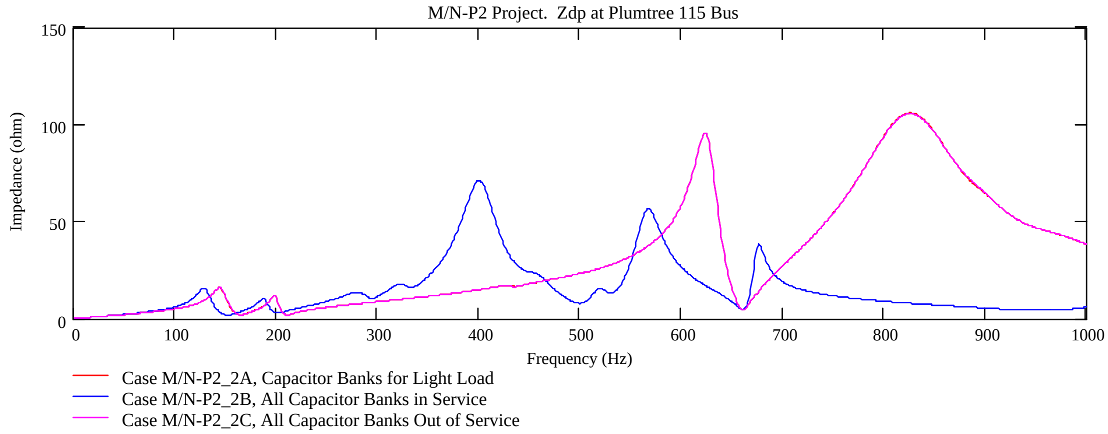
[2] Also, damping of the system at the relatively high frequency of this interaction (600 Hz – 1 kHz) may be greater than represented in the simulation model, due to skin effects in the transmission cables and overhead 1ines.

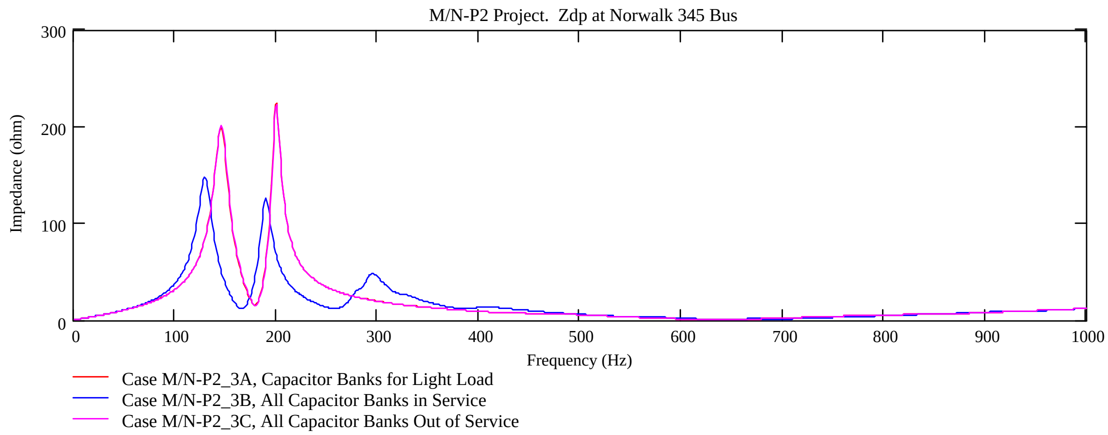
observed during switching events. The shunt reactor protection scheme would need to ensure that a common response to a disturbance could not trip multiple reactors while leaving cable sections uncompensated. Due to the multiple significant risks and the complex system requirements needed to address them, it is recommended that the M/N-P2 configuration be avoided.

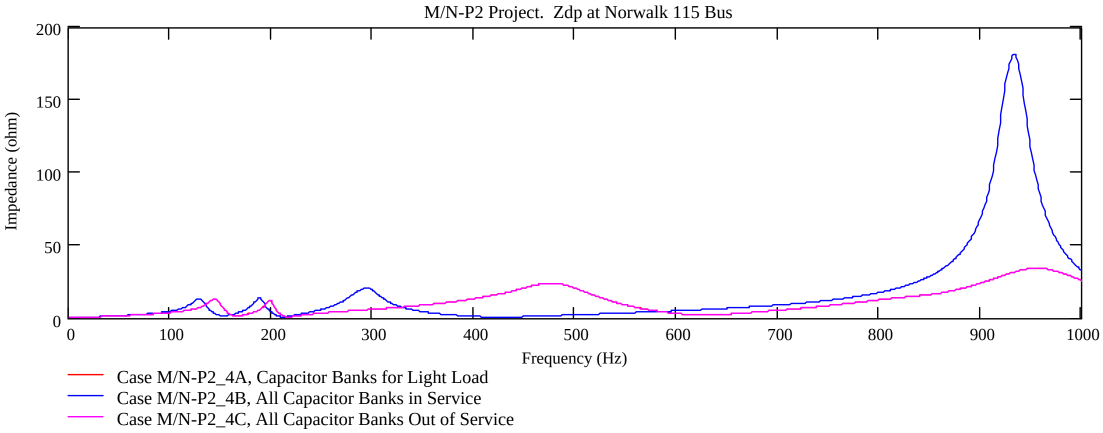
Appendix A – Driving-Point Impedance Plots

M/N-P2 Project Driving Point Impedance

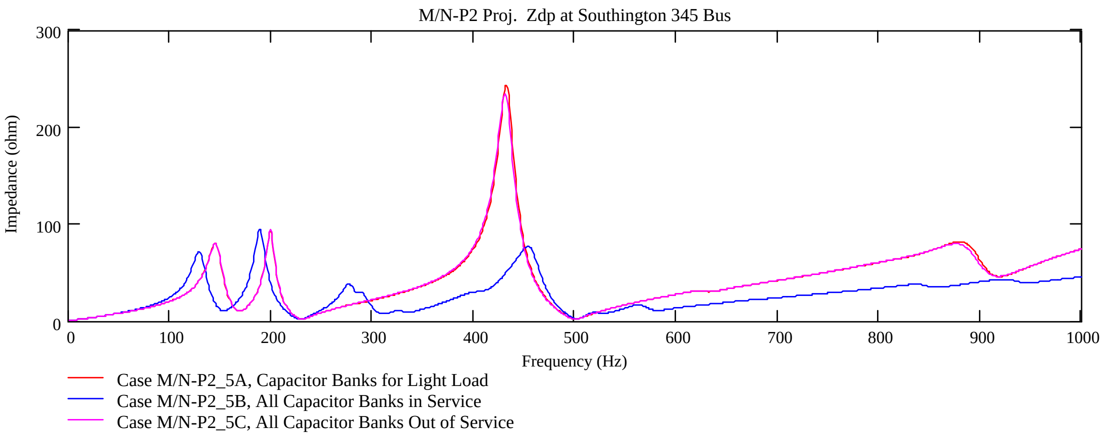




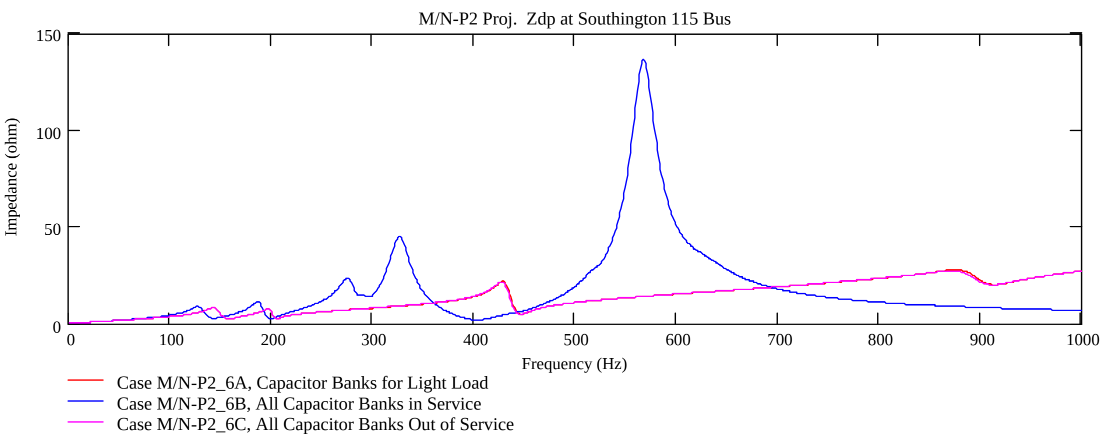




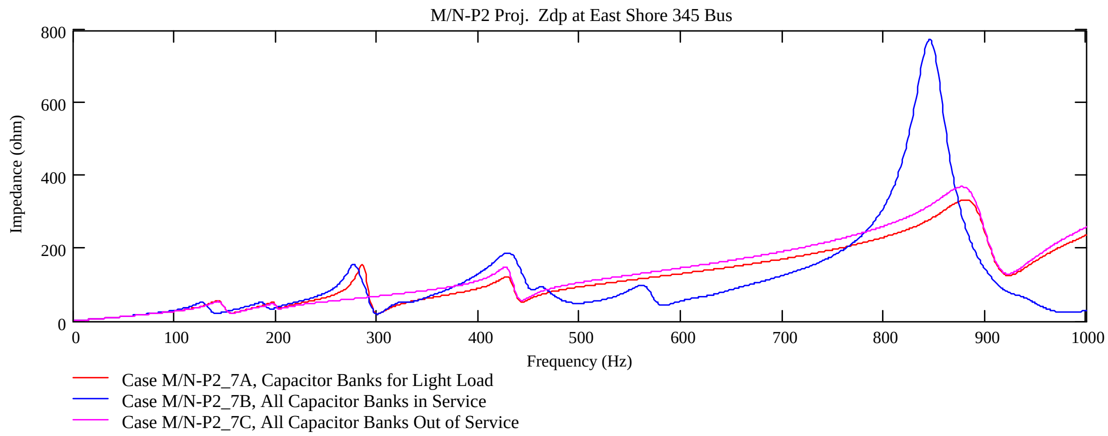
M/N-P2 Project. Zdp at Norwalk 115 Bus
Impedance (ohm)
200
150
100
50
0
0
100
200
300
400
500
600
700
800
900
1000
Frequency (Hz)
Case M/N-P2_4A, Capacitor Banks for Light Load
Case M/N-P2_4B, All Capacitor Banks in Service
Case M/N-P2_4C, All Capacitor Banks Out of Service

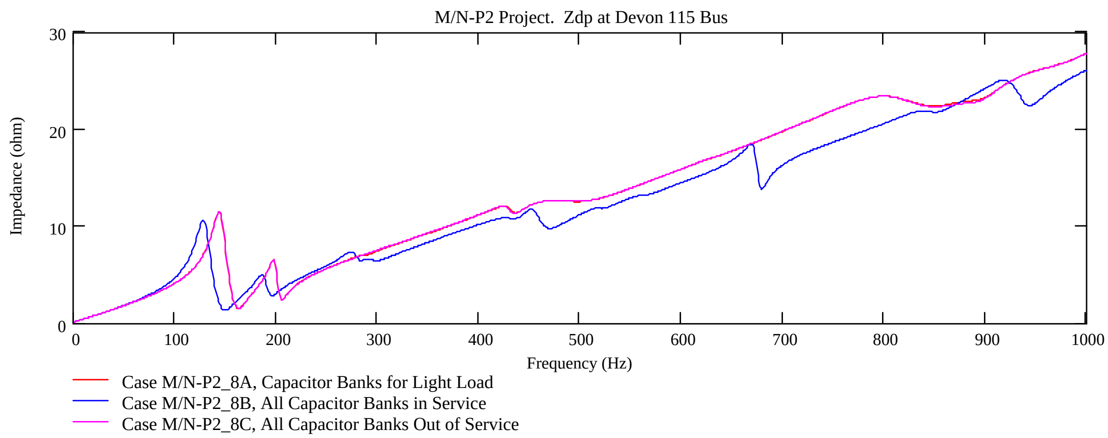


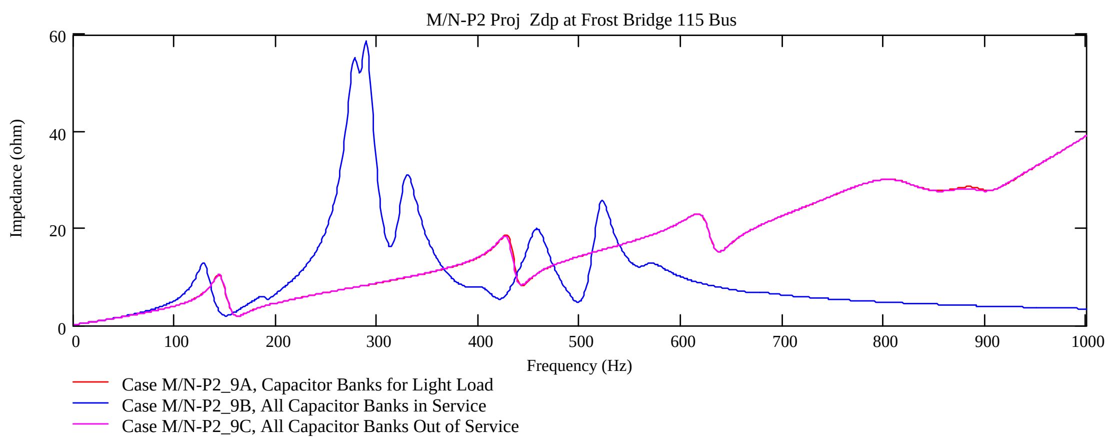
M/N-P2 Proj. Zdp at Southington 345 Bus
Impedance (ohm)
300
200
100
0
0
100
200
300
400
500
600
700
800
900
1000
Frequency (Hz)
Case M/N-P2_5A, Capacitor Banks for Light Load
Case M/N-P2_5B, All Capacitor Banks in Service
Case M/N-P2_5C, All Capacitor Banks Out of Service

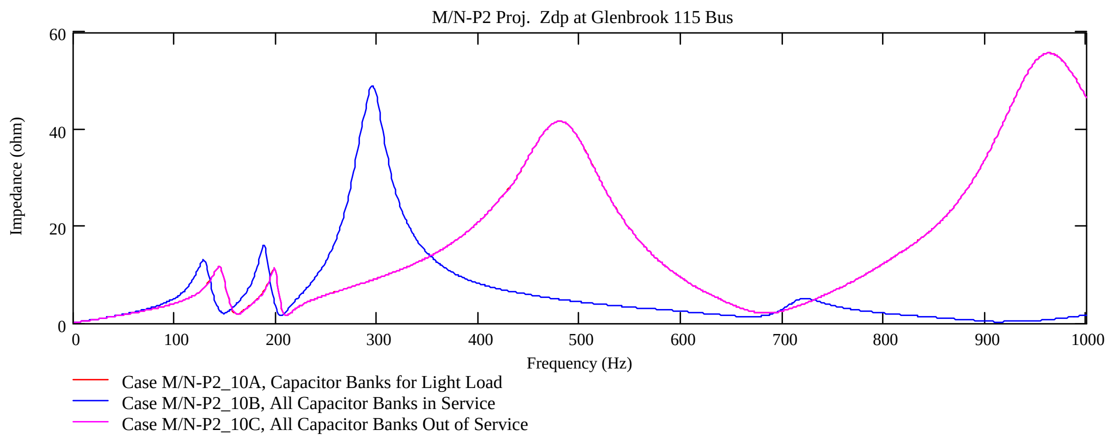


M/N-P2 Proj. Zdp at Southington 115 Bus
Impedance (ohm)
150
100
50
0
0
100
200
300
400
500
600
700
800
900
1000
Frequency (Hz)
Case M/N-P2_6A, Capacitor Banks for Light Load
Case M/N-P2_6B, All Capacitor Banks in Service
Case M/N-P2_6C, All Capacitor Banks Out of Service

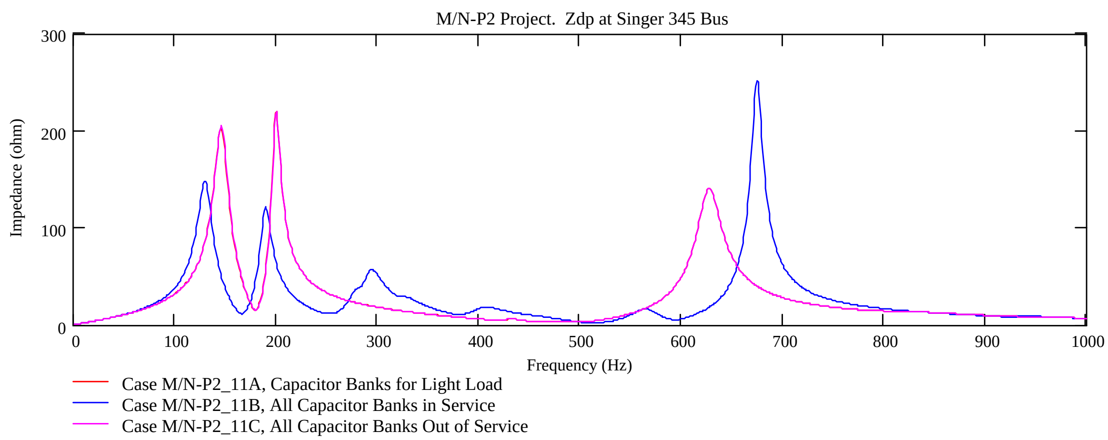

M/N-P2 Proj. Zdp at East Shore 345 Bus
Impedance (ohm)
0
200
400
600
800
0
100
200
300
400
500
600
700
800
900
1000
Frequency (Hz)
Case M/N-P2_7A, Capacitor Banks for Light Load
Case M/N-P2_7B, All Capacitor Banks in Service
Case M/N-P2_7C, All Capacitor Banks Out of Service


M/N-P2 Project. Zdp at Devon 115 Bus
Impedance (ohm)
0
10
20
30
0
100
200
300
400
500
600
700
800
900
1000
Frequency (Hz)
Case M/N-P2_8A, Capacitor Banks for Light Load
Case M/N-P2_8B, All Capacitor Banks in Service
Case M/N-P2_8C, All Capacitor Banks Out of Service

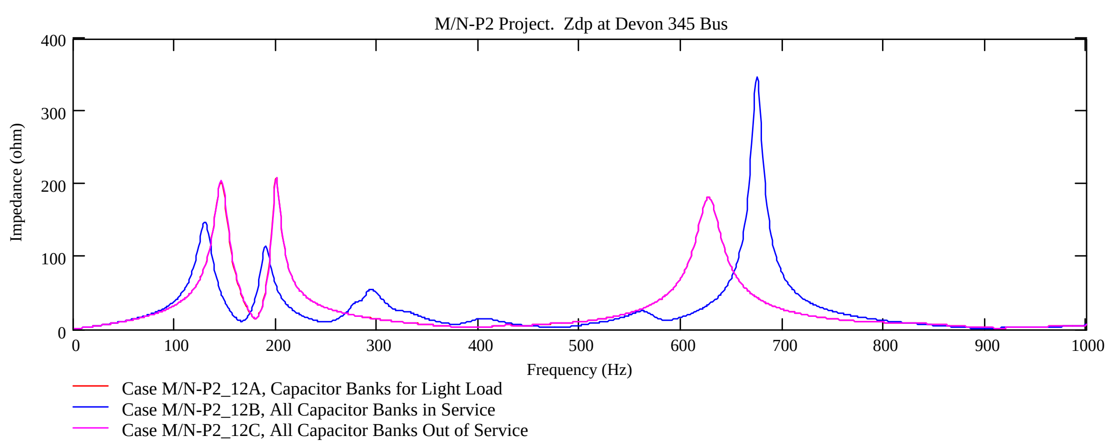

M/N-P2 Proj Zdp at Frost Bridge 115 Bus
Impedance (ohm)
0
20
40
60
0
100
200
300
400
500
600
700
800
900
1000
Frequency (Hz)
Case M/N-P2_9A, Capacitor Banks for Light Load
Case M/N-P2_9B, All Capacitor Banks in Service
Case M/N-P2_9C, All Capacitor Banks Out of Service



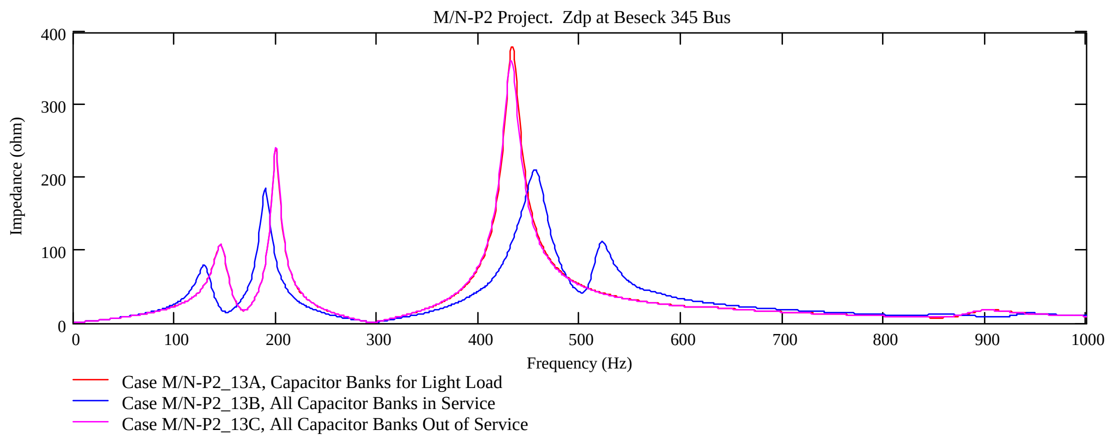
M/N-P2 Proj. Zdp at Glenbrook 115 Bus
Impedance (ohm)
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
Frequency (Hz)
Case M/N-P2_10A, Capacitor Banks for Light Load
Case M/N-P2_10B, All Capacitor Banks in Service
Case M/N-P2_10C, All Capacitor Banks Out of Service



M/N-P2 Project. Zdp at Singer 345 Bus
Impedance (ohm)
300
200
100
0
0
100
200
300
400
500
600
700
800
900
1000
Frequency (Hz)
Case M/N-P2_11A, Capacitor Banks for Light Load
Case M/N-P2_11B, All Capacitor Banks in Service
Case M/N-P2_11C, All Capacitor Banks Out of Service

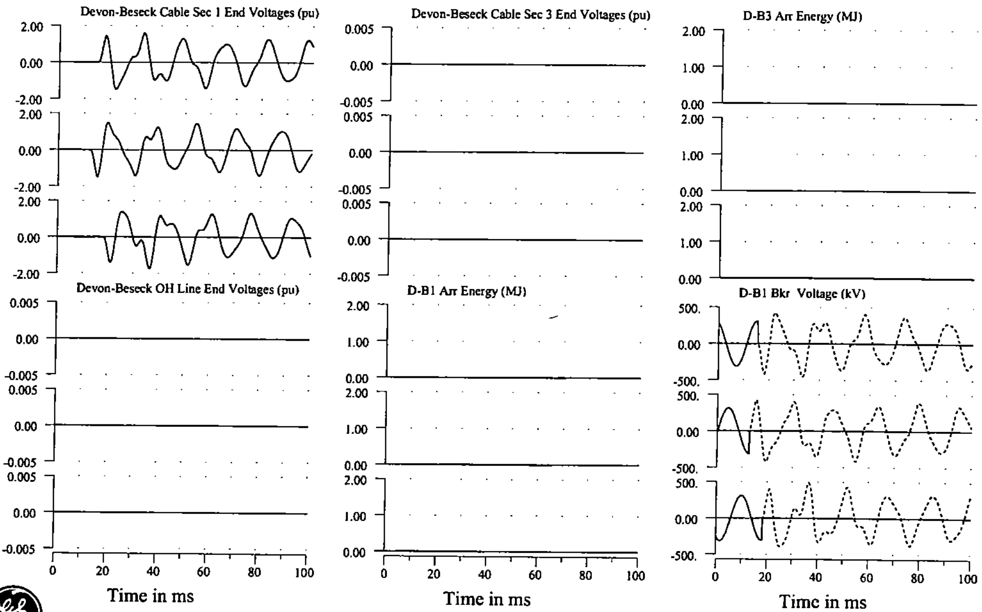


M/N-P2 Project. Zdp at Devon 345 Bus
Impedance (ohm)
400
300
200
100
0
0
100
200
300
400
500
600
700
800
900
1000
Frequency (Hz)
Case M/N-P2_12A, Capacitor Banks for Light Load
Case M/N-P2_12B, All Capacitor Banks in Service
Case M/N-P2_12C, All Capacitor Banks Out of Service


M/N-P2 Project. Zdp at Beseck 345 Bus
Impedance (ohm)
0
100
200
300
400
0
100
200
300
400
500
600
700
800
900
1000
Frequency (Hz)
Case M/N-P2_13A, Capacitor Banks for Light Load
Case M/N-P2_13B, All Capacitor Banks in Service
Case M/N-P2_13C, All Capacitor Banks Out of Service

Appendix B – Switching Simulation Case Plots

Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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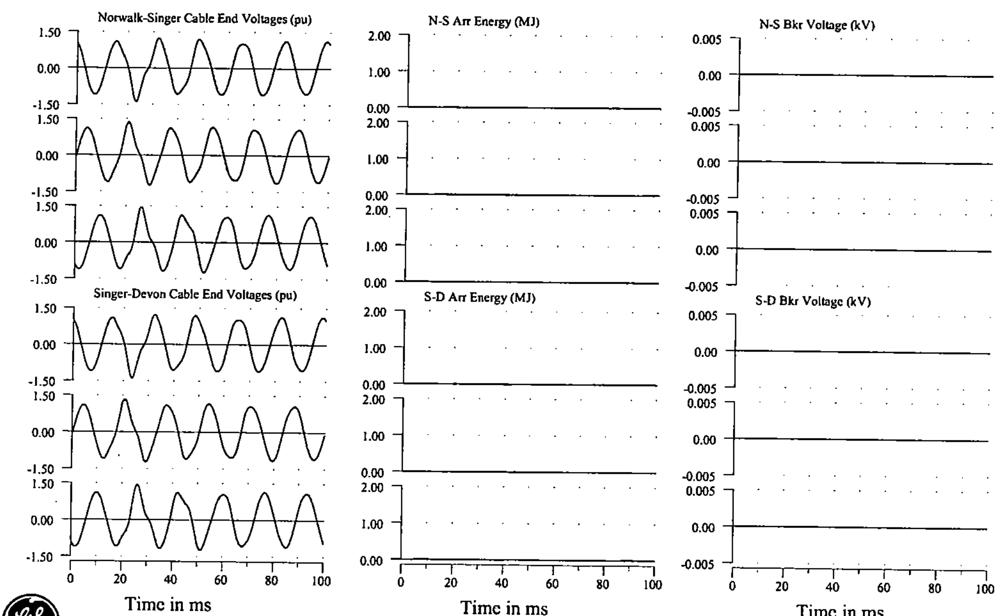
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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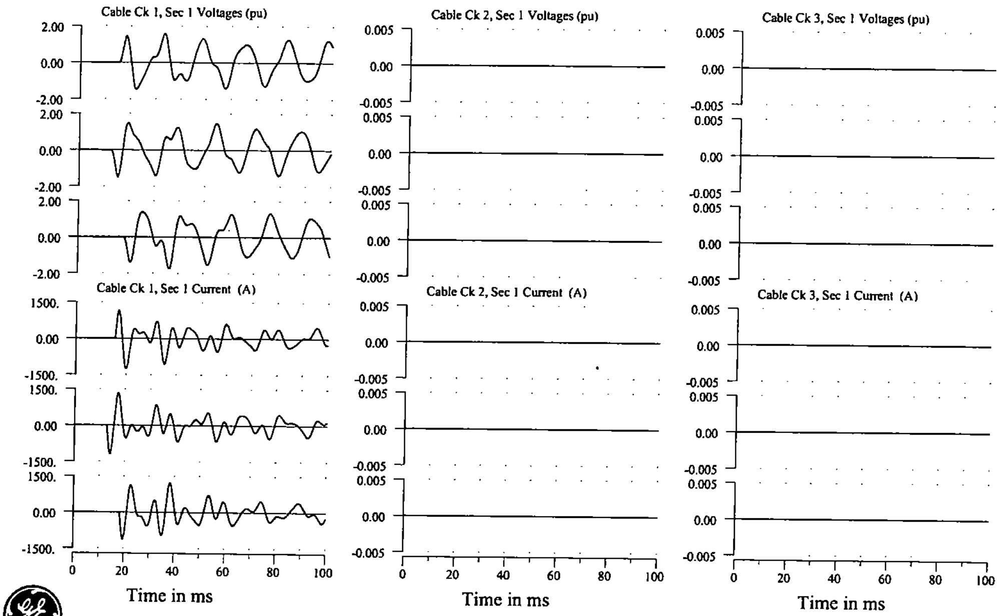
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01
Devon-Beseck 345 kV Cables



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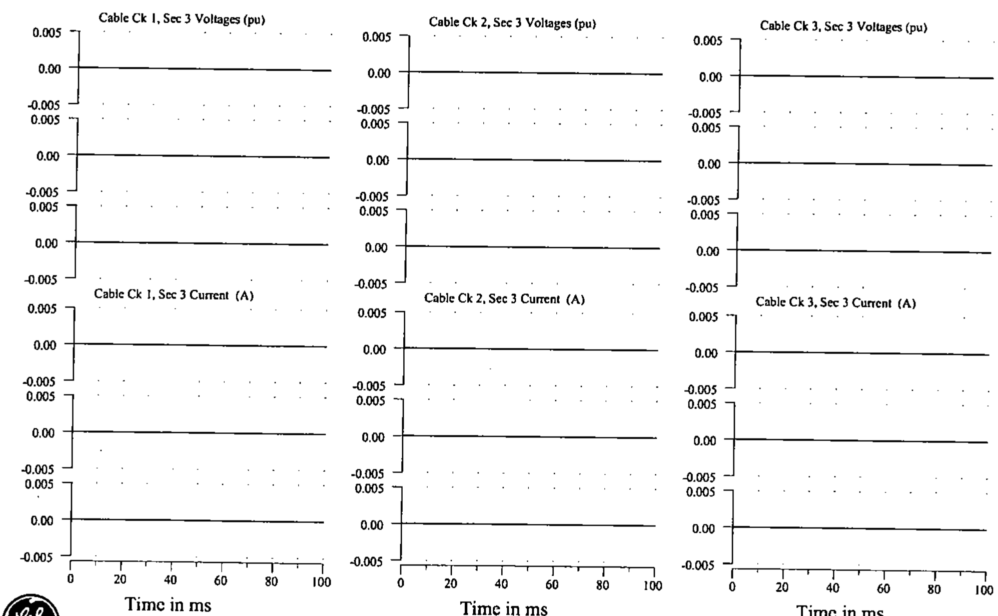
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01
Devon-Beseck 345 kV Cables



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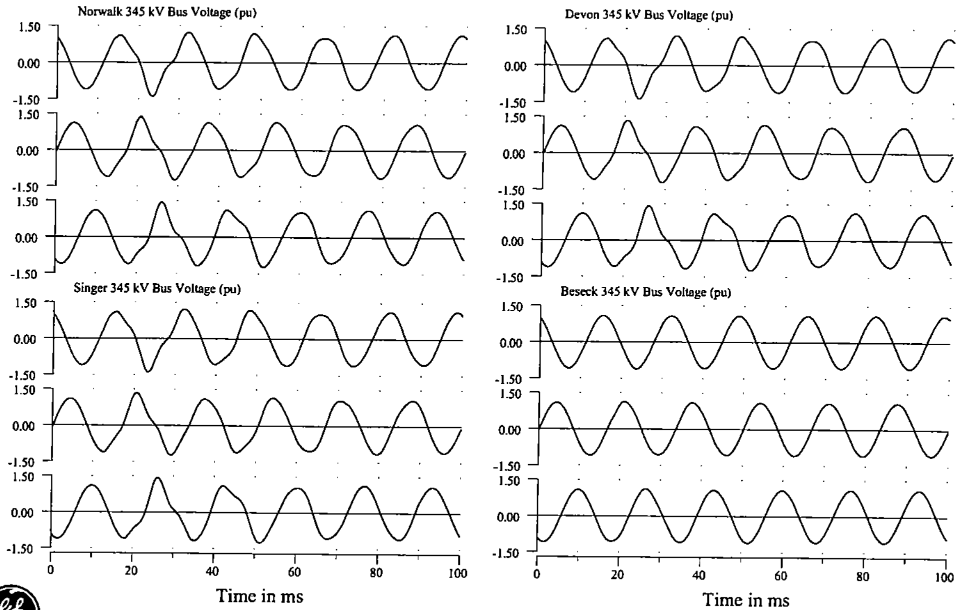
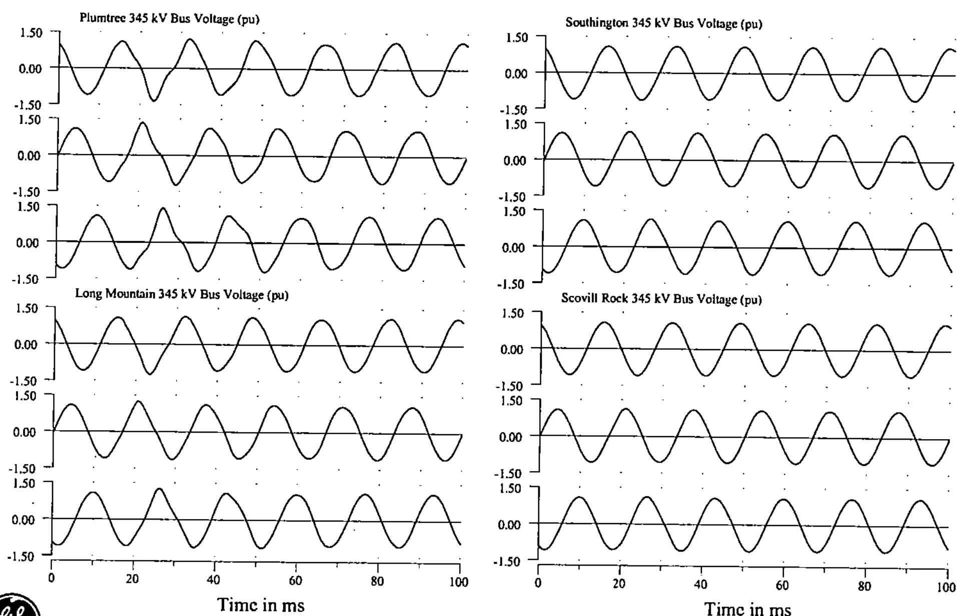
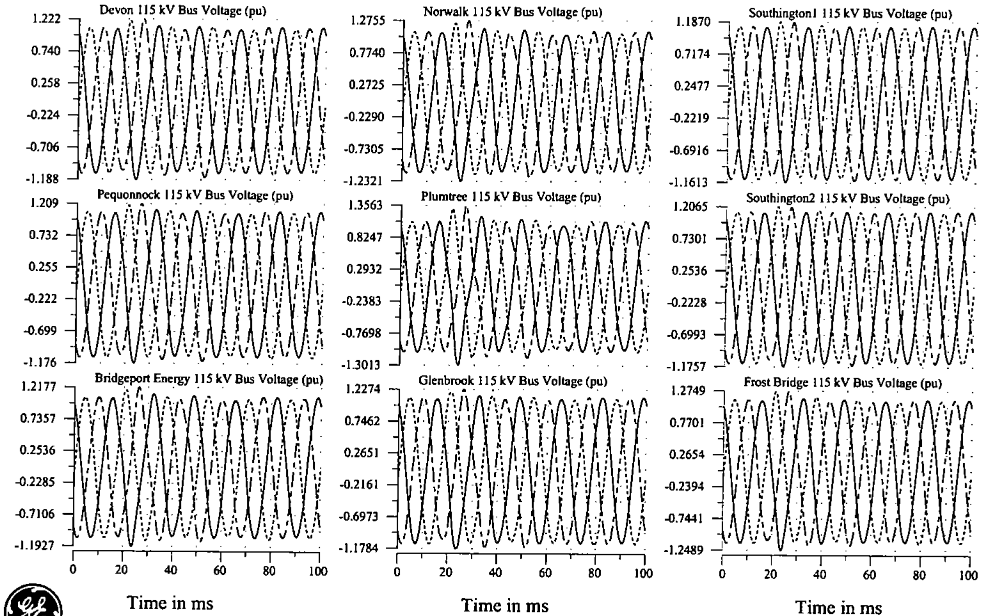
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01
345 kV Bus Voltages



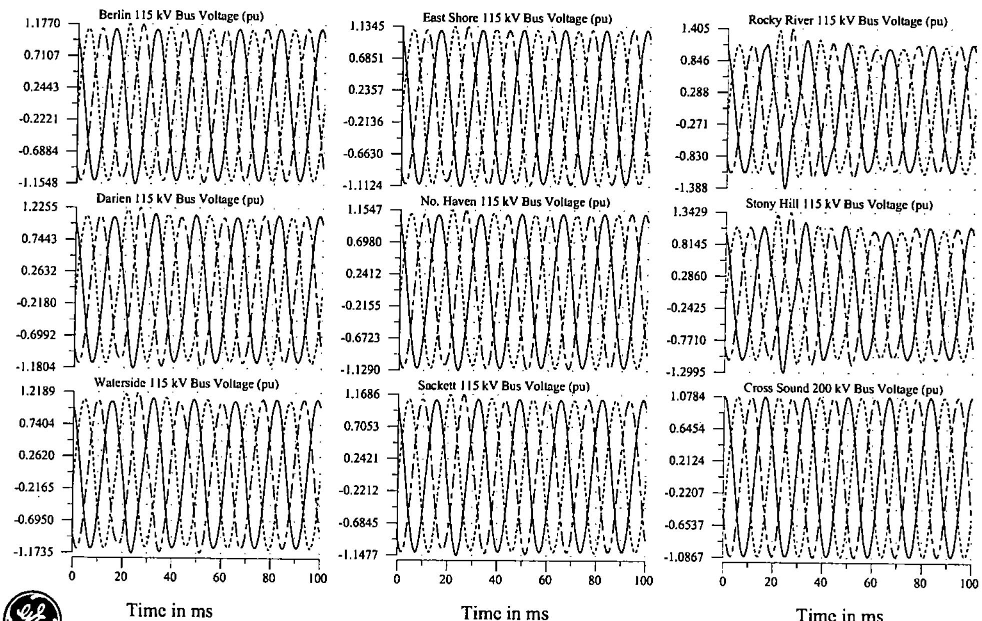
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01
345 kV Bus Voltages



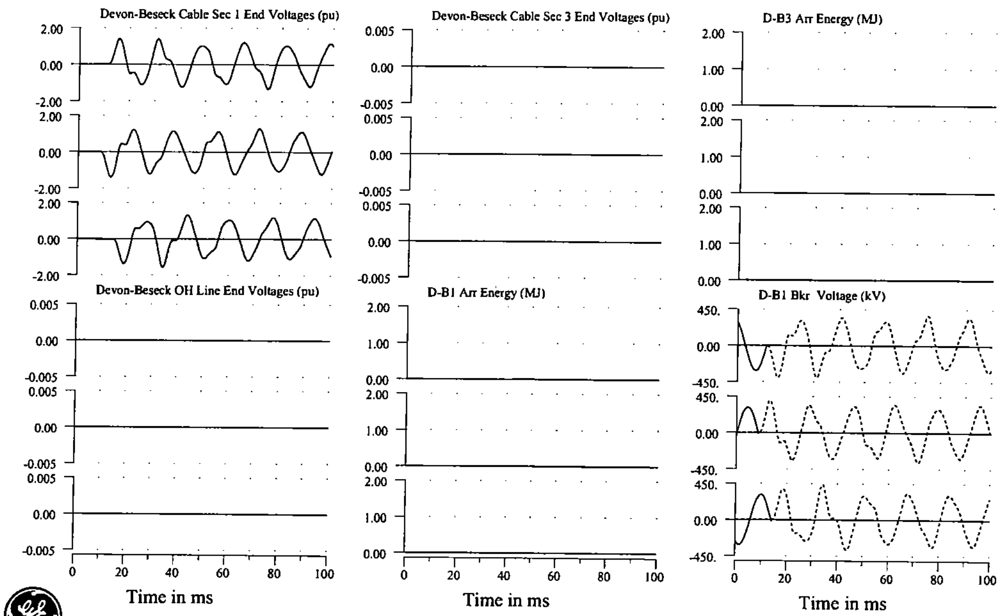
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01A
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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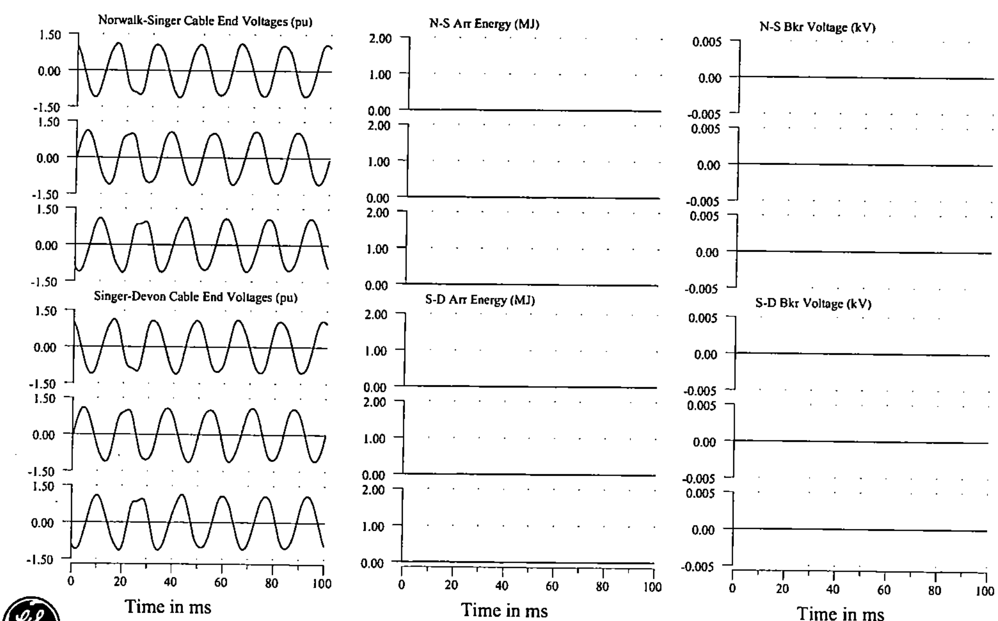
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01A
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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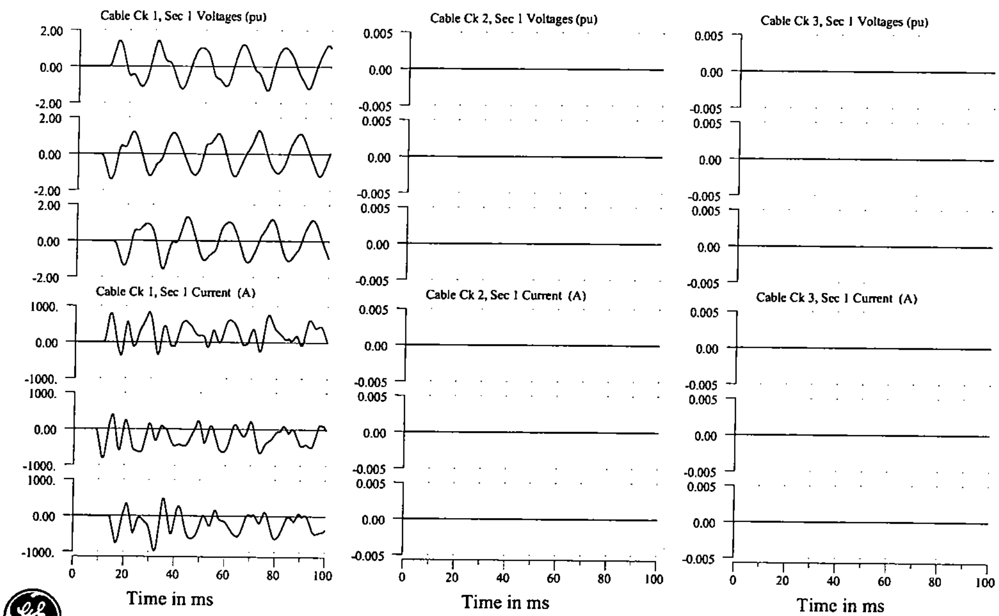
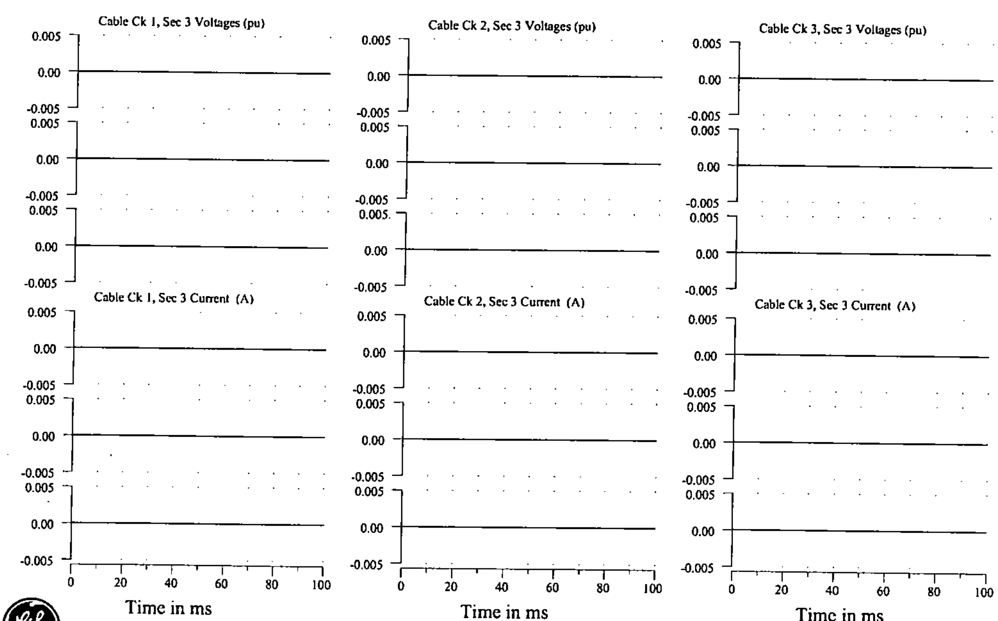
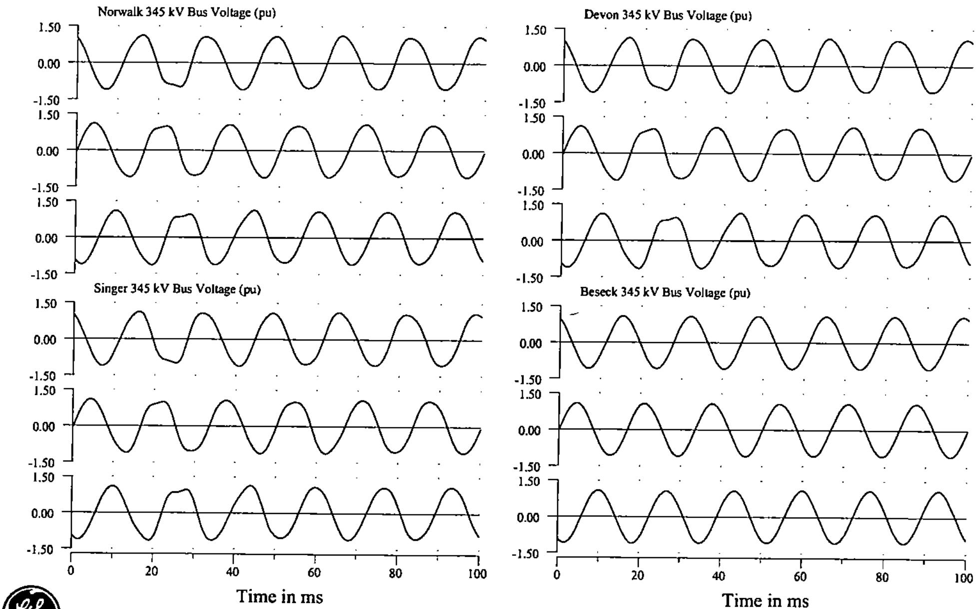
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01A
Devon-Beseck 345 kV Cables



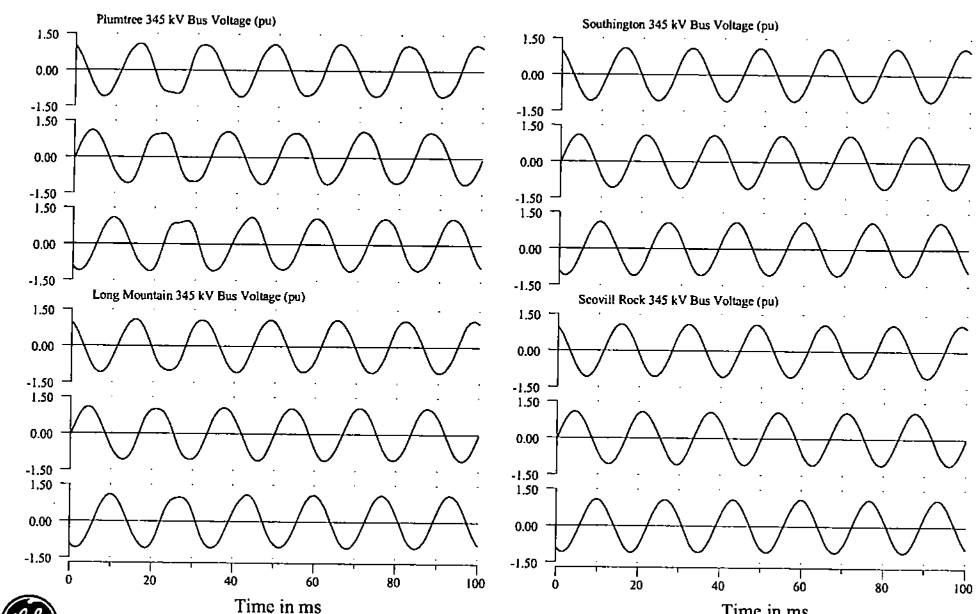
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01A
Devon-Beseck 345 kV Cables



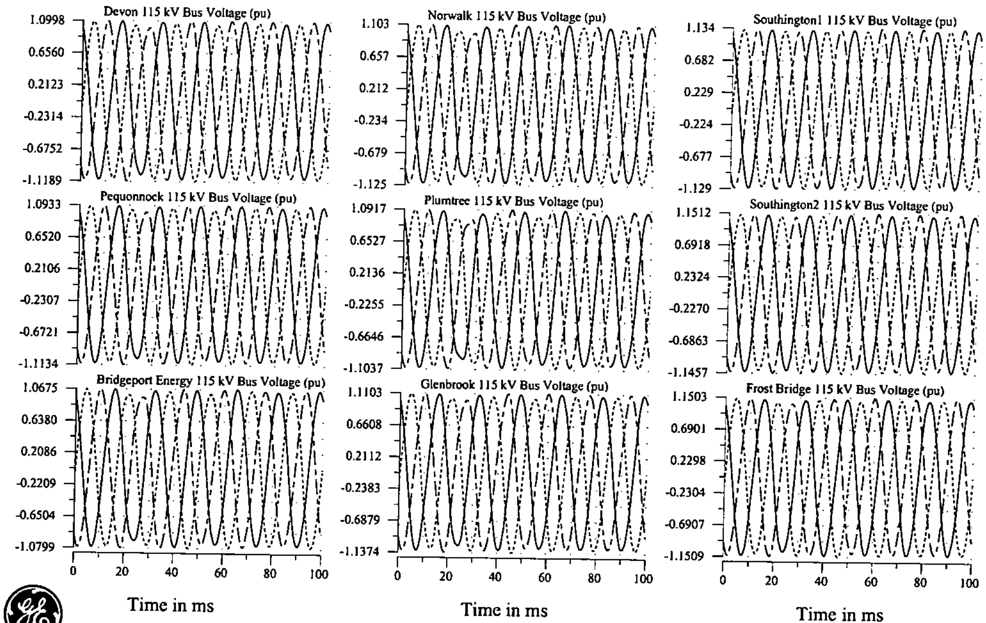
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01A
345 kV Bus Voltages



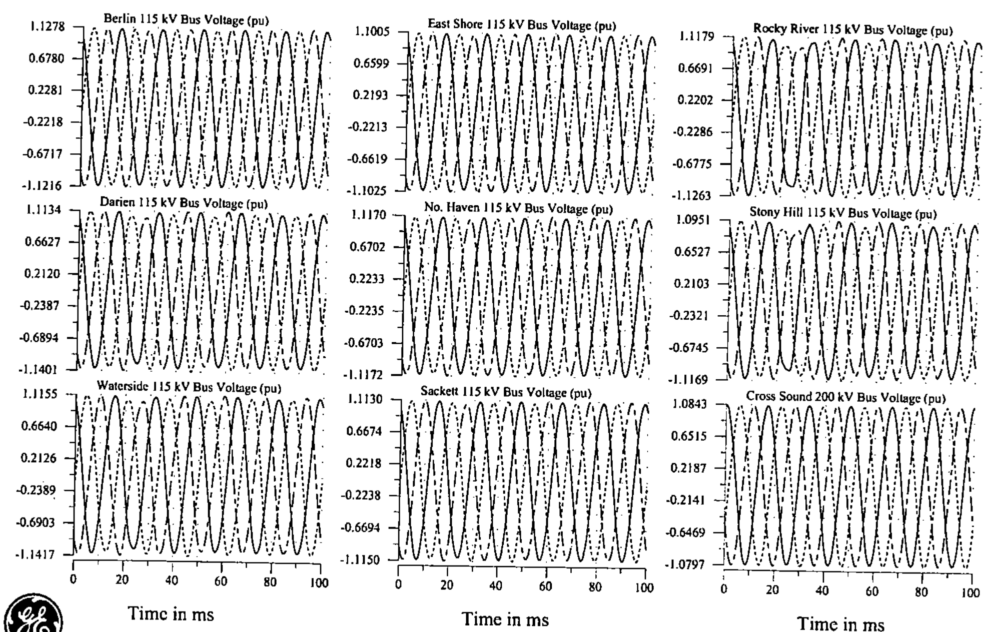
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01A
345 kV Bus Voltages



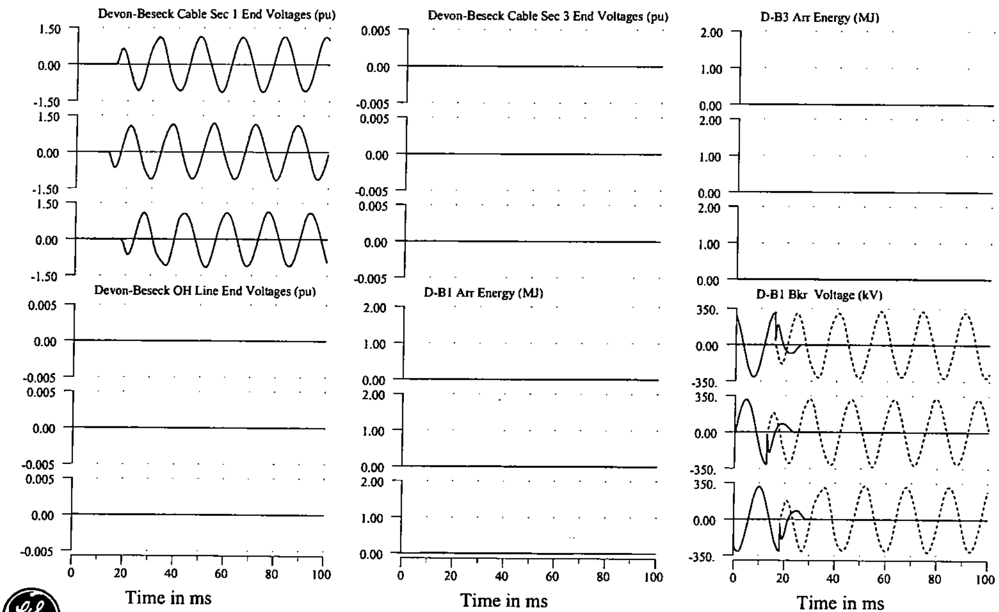
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01A
115 kV Bus Voltages and Capacitor Bank Locations



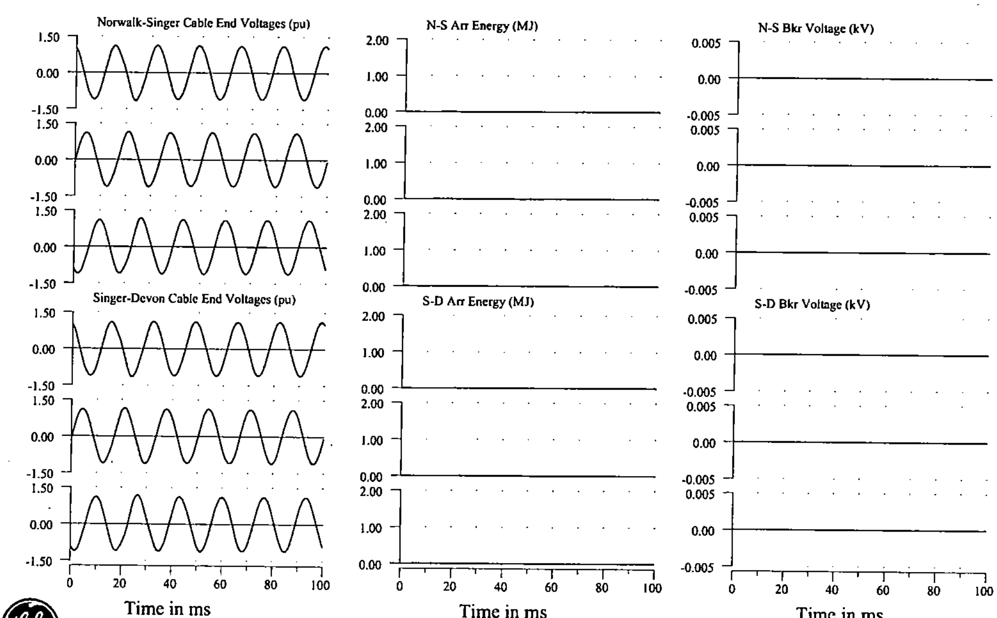
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01A
115 kV Bus Voltages and Capacitor Bank Locations



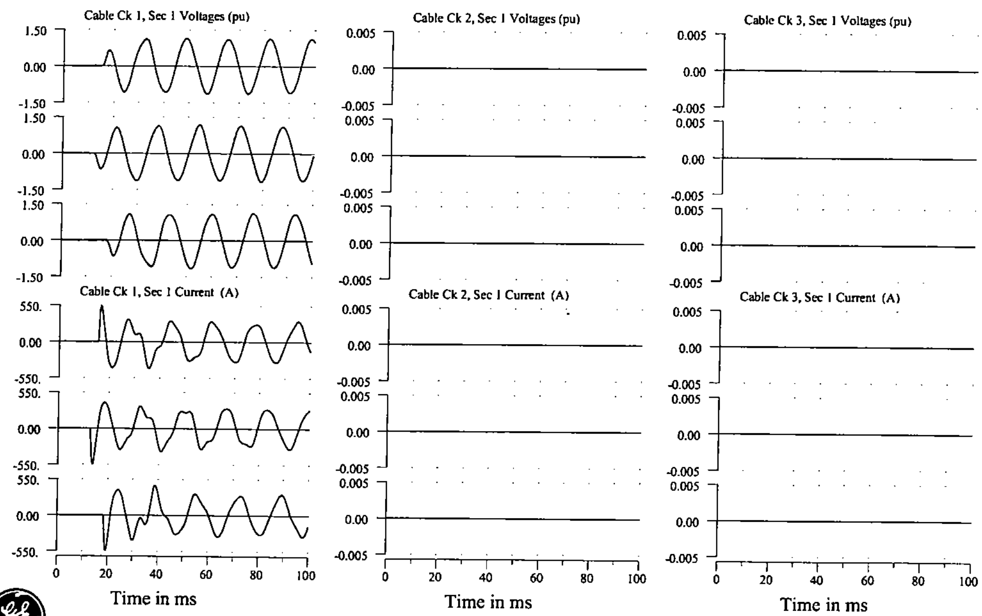
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01R
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



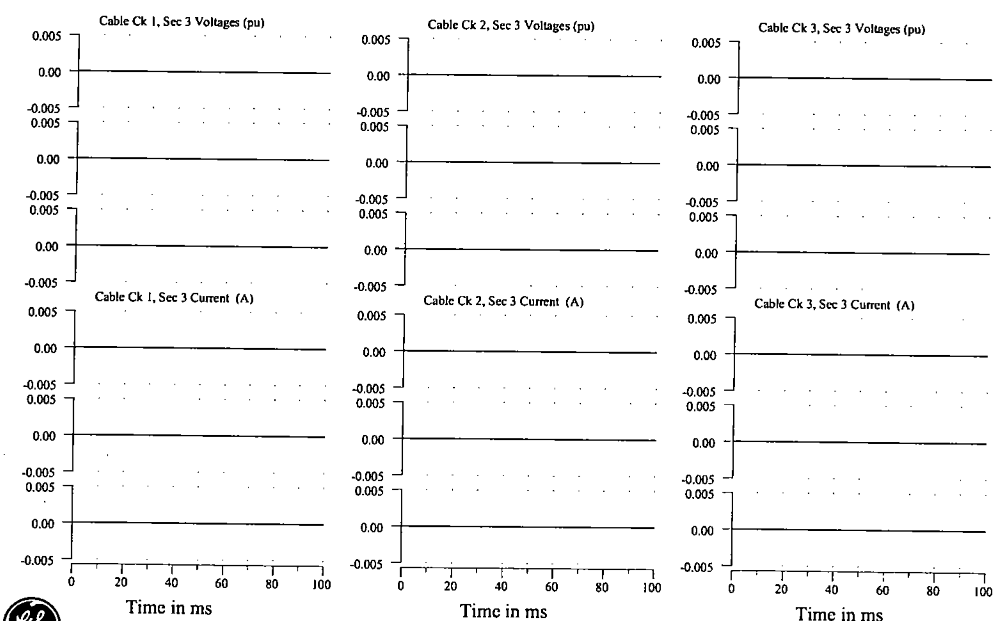
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01R
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



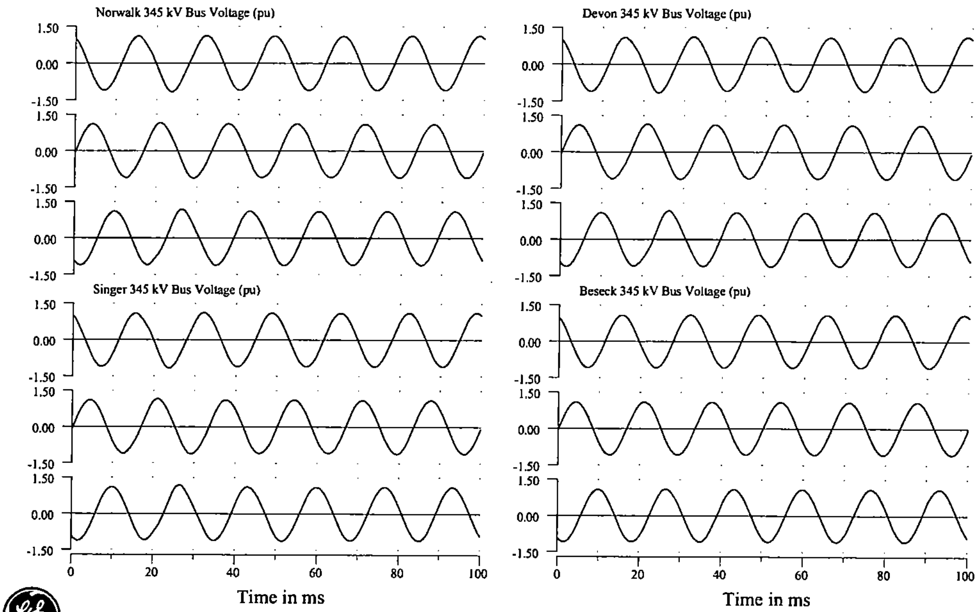
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01R
Devon-Beseck 345 kV Cables



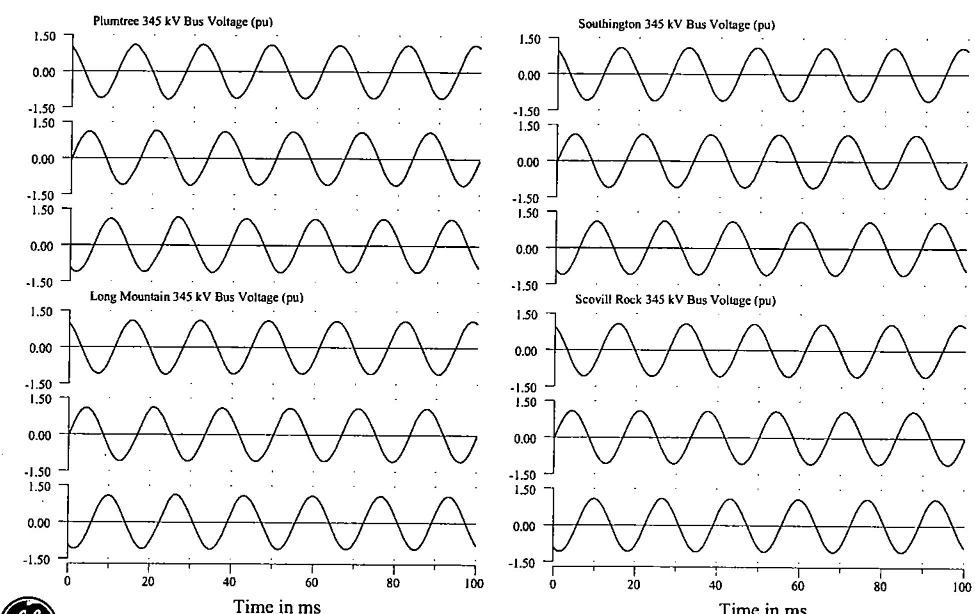
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01R
Devon-Beseck 345 kV Cables



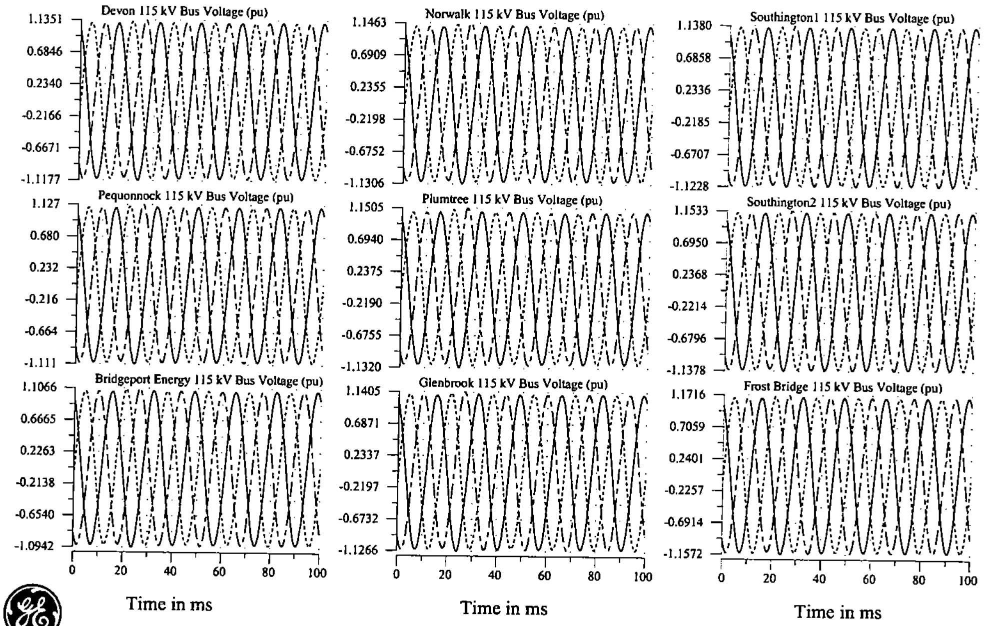
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01R
345 kV Bus Voltages



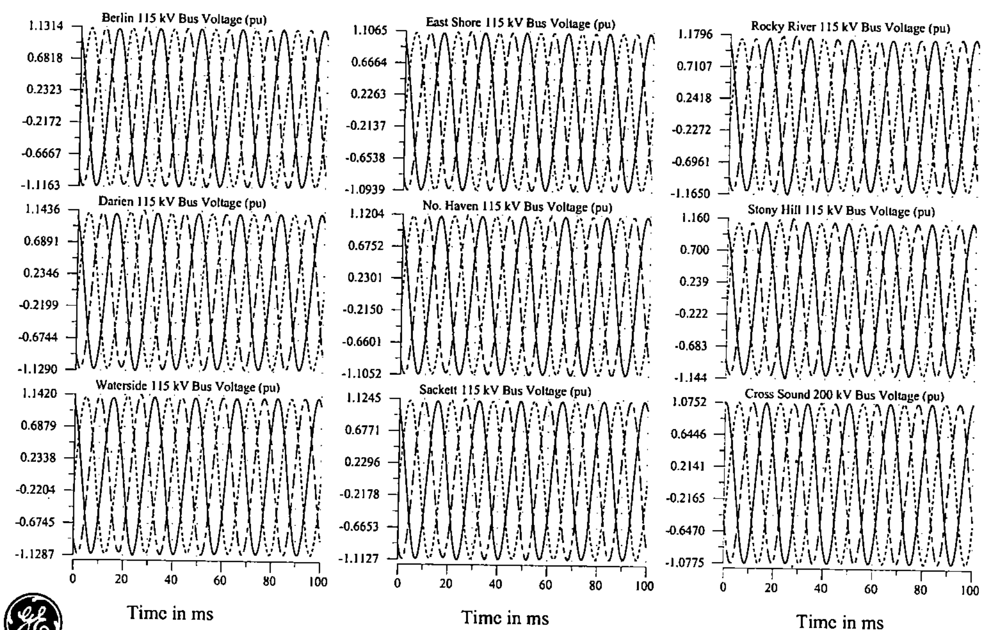
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01R
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01R
115 kV Bus Voltages and Capacitor Bank Locations



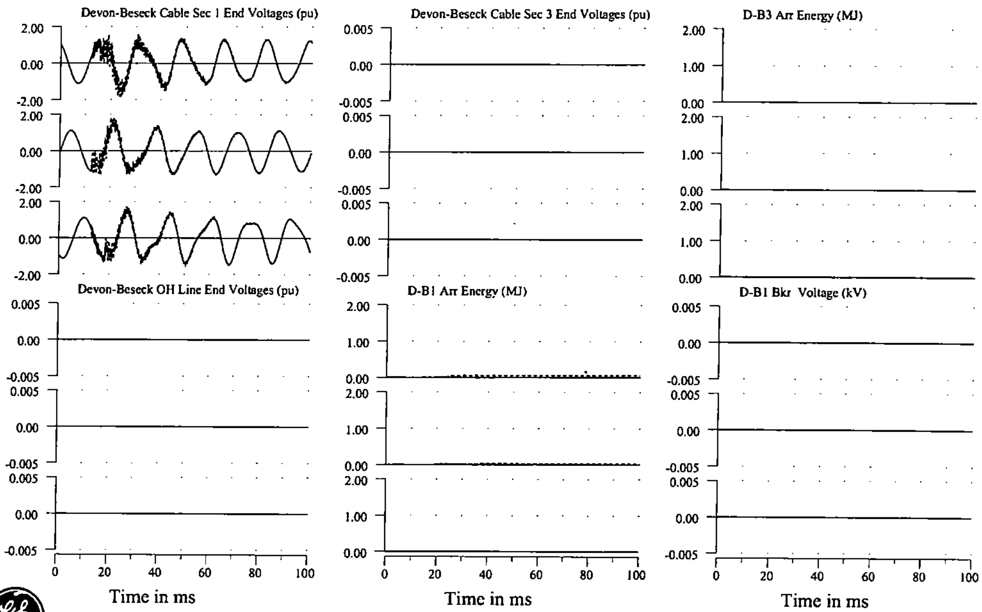
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_01R
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_02

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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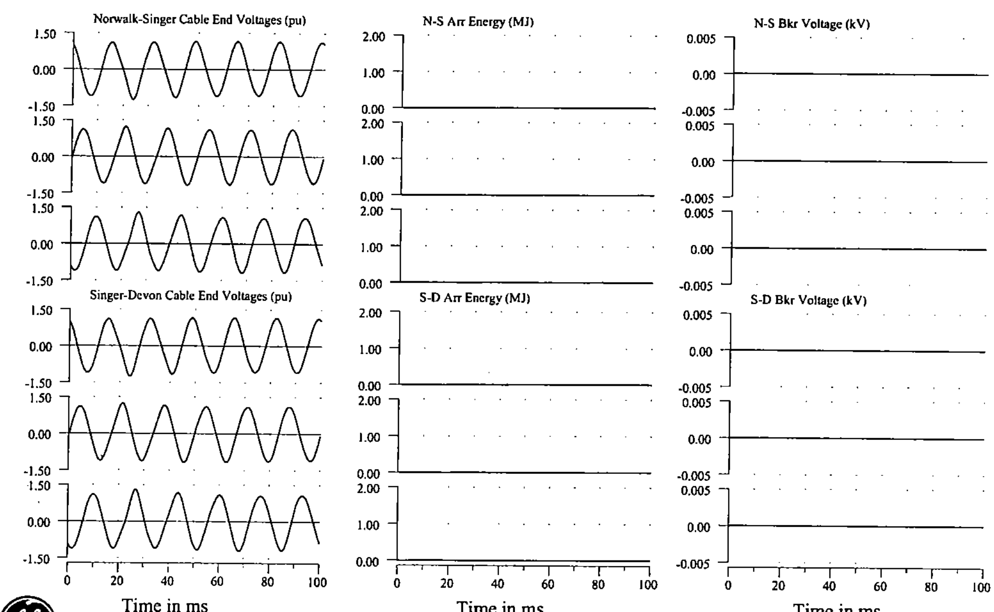
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_02

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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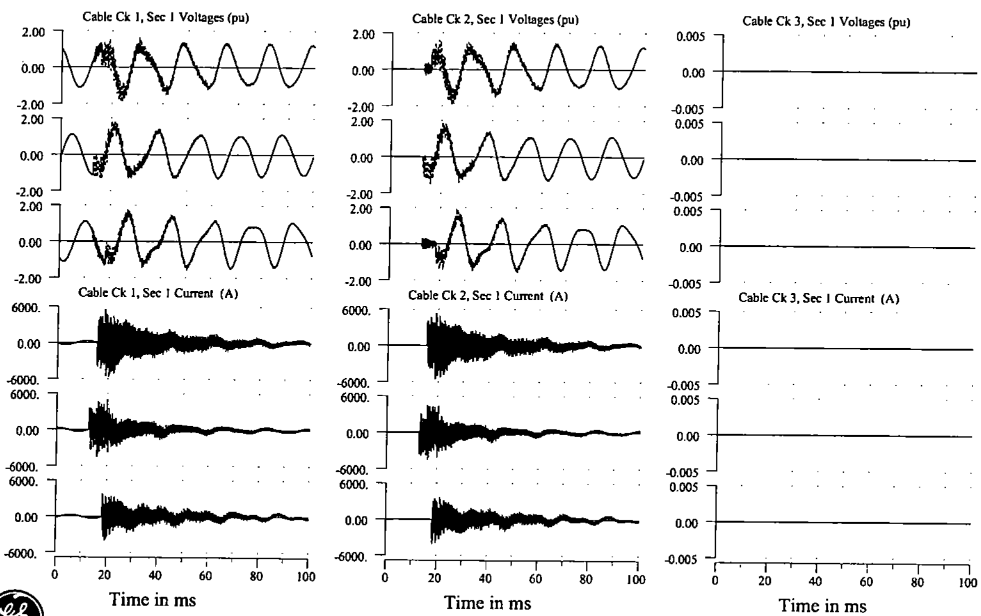
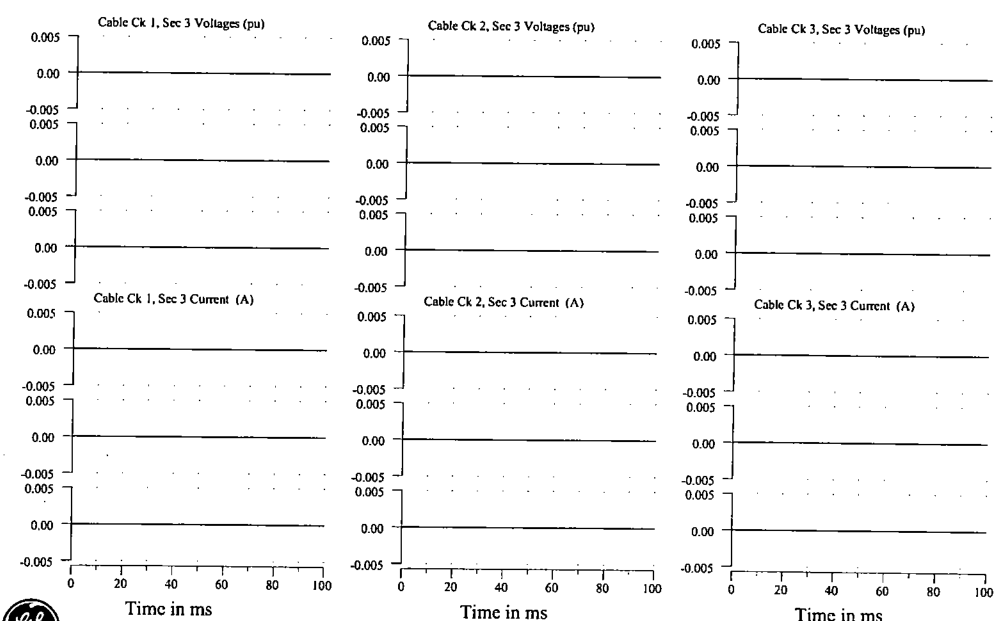
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_02
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_02
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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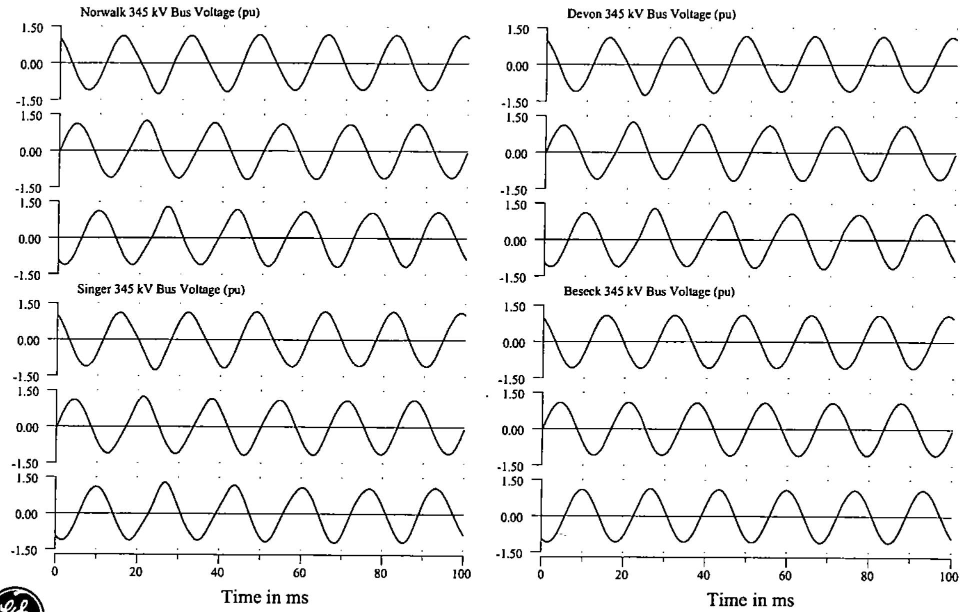
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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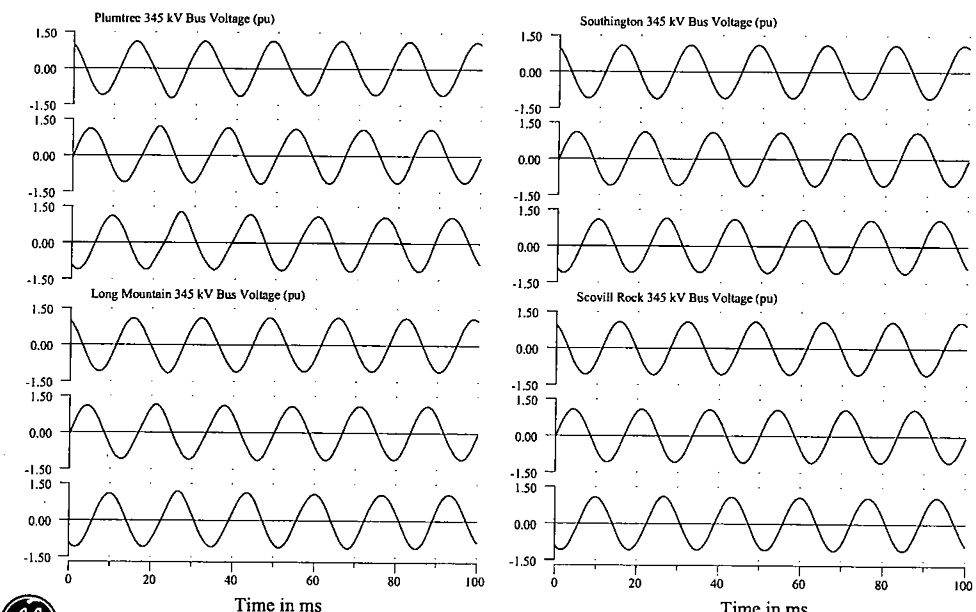
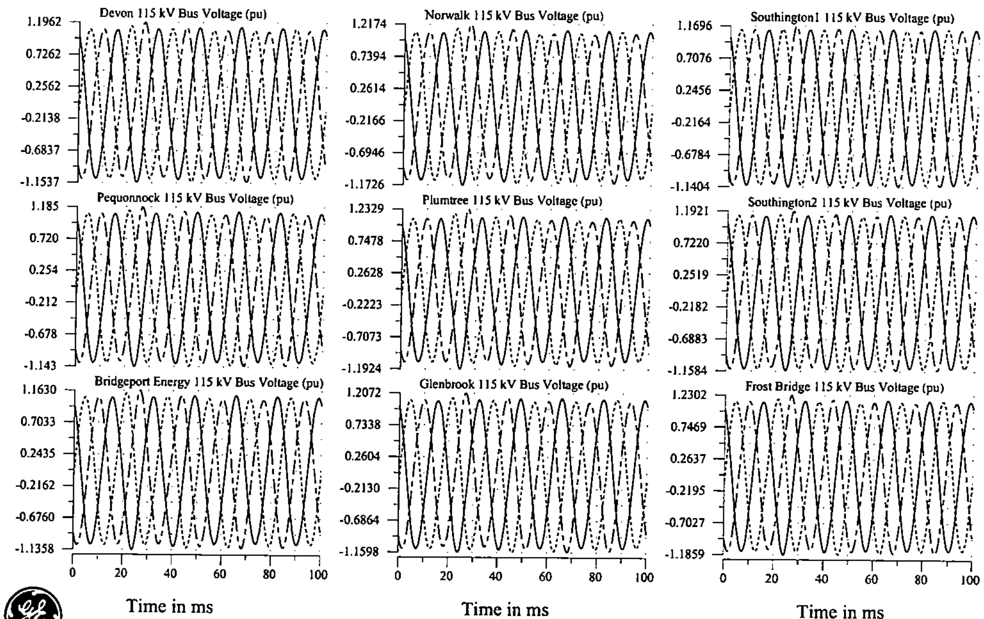
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_02
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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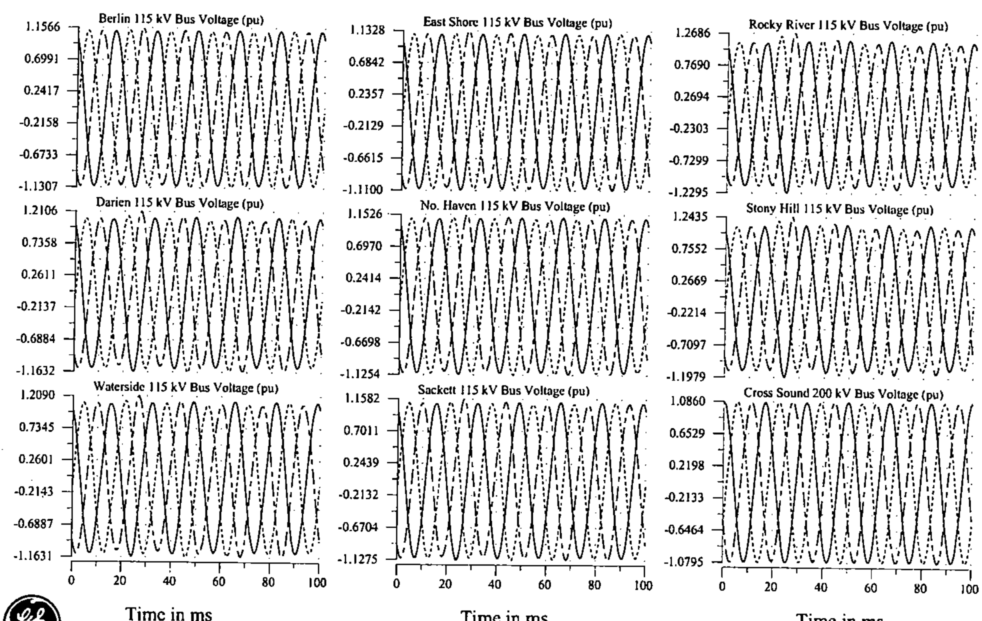
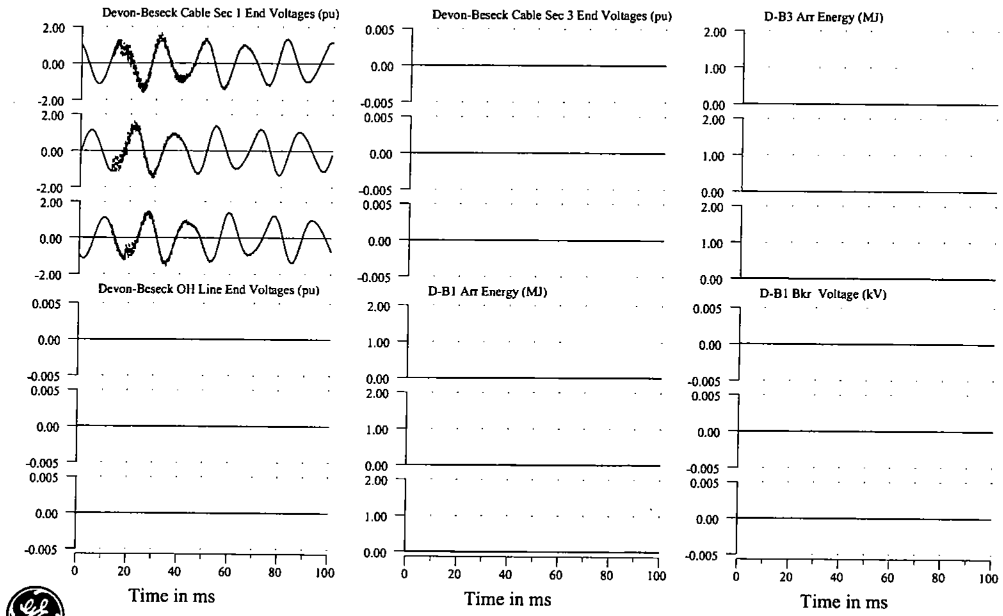
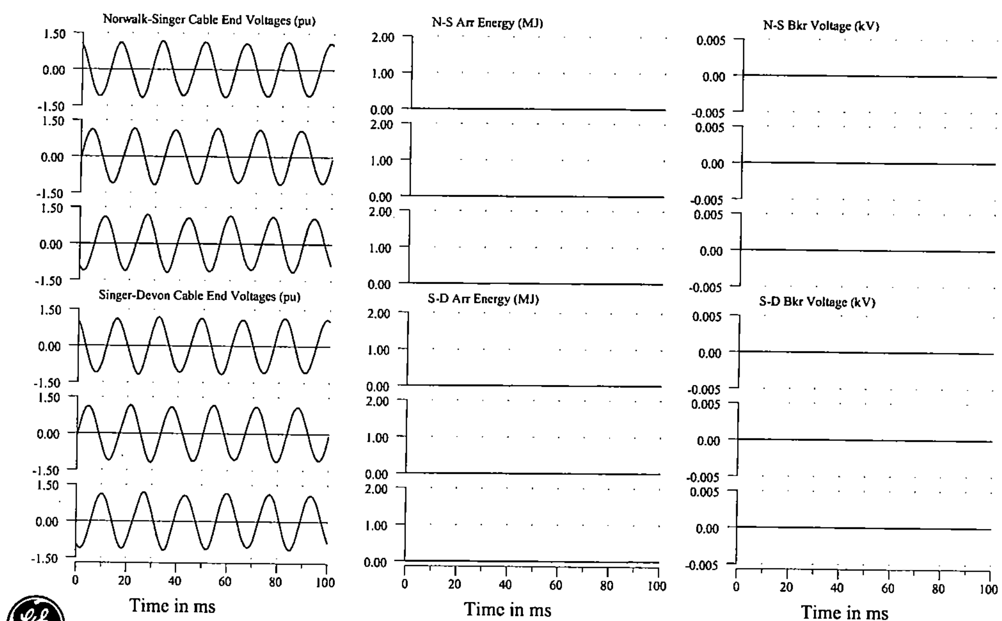
115 kV Bus Voltages and Capacitor Bank Locations



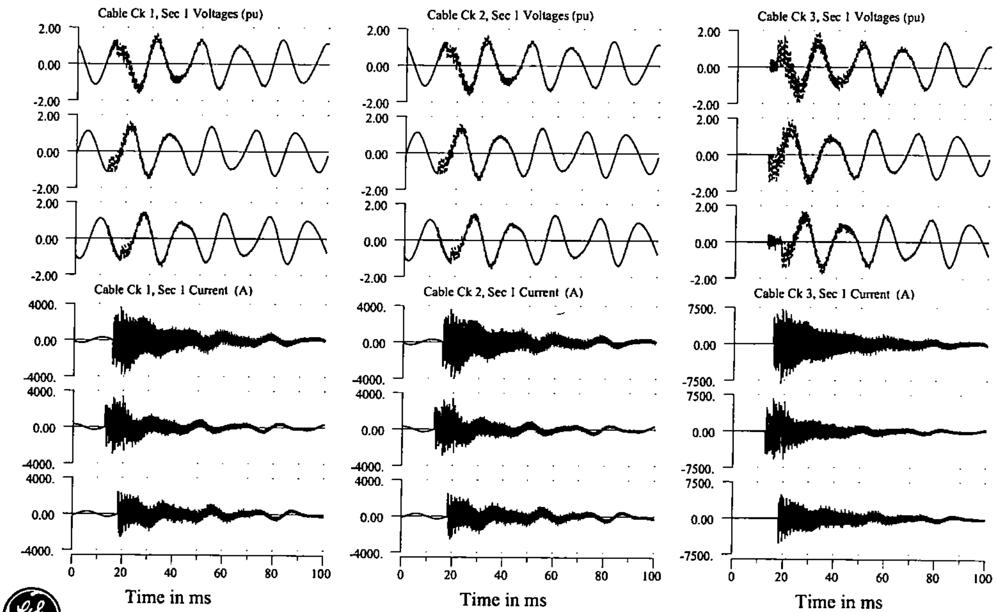
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



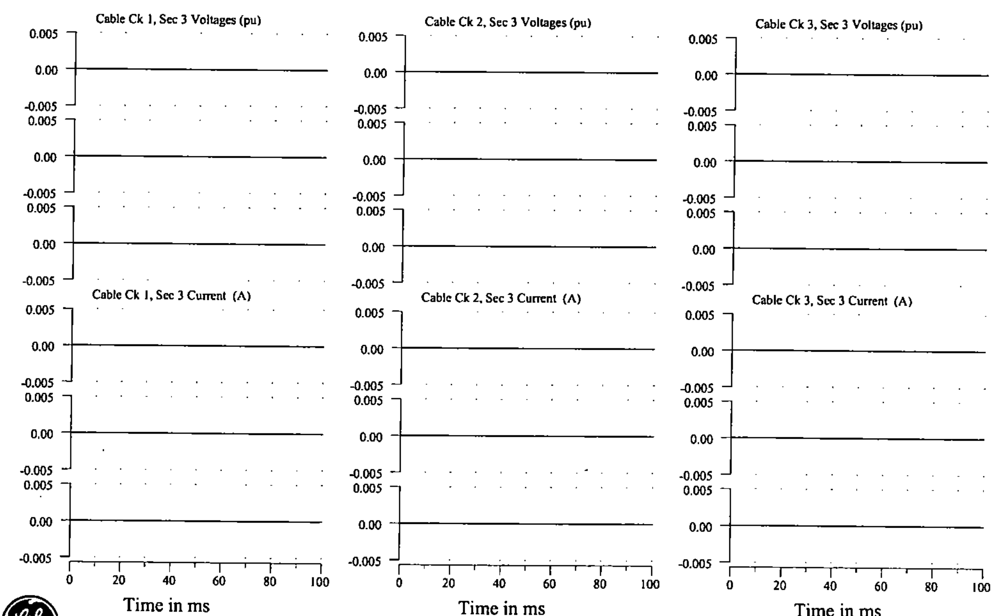
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



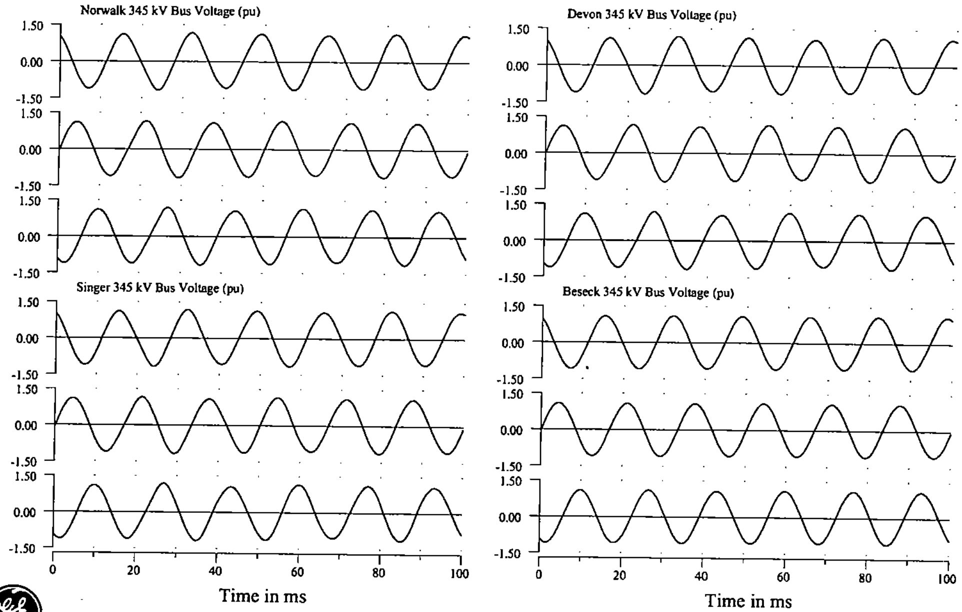
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03
Devon-Beseck 345 kV Cables



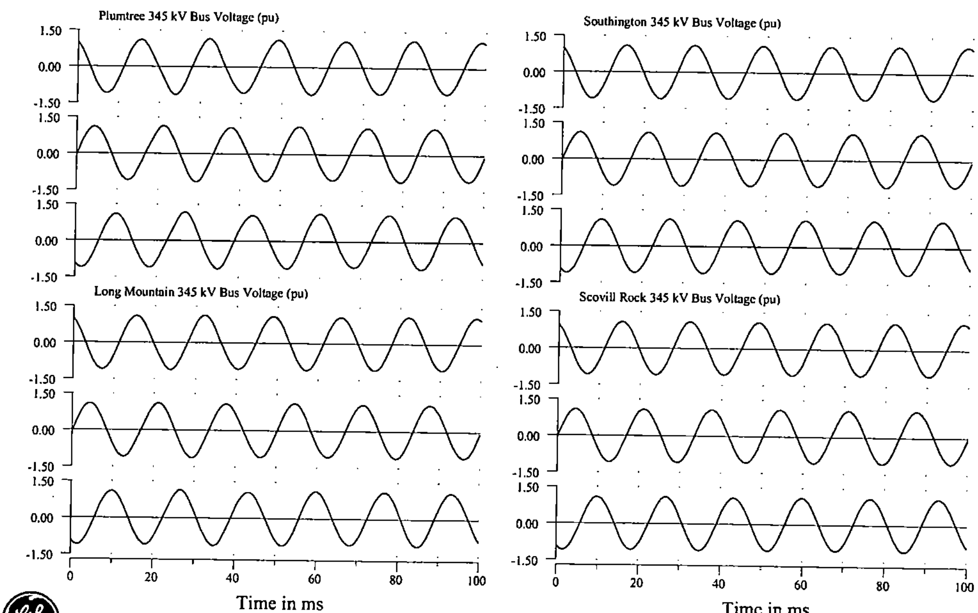
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03
Devon-Beseck 345 kV Cables



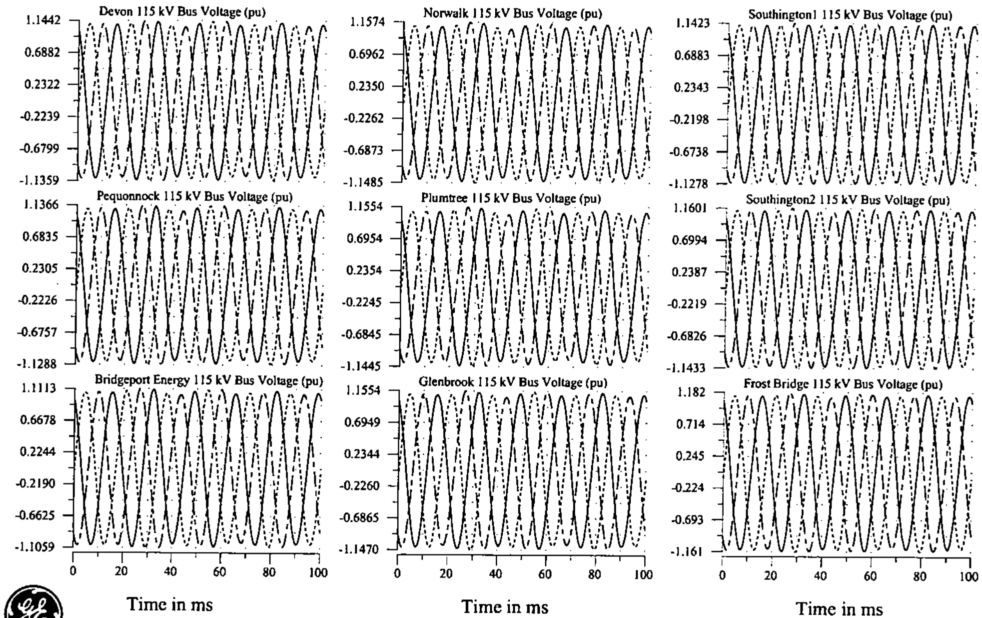
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03
345 kV Bus Voltages



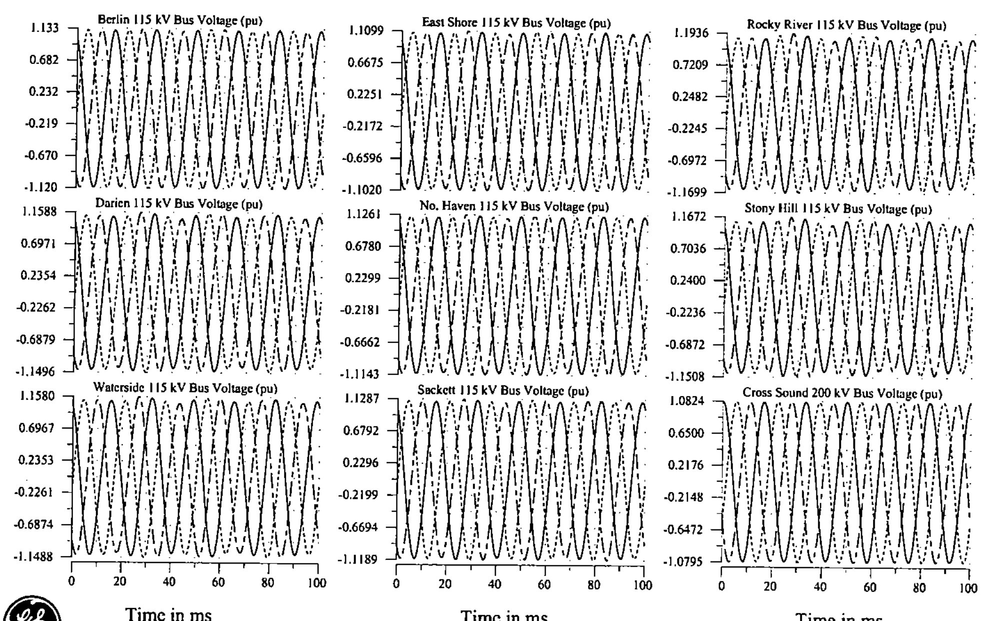
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03
345 kV Bus Voltages



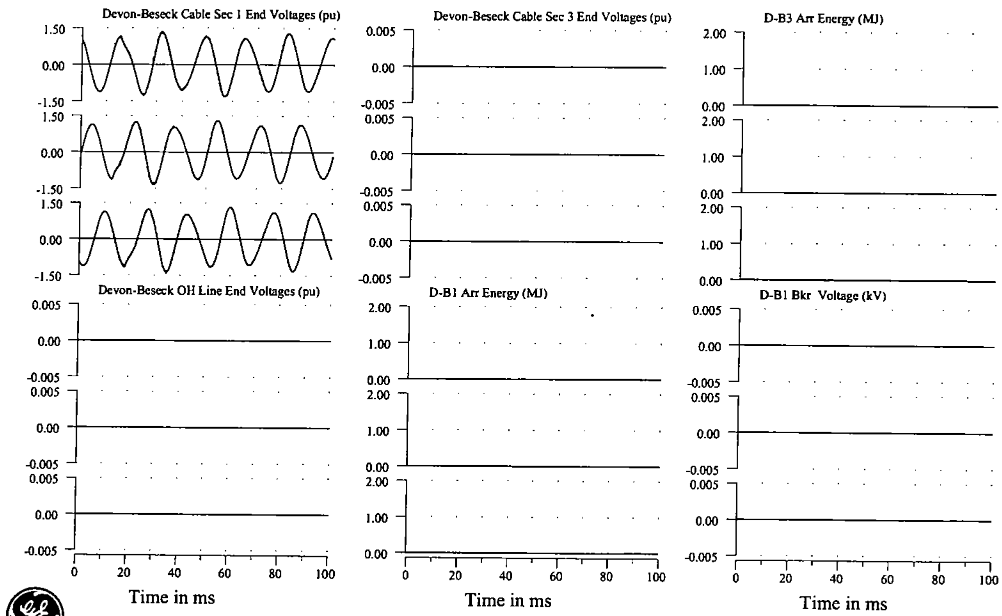
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03
115 kV Bus Voltages and Capacitor Bank Locations



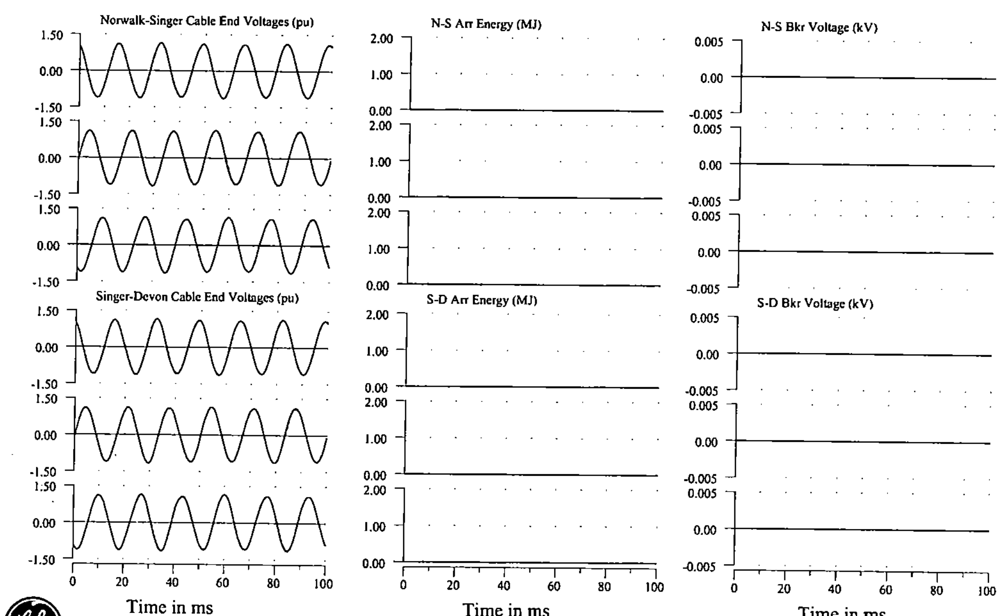
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03
115 kV Bus Voltages and Capacitor Bank Locations



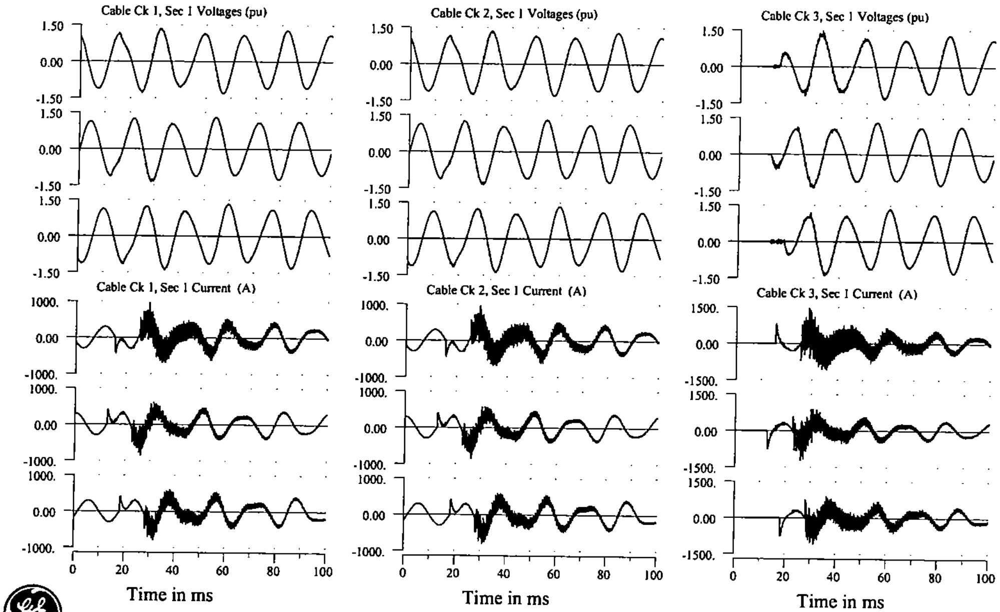
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03R
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03R
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03R
Devon-Beseck 345 kV Cables



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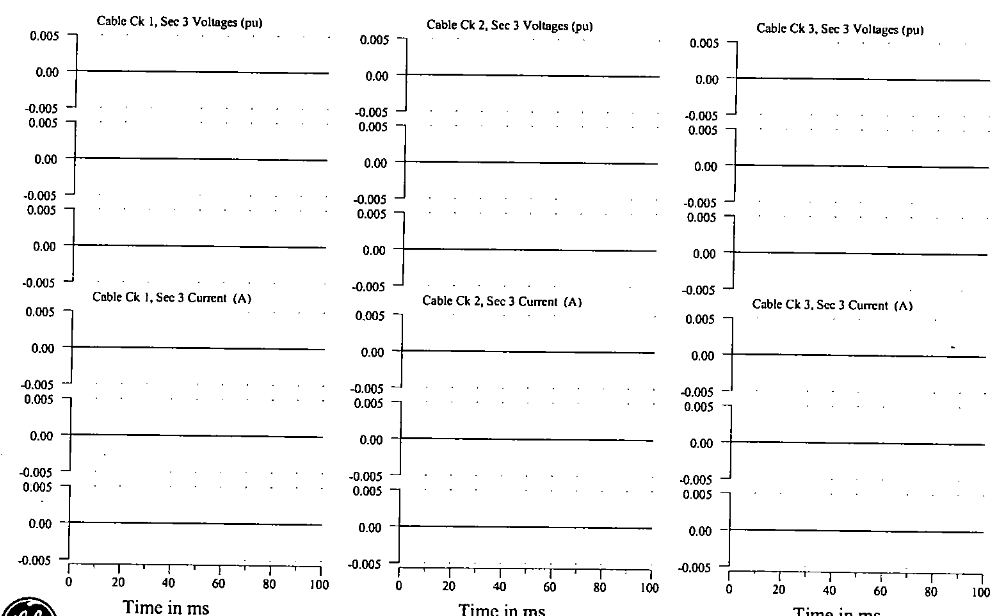
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03R
Devon-Beseck 345 kV Cables



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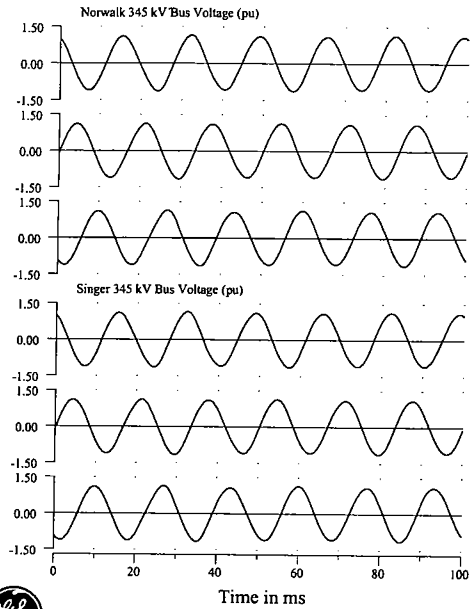
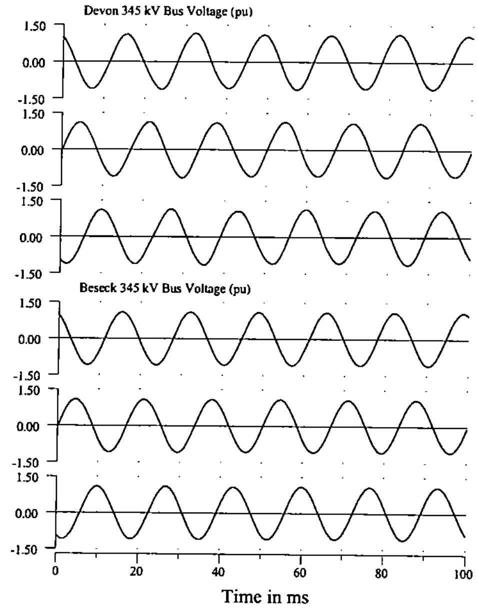
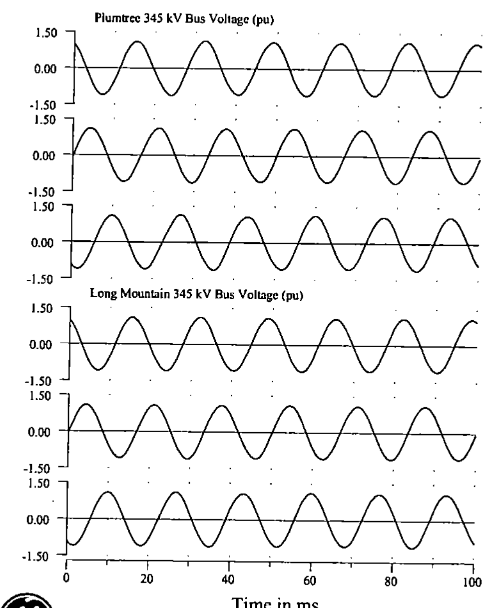
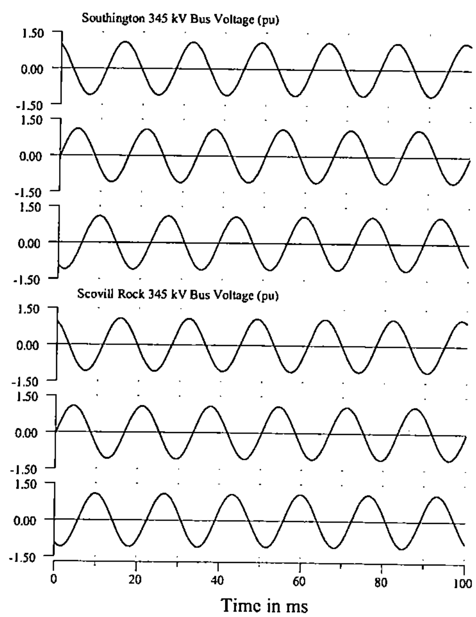
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03R
345 kV Bus Voltages



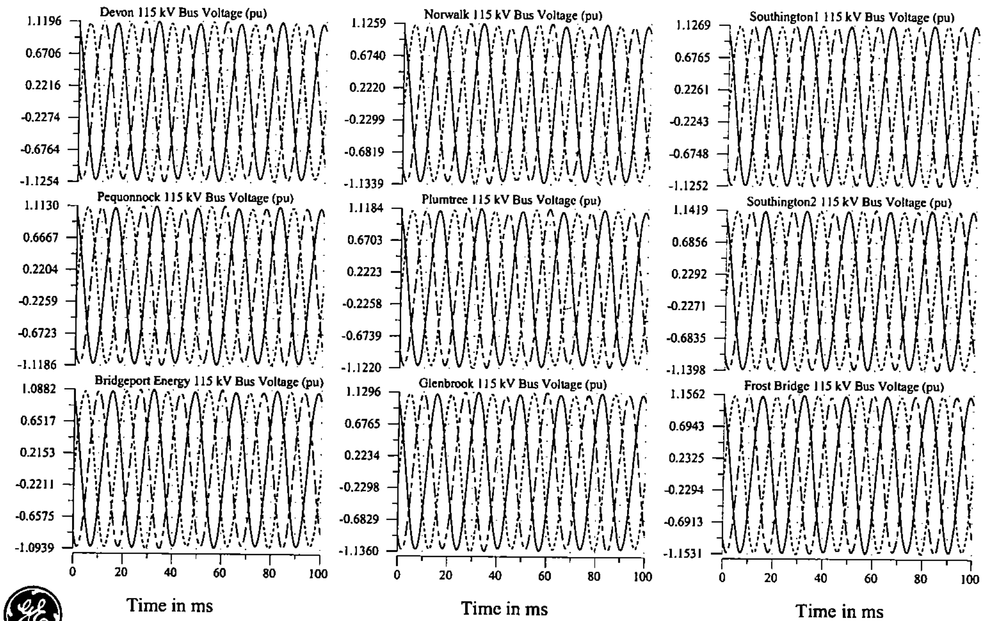


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03R
345 kV Bus Voltages

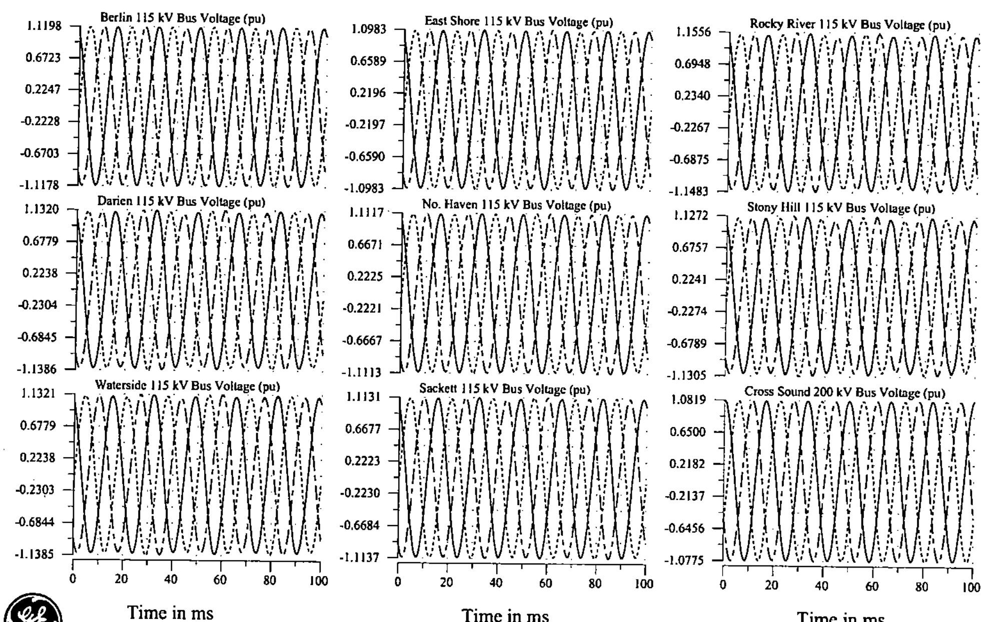




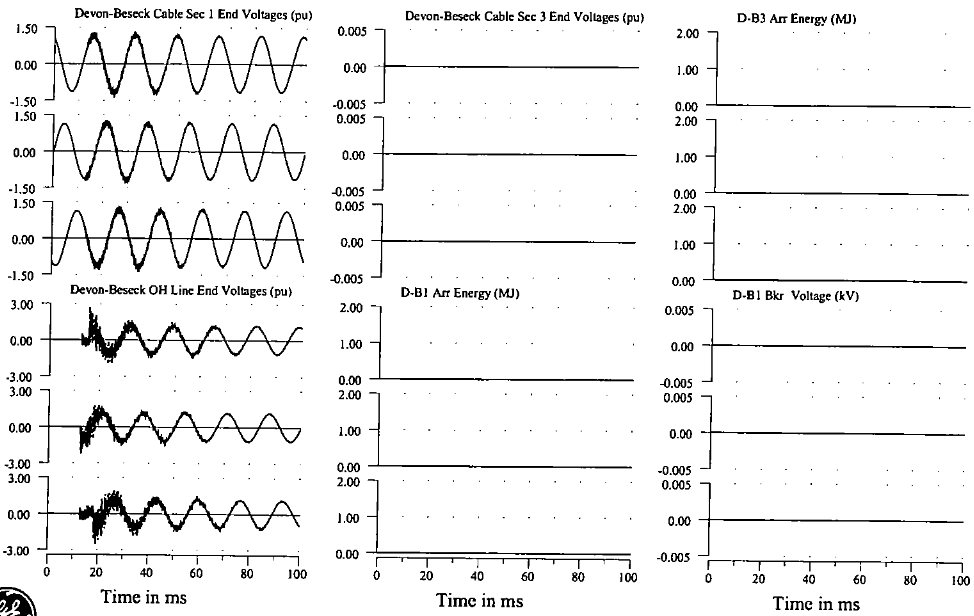
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03R
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_03R
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_04
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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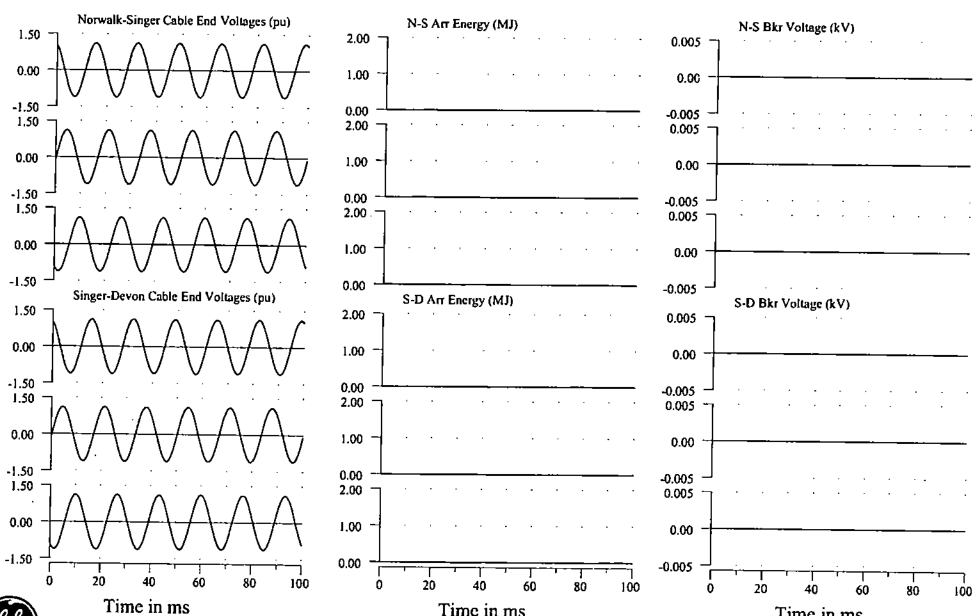
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_04
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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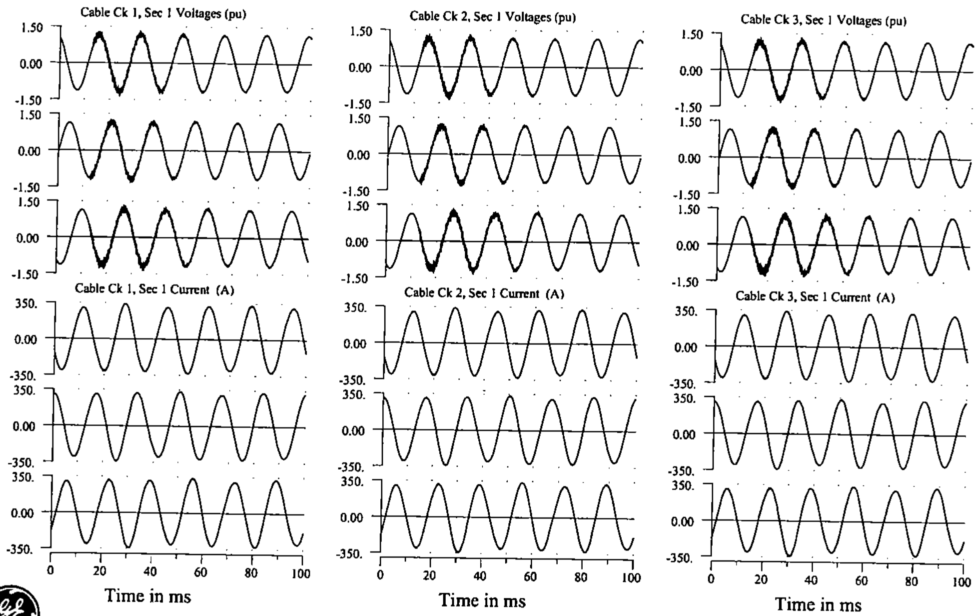
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_04
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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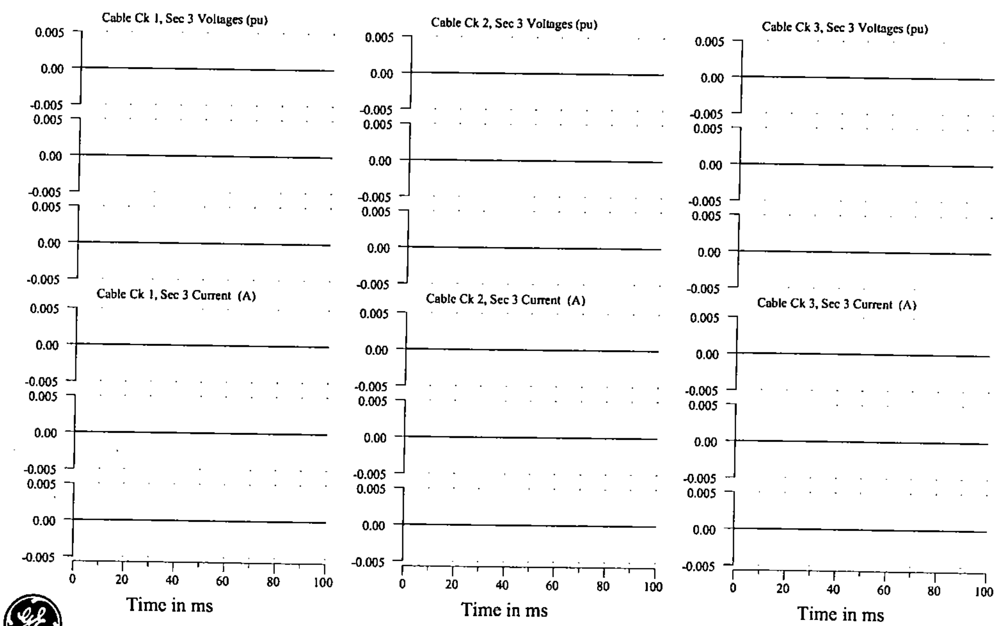
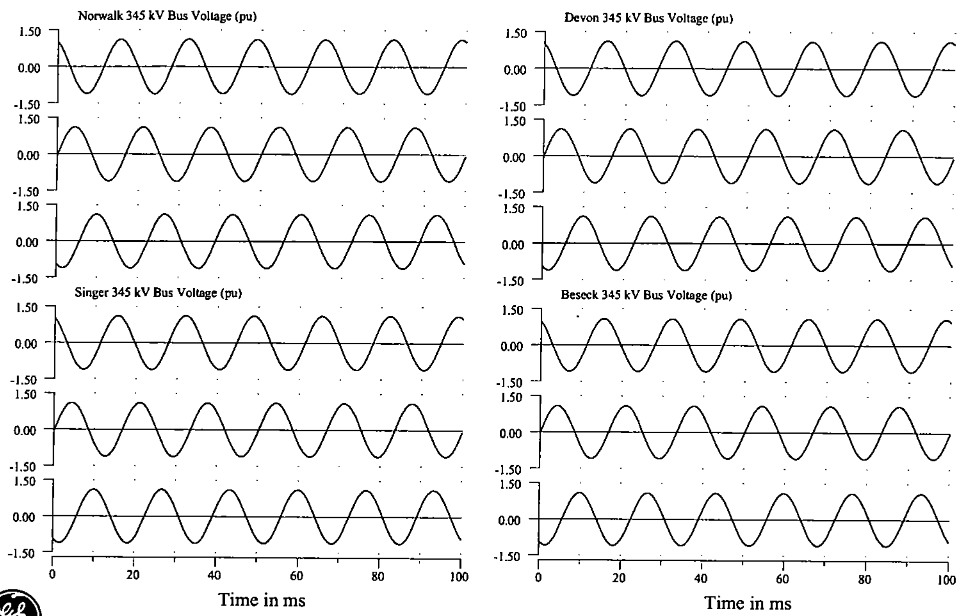
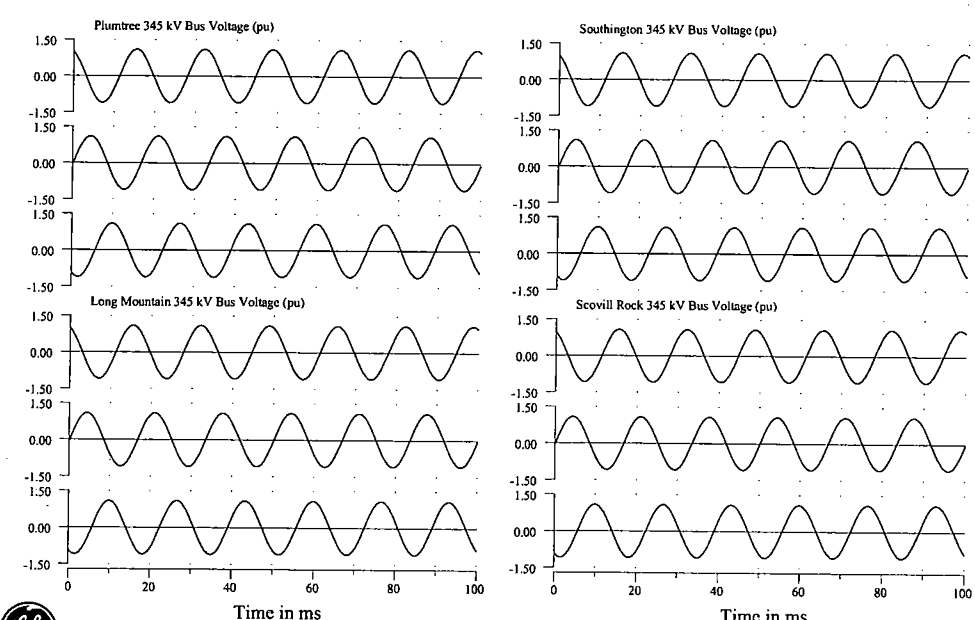
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_04
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_04
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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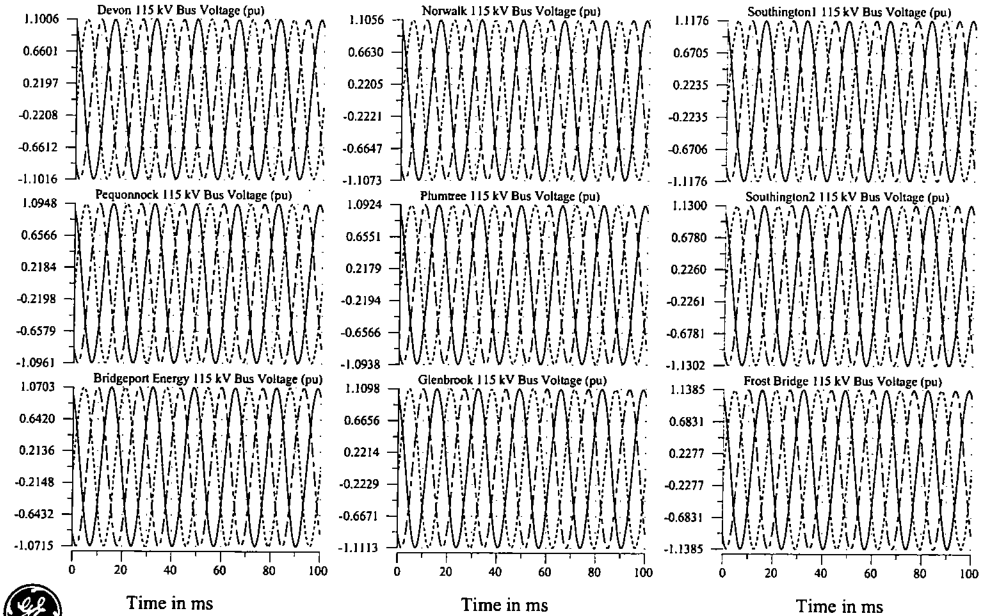
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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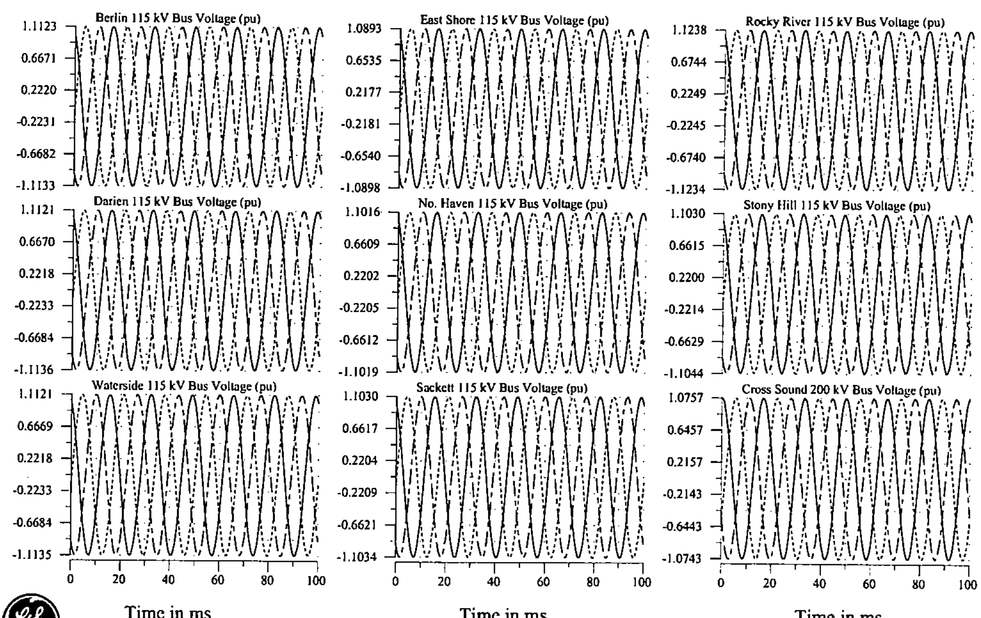
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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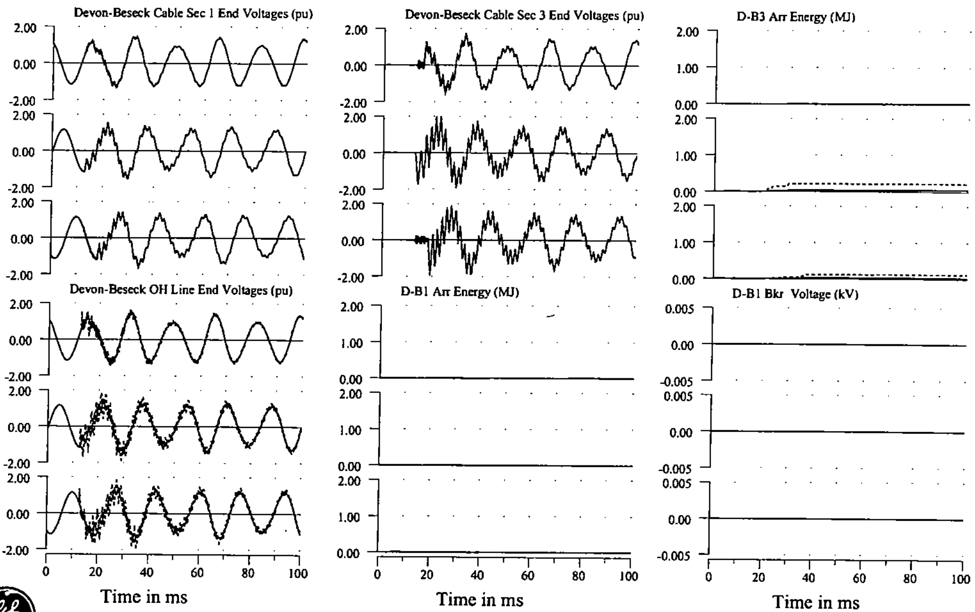
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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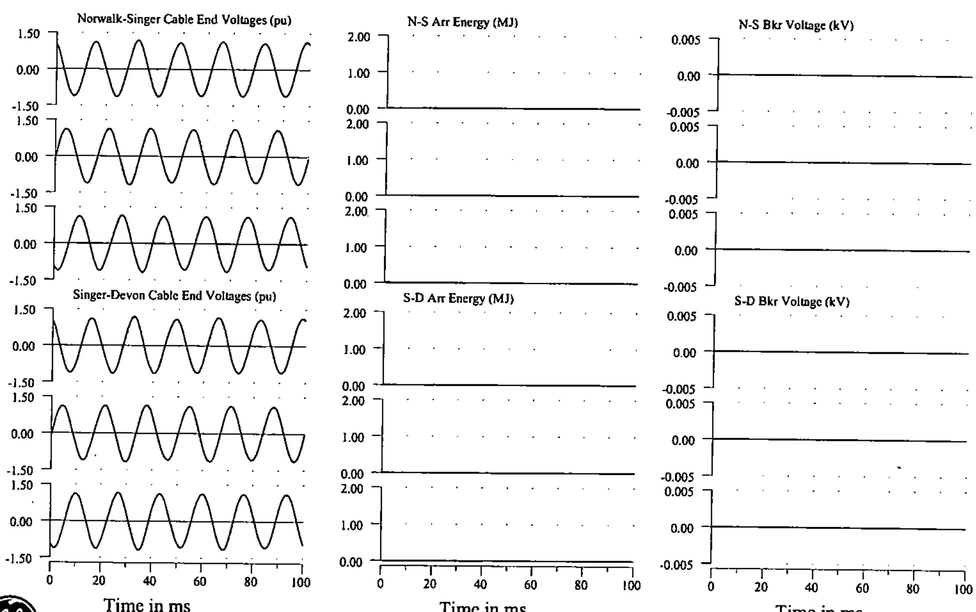
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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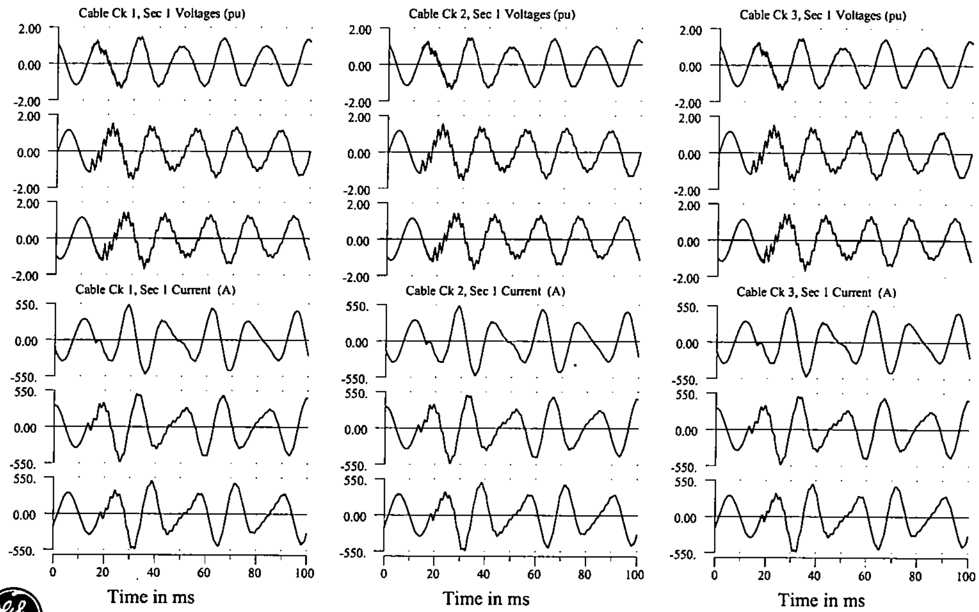
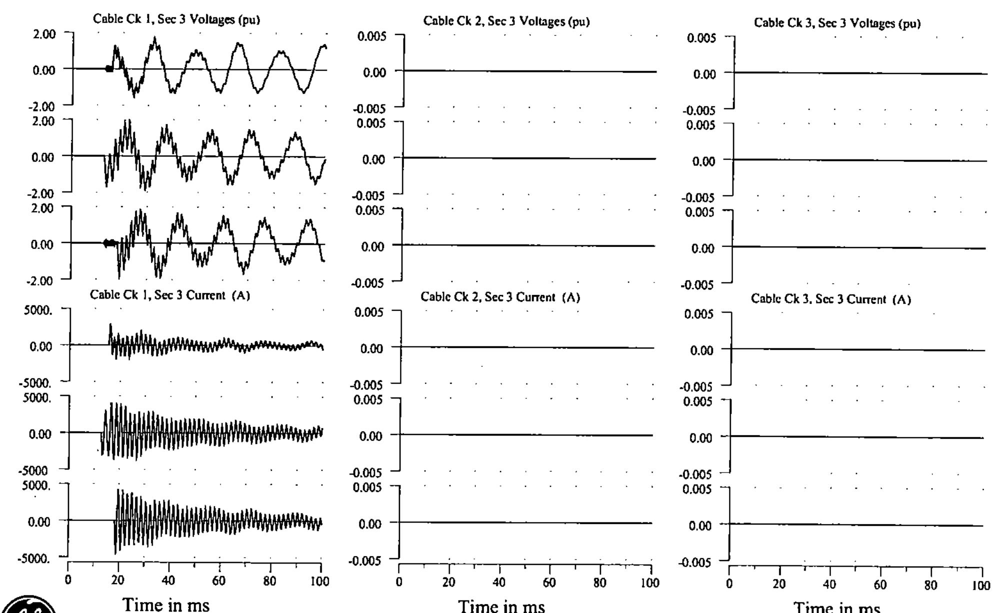
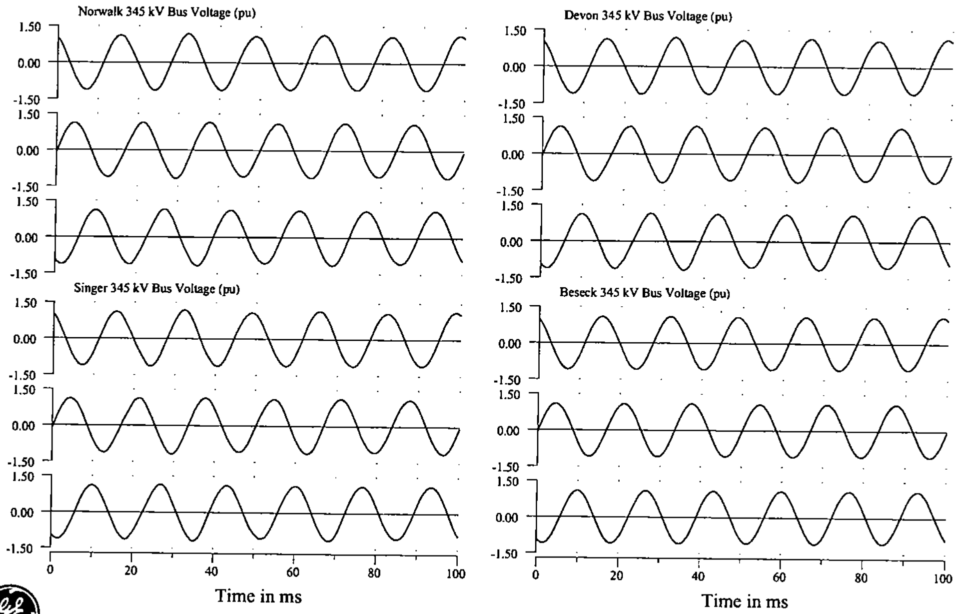
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05
Devon-Beseck 345 kV Cables



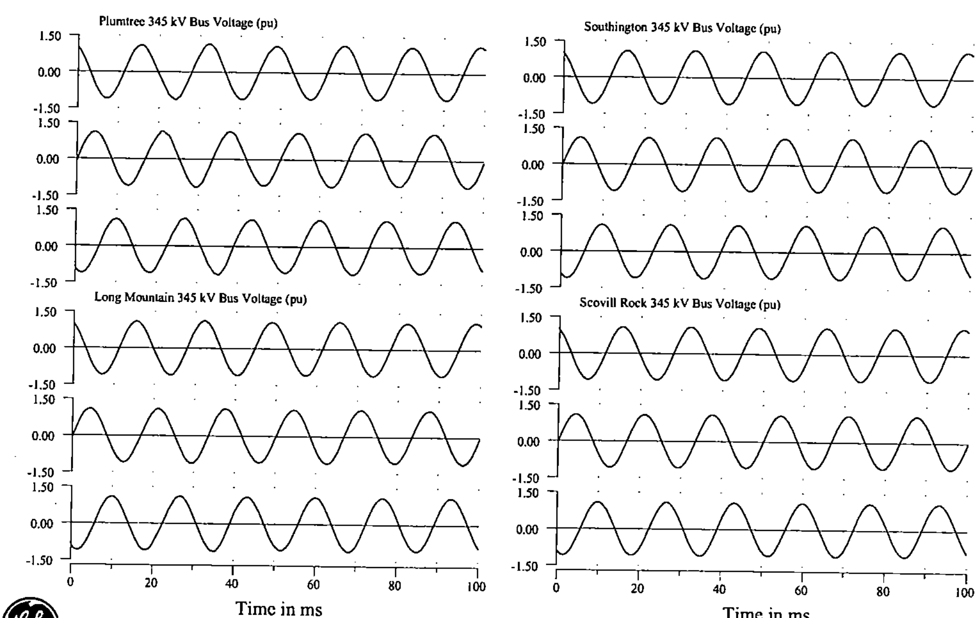
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05
Devon-Beseck 345 kV Cables



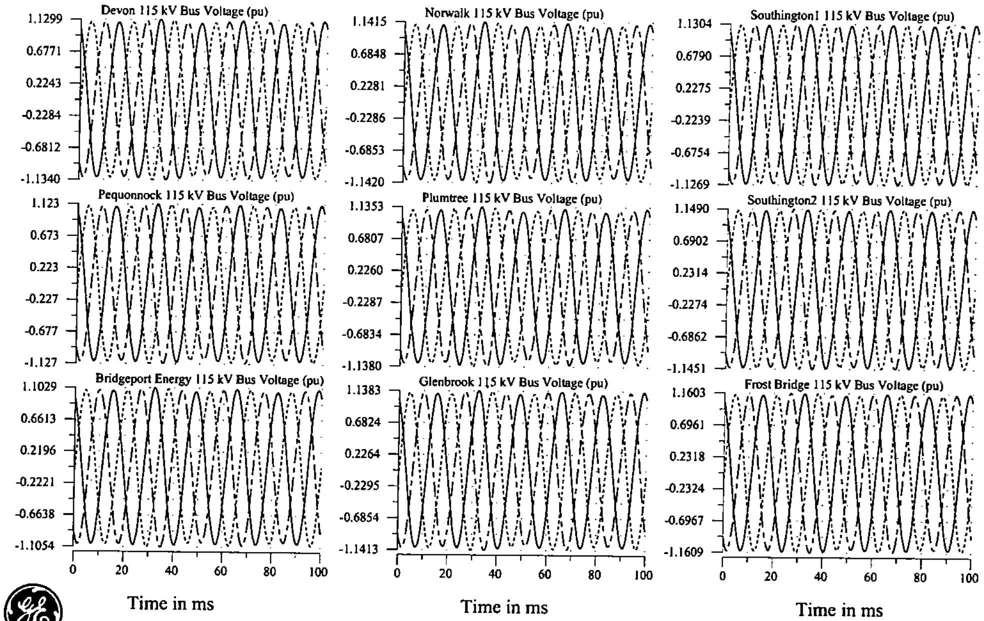
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05
345 kV Bus Voltages



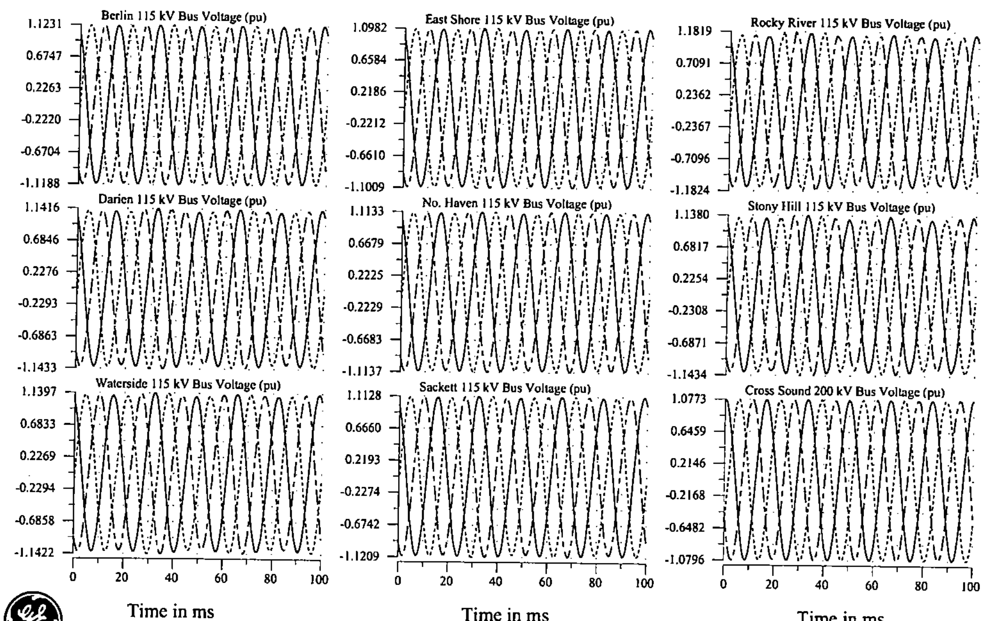
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05
115 kV Bus Voltages and Capacitor Bank Locations



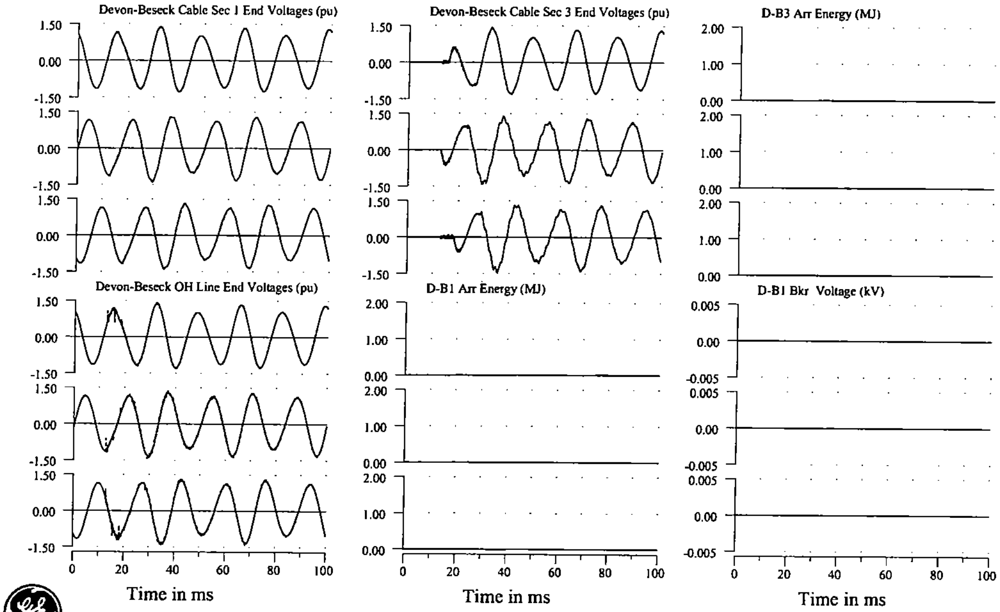
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_05R

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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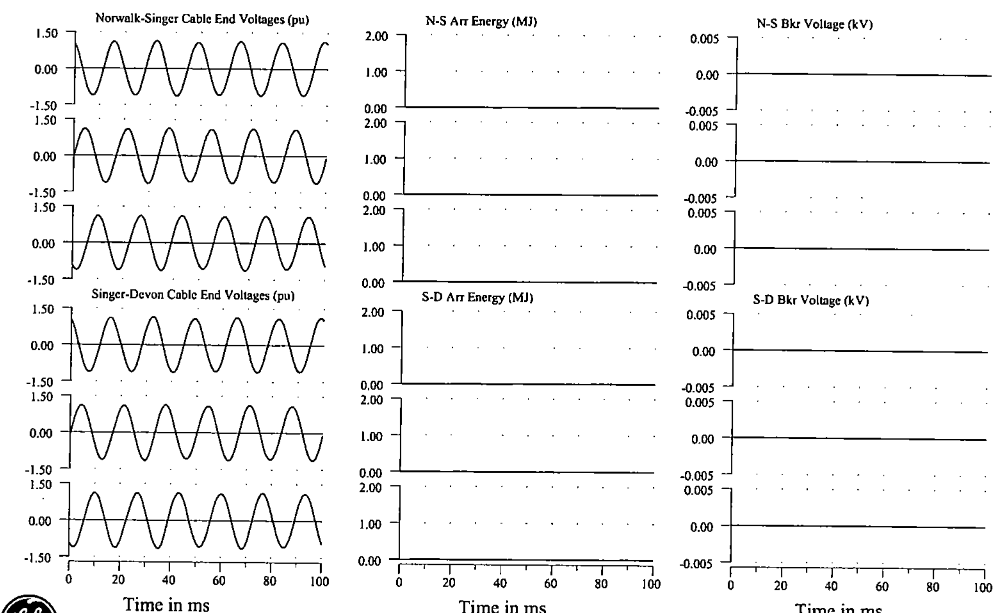
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_05R

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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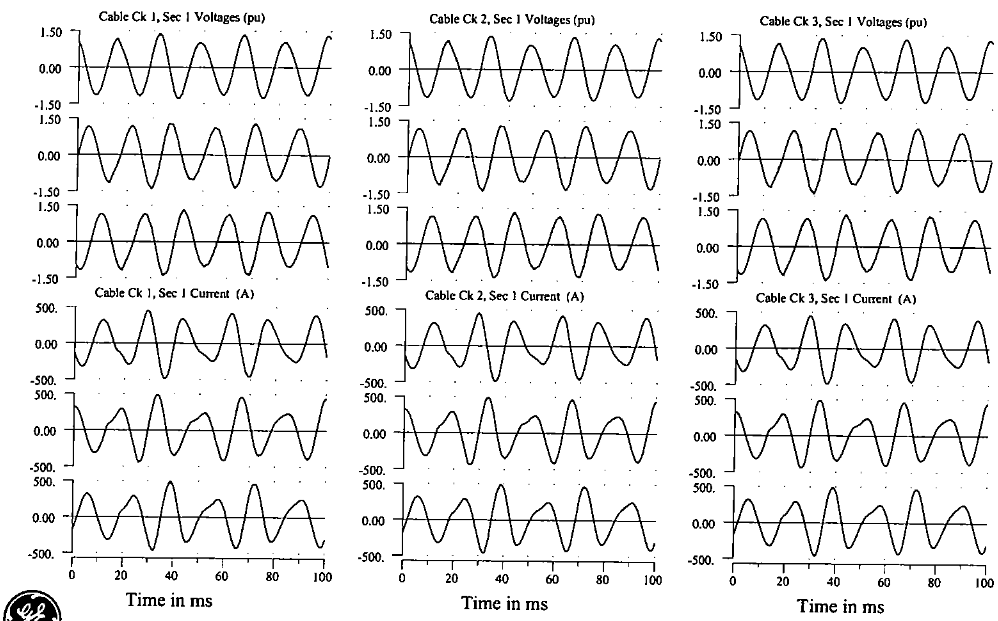
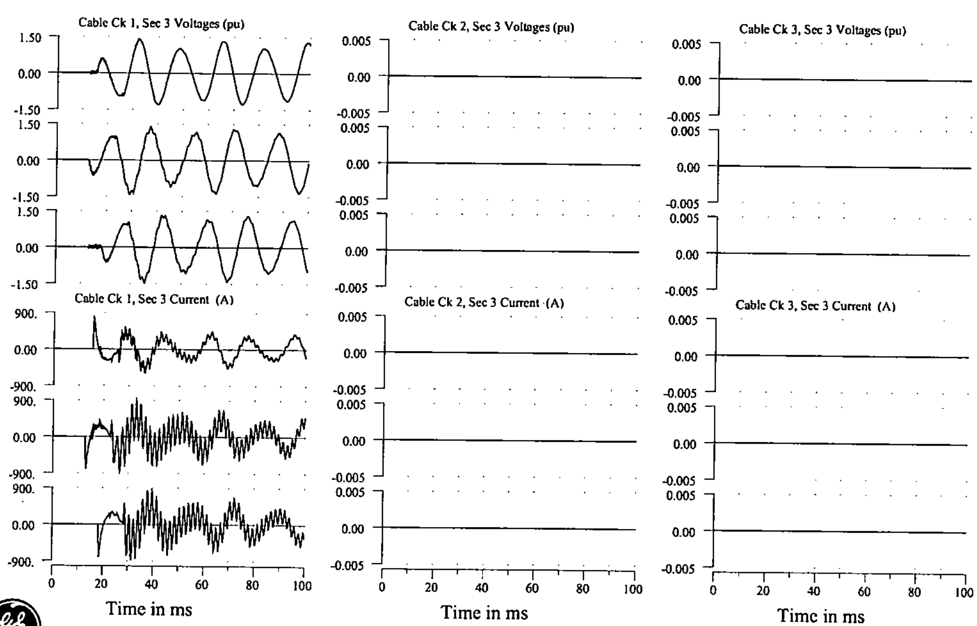
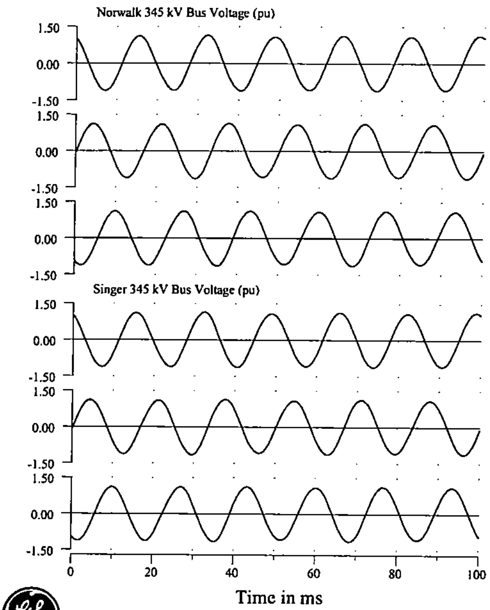
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05R
Devon-Beseck 345 kV Cables

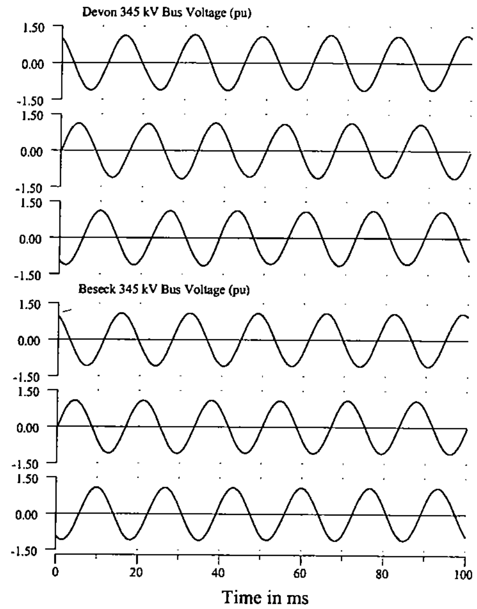


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05R
Devon-Beseck 345 kV Cables

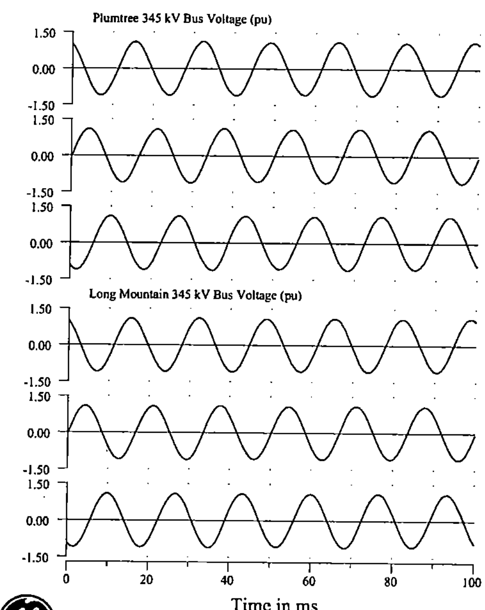


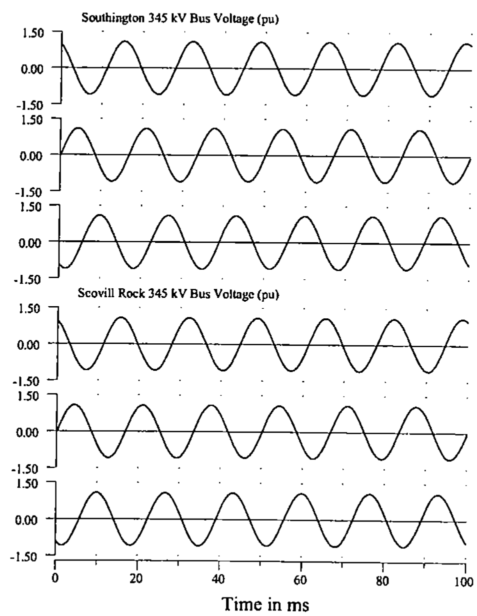
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05R
345 kV Bus Voltages



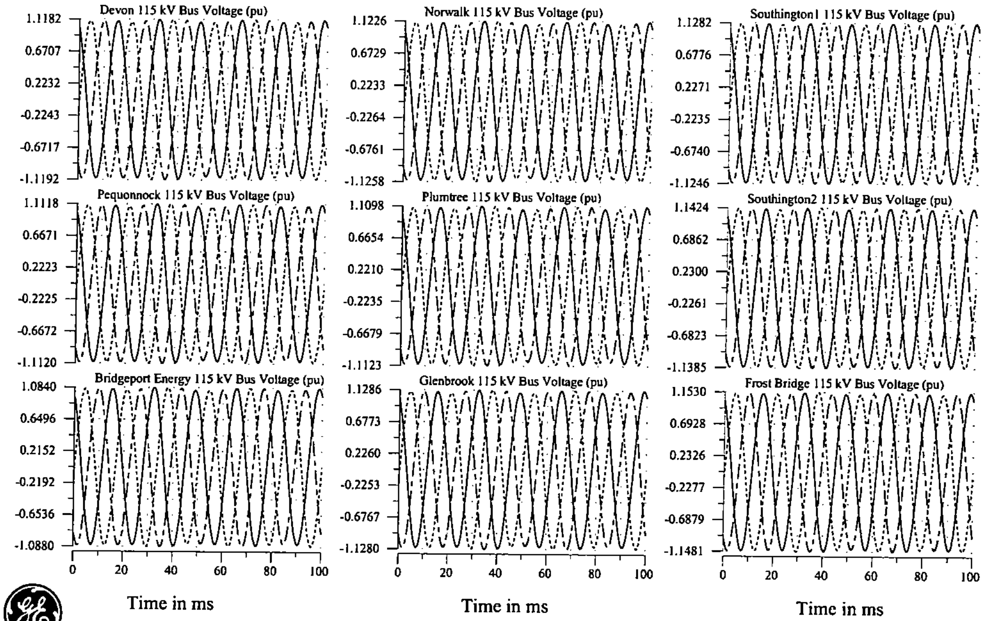


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05R
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05R
115 kV Bus Voltages and Capacitor Bank Locations



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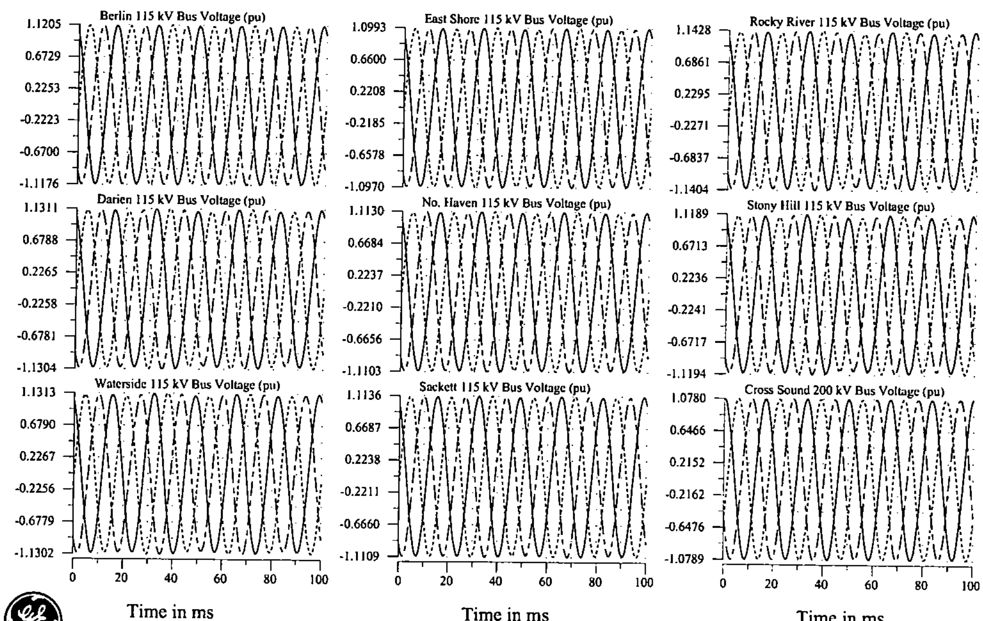
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_05R
115 kV Bus Voltages and Capacitor Bank Locations



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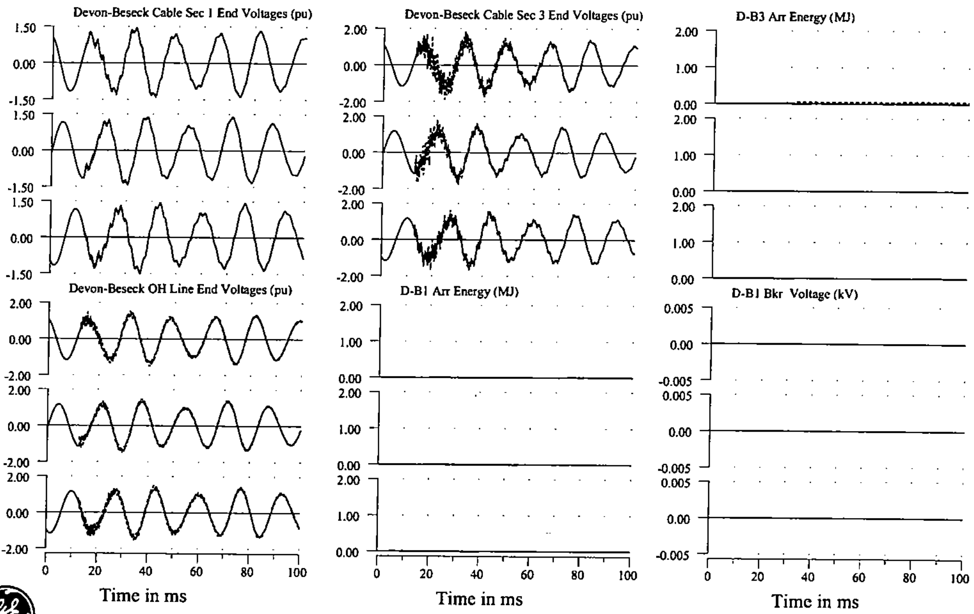
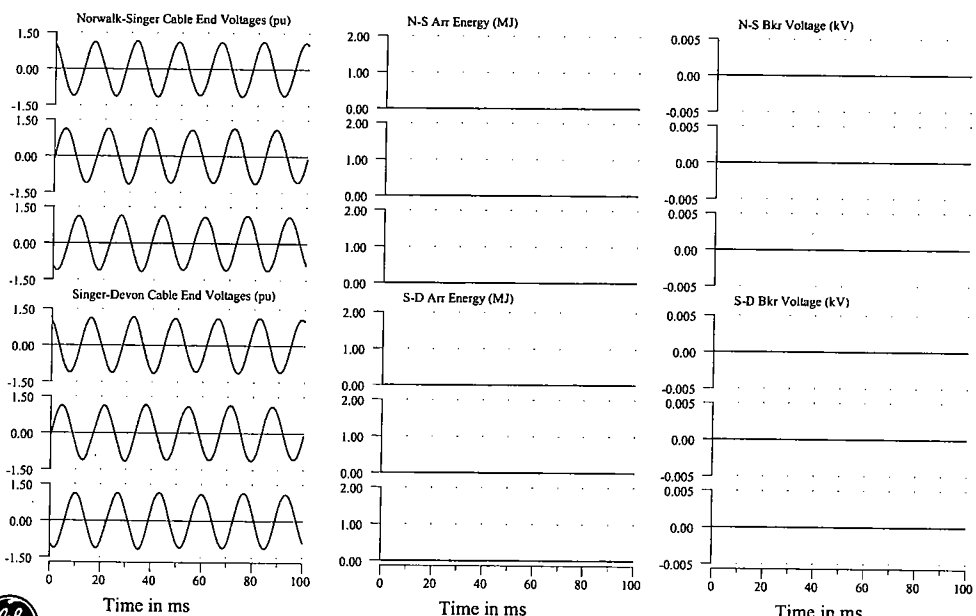
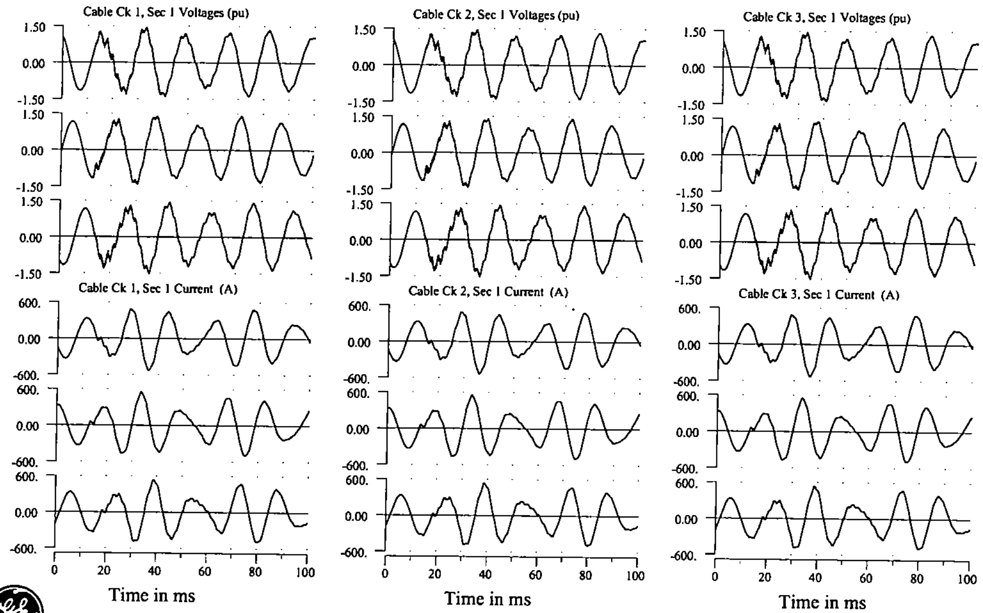
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_06
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_06
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_06
Devon-Beseck 345 kV Cables



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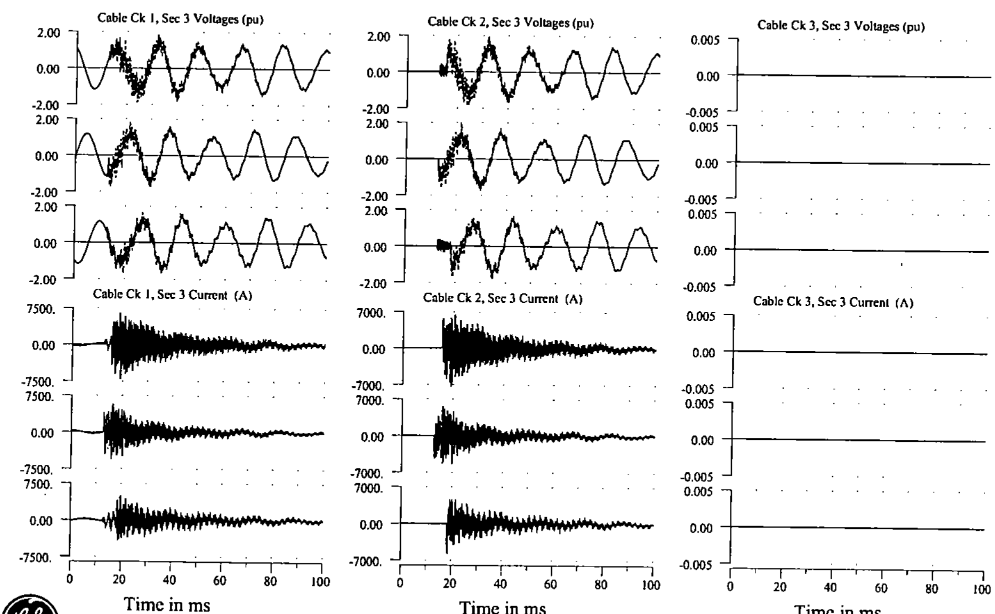
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_06
Devon-Beseck 345 kV Cables



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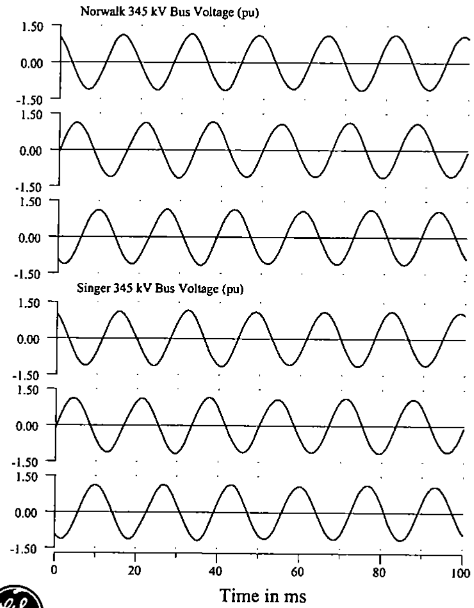
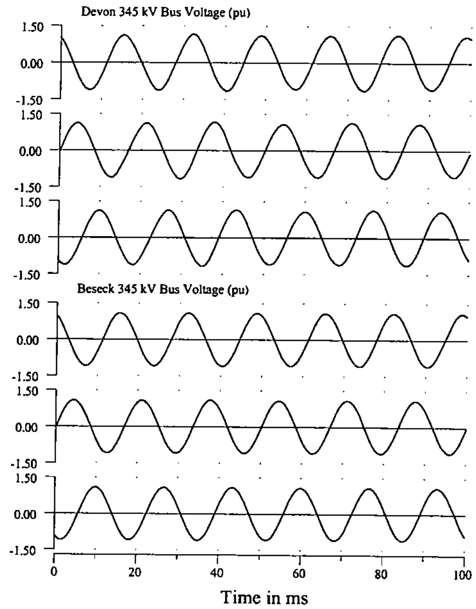
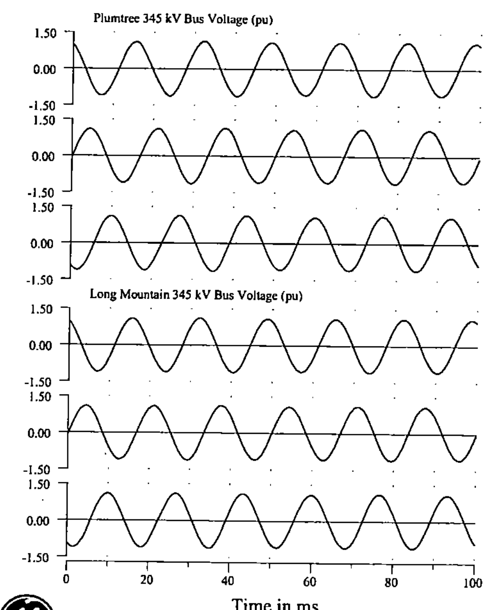
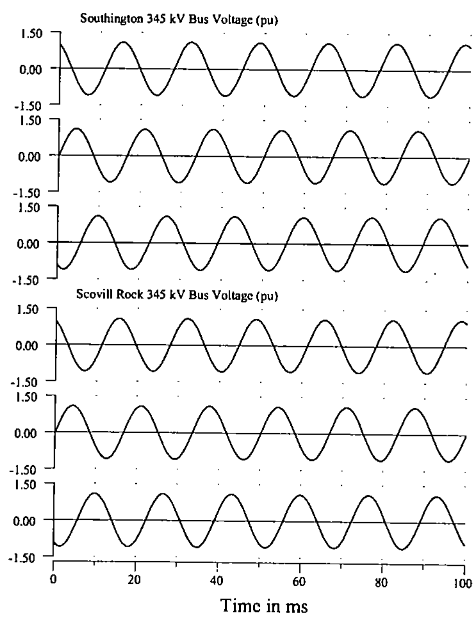
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_06
345 kV Bus Voltages



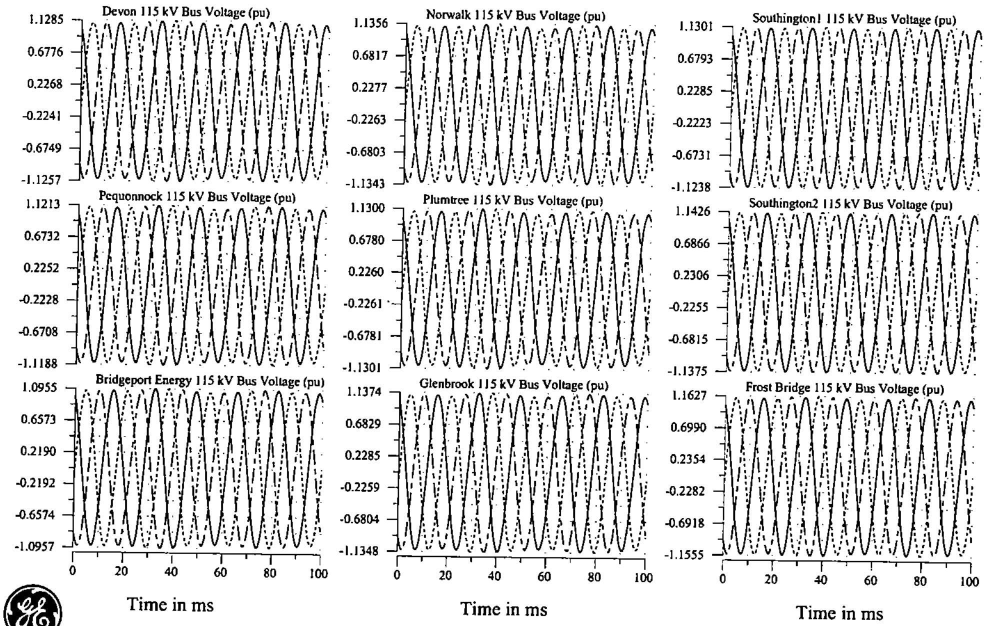


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_06
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_06
115 kV Bus Voltages and Capacitor Bank Locations



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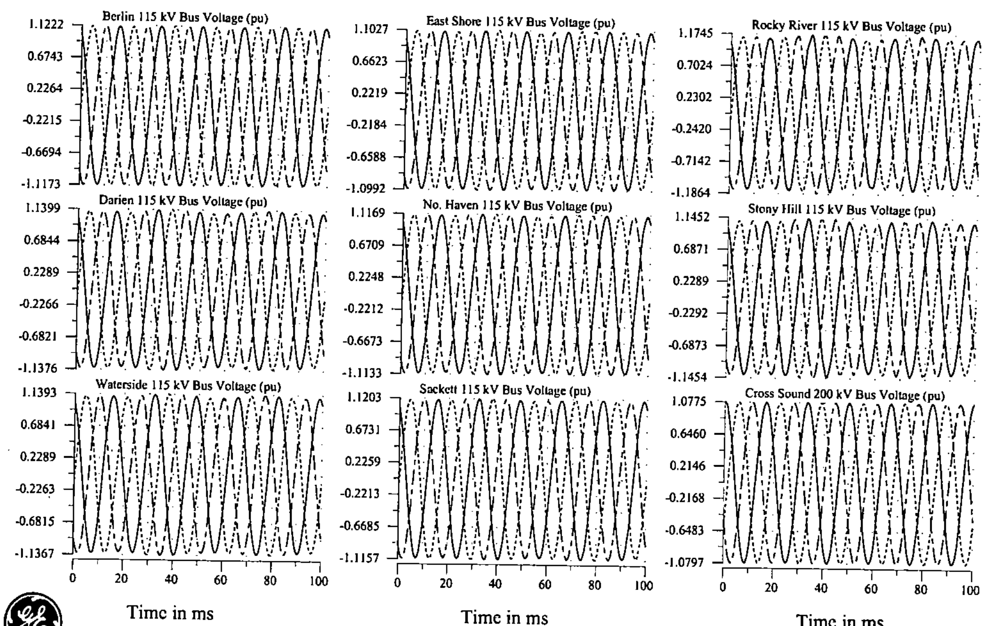
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_06
115 kV Bus Voltages and Capacitor Bank Locations



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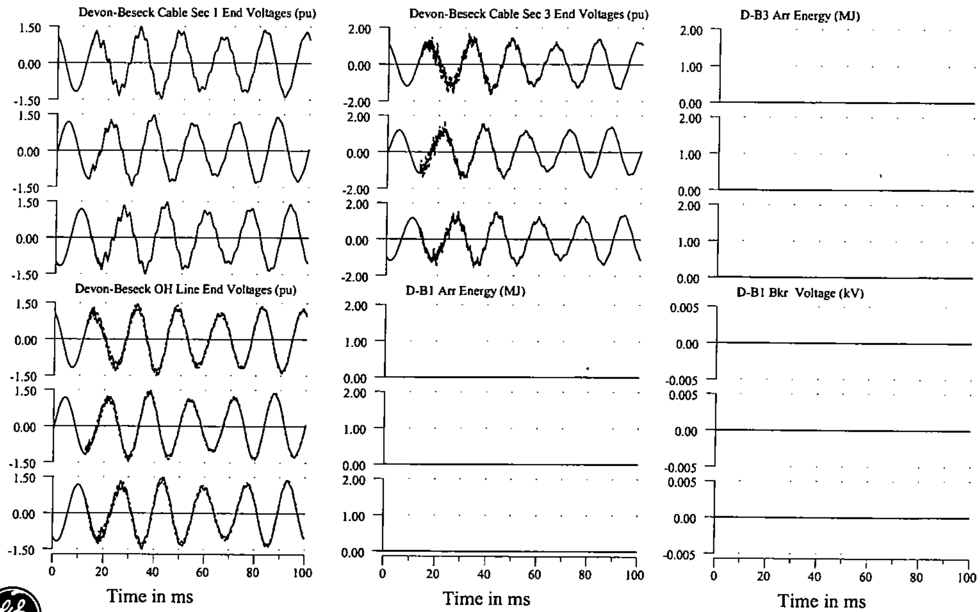
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_07

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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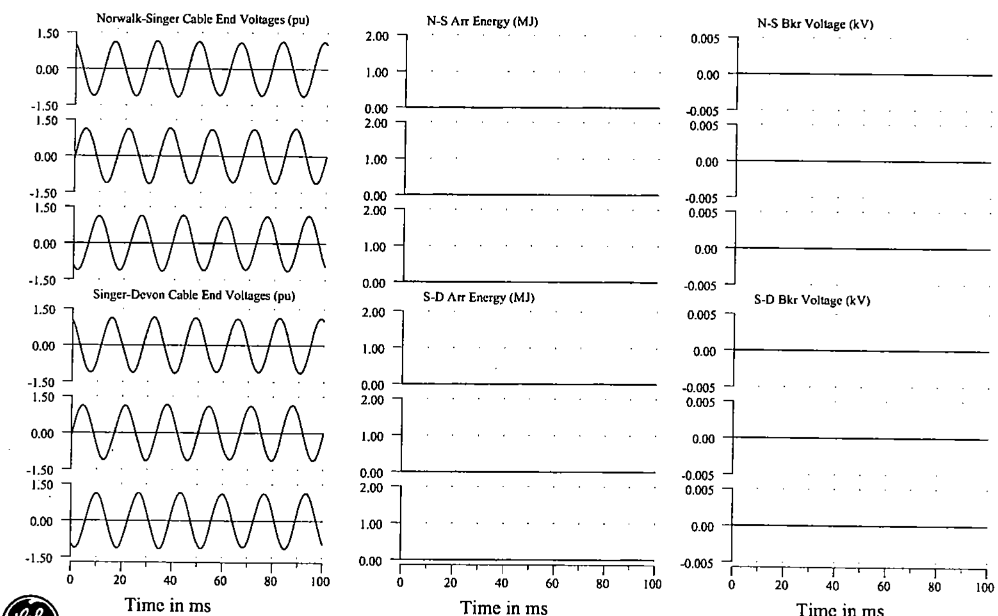
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_07

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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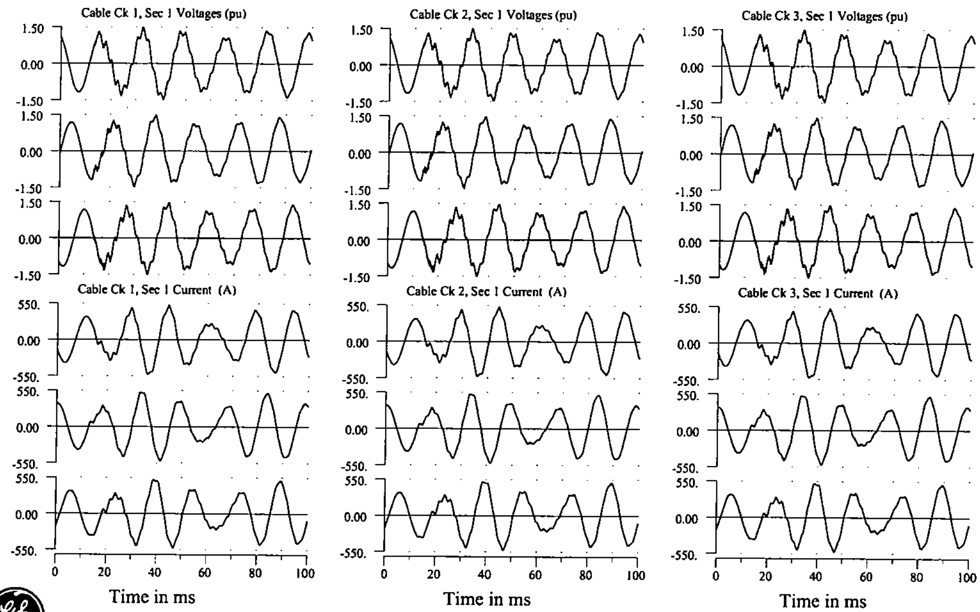
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_07
Devon-Beseck 345 kV Cables



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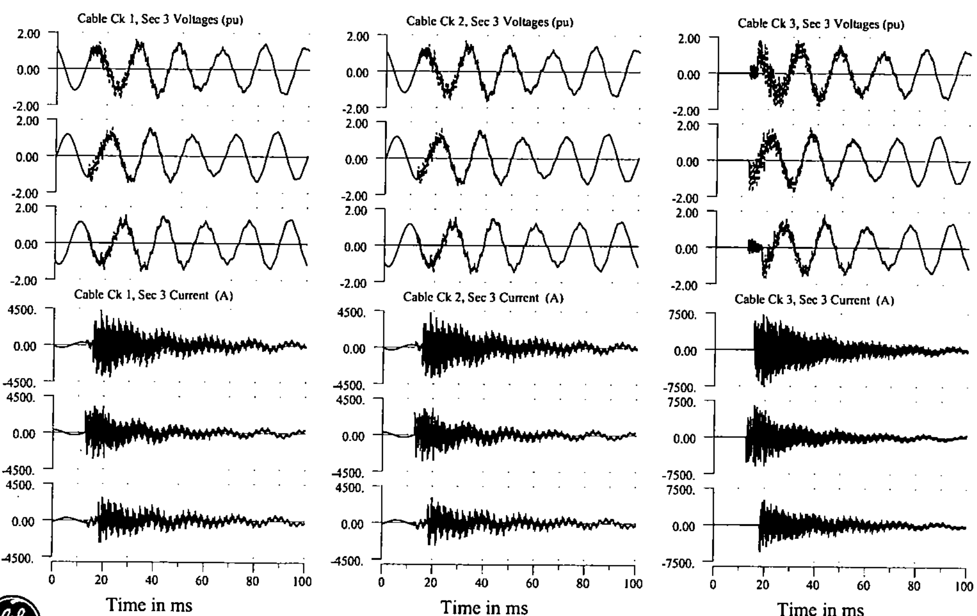
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_07
Devon-Beseck 345 kV Cables



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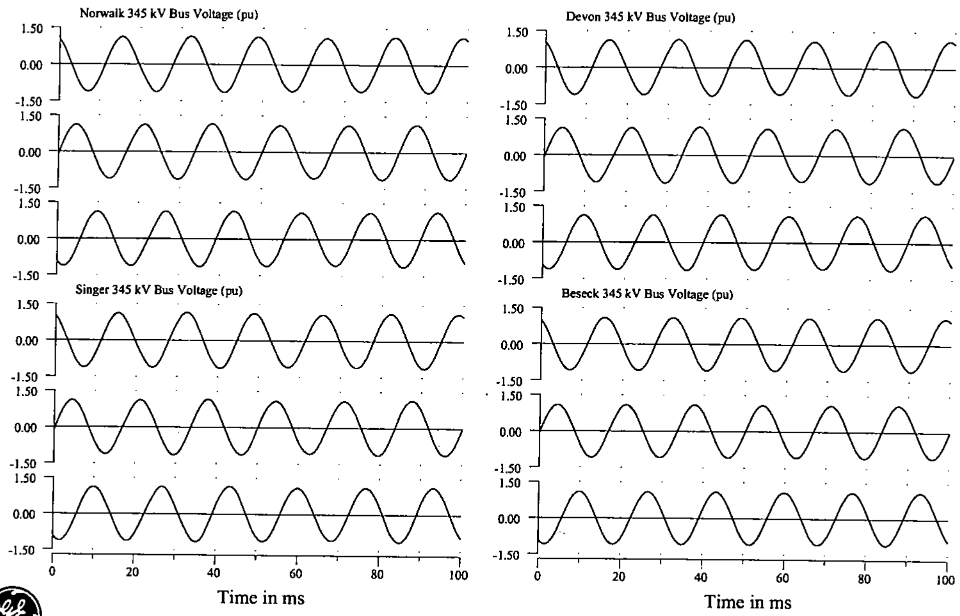
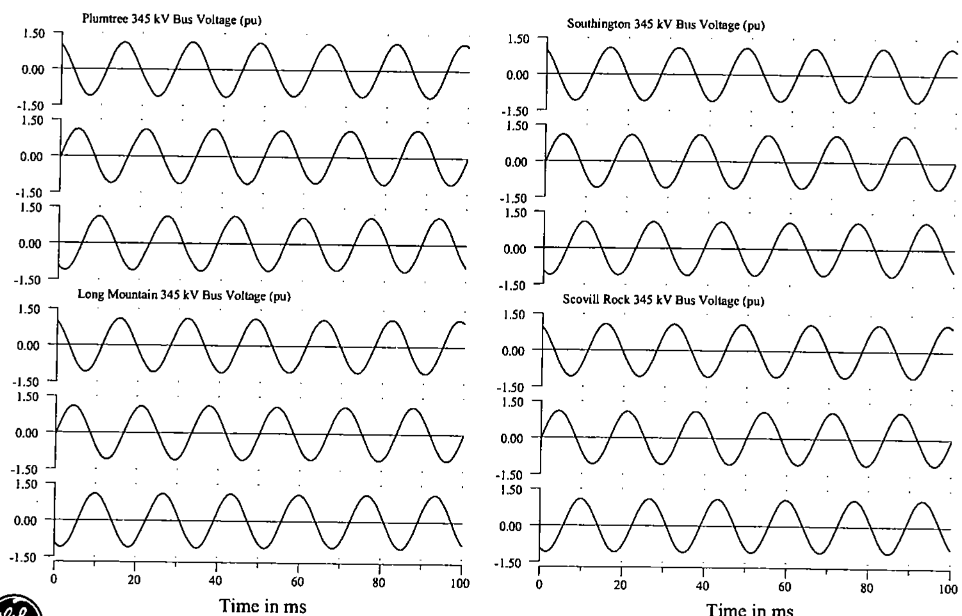
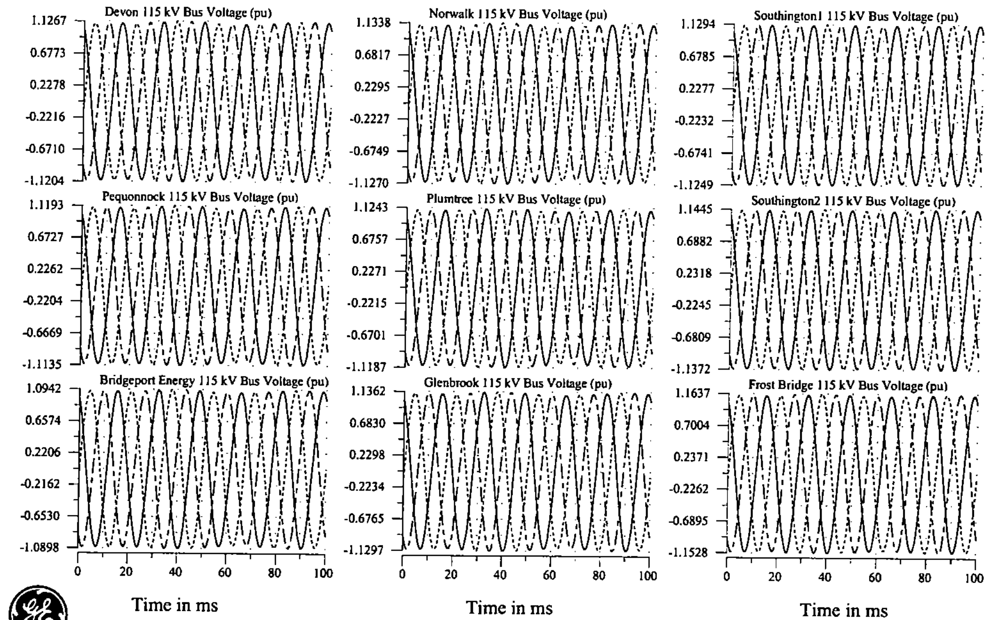
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_07
345 kV Bus Voltages



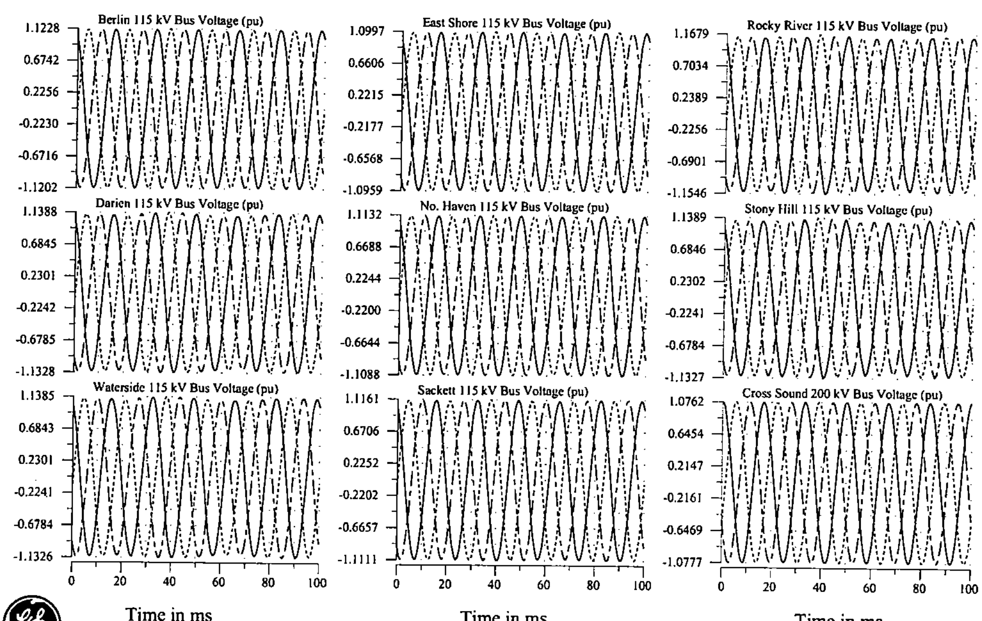
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_07
345 kV Bus Voltages



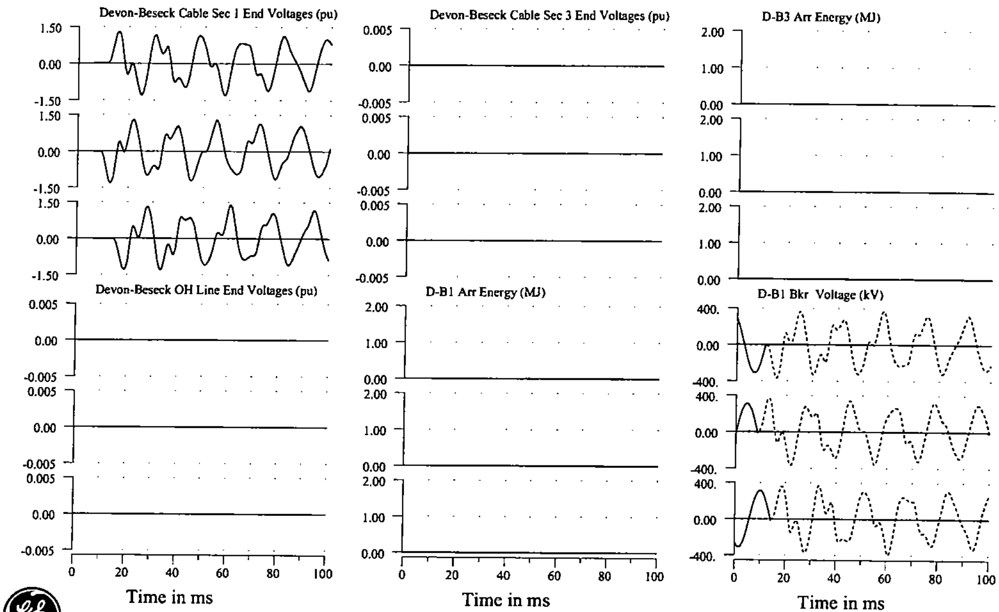
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_07
115 kV Bus Voltages and Capacitor Bank Locations



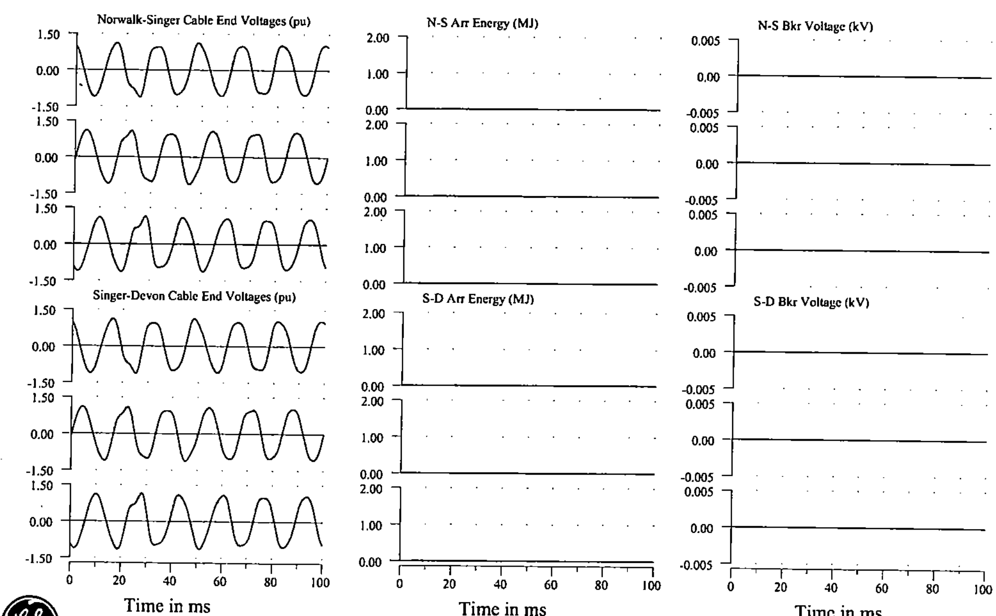
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_07
115 kV Bus Voltages and Capacitor Bank Locations



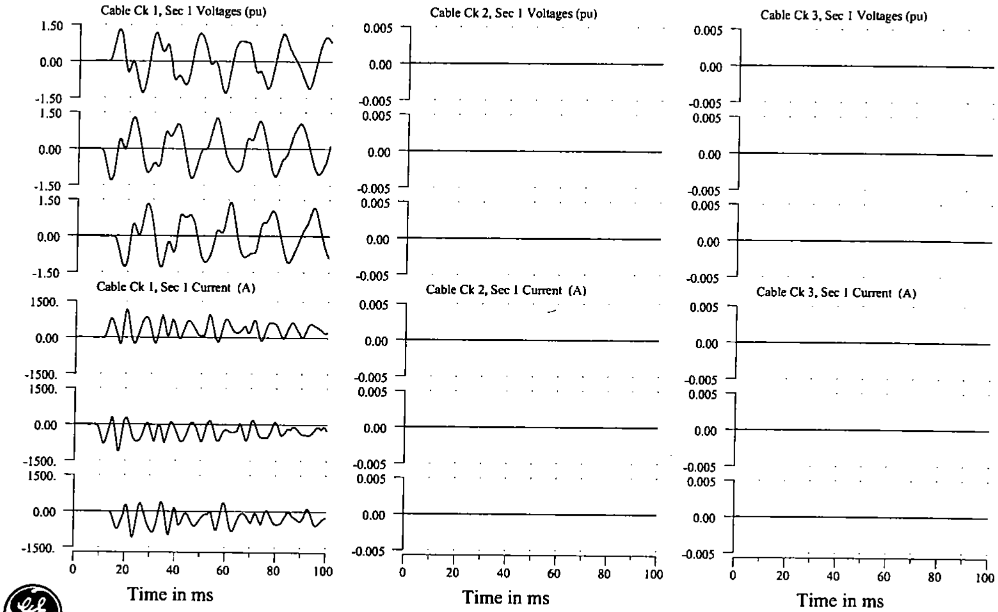
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_08
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



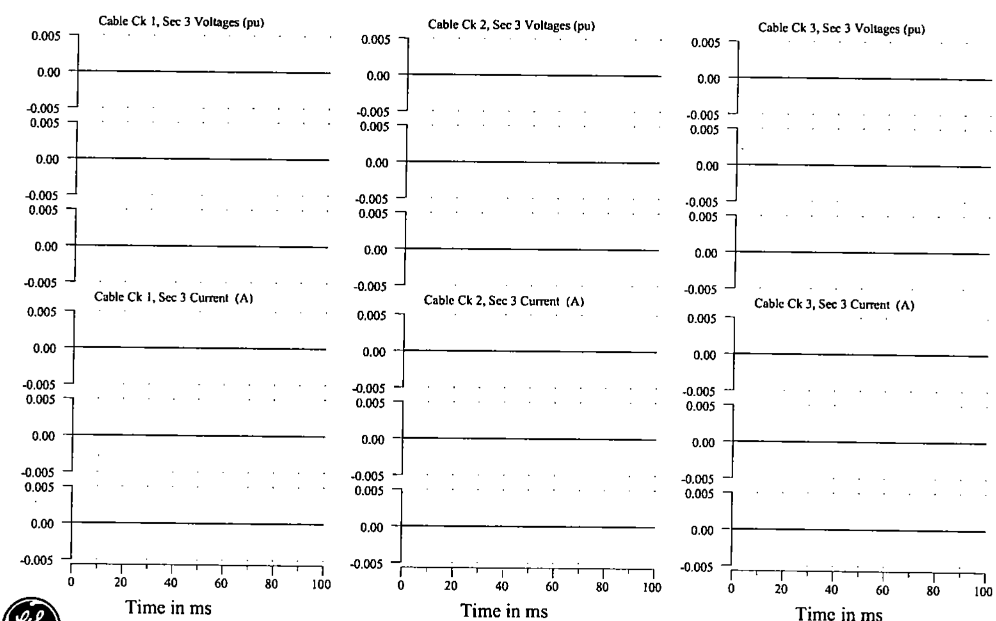
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_08
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



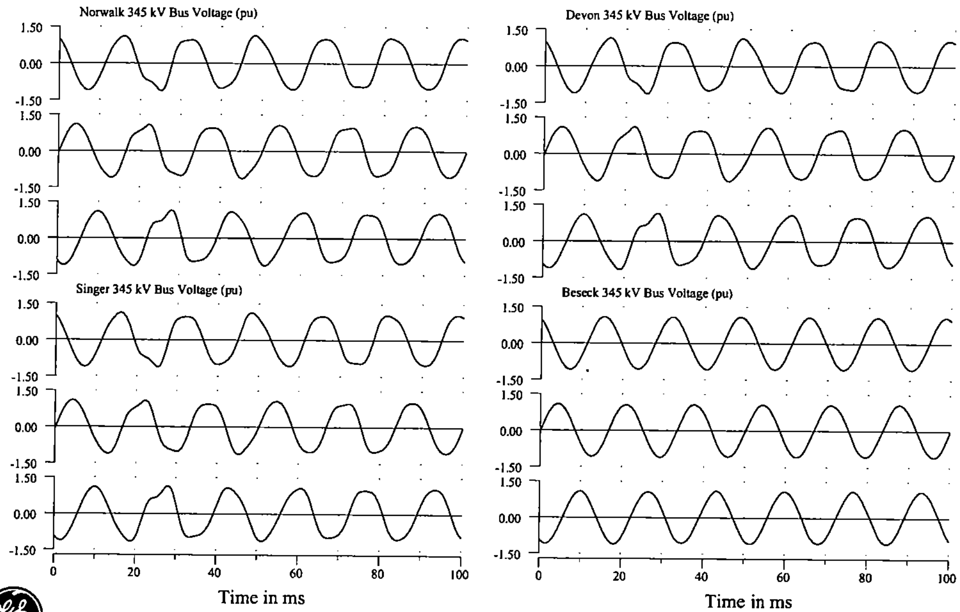
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_08
Devon-Beseck 345 kV Cables



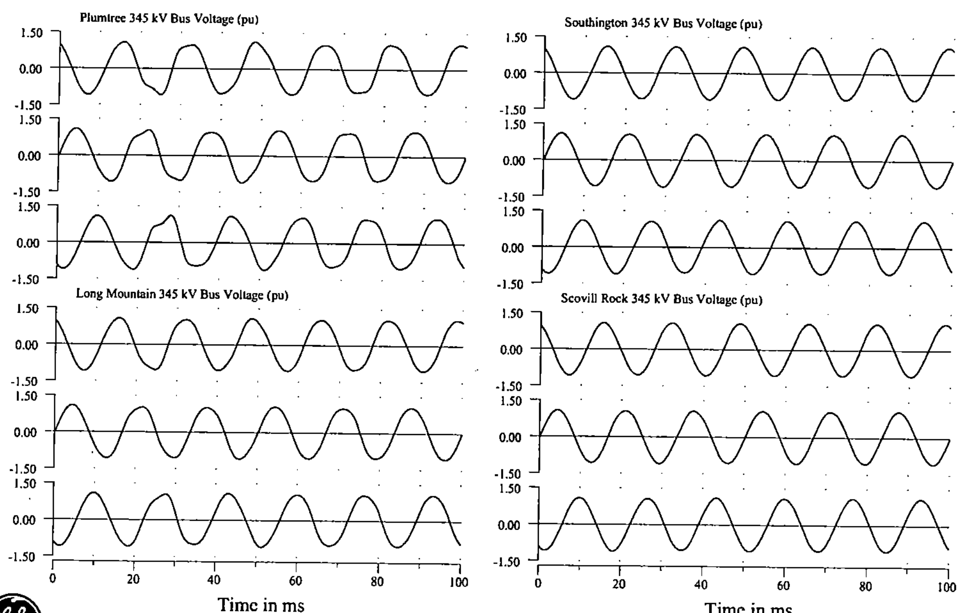
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_08
Devon-Beseck 345 kV Cables



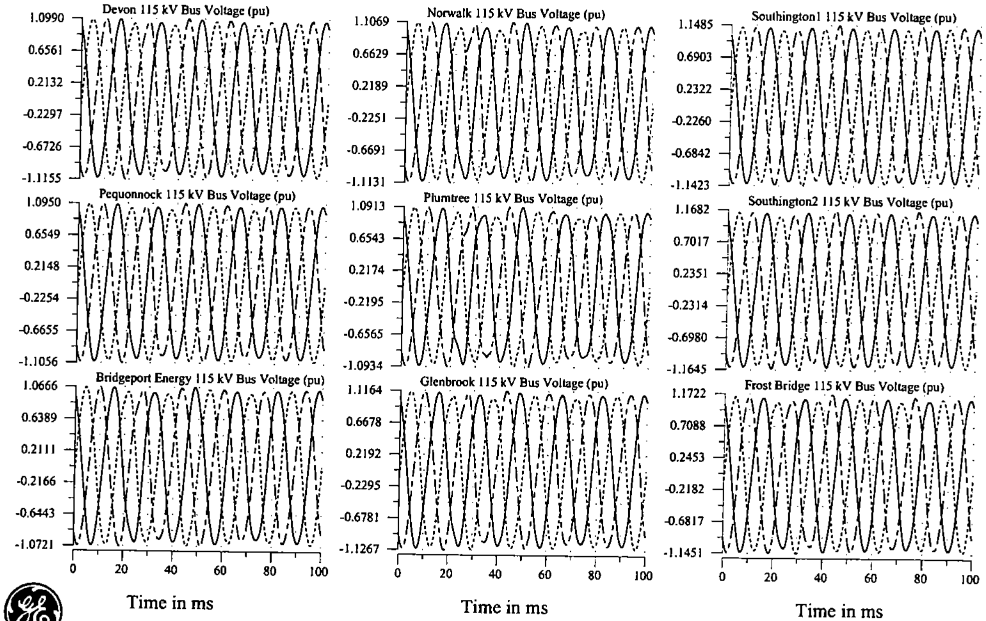
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_08
345 kV Bus Voltages



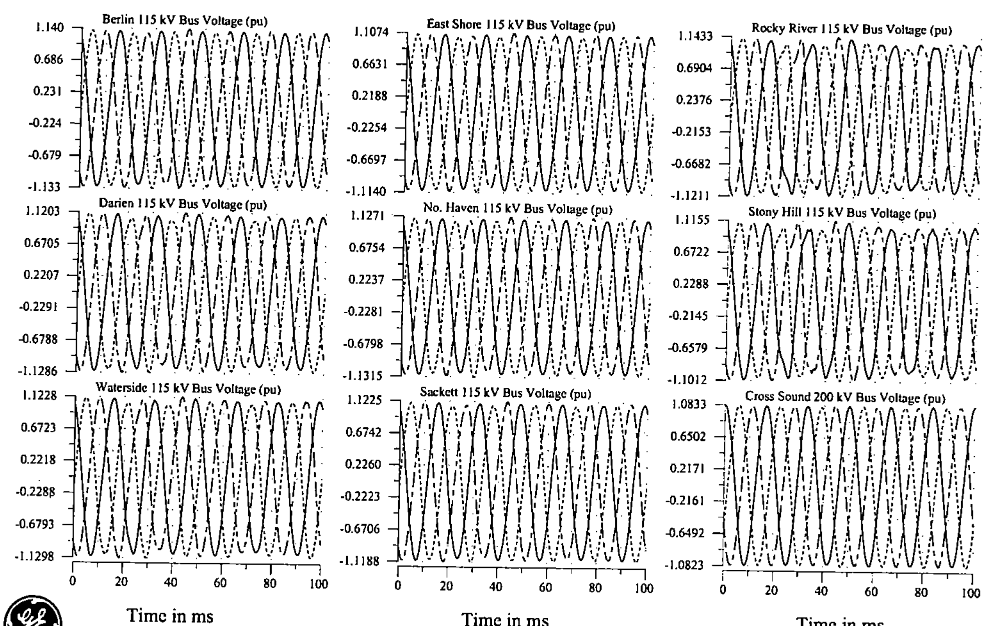
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_08
345 kV Bus Voltages



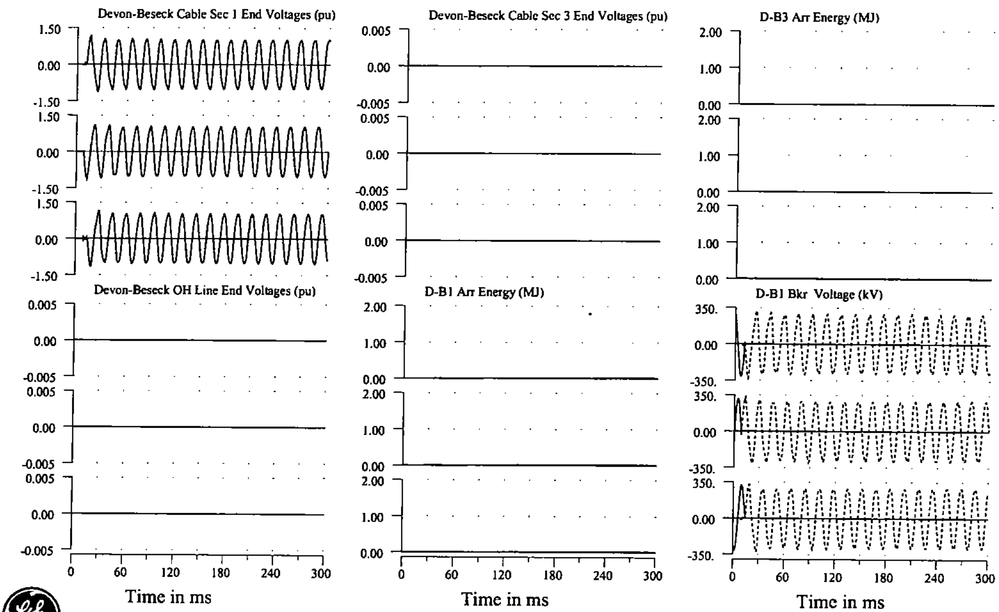
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_08
115 kV Bus Voltages and Capacitor Bank Locations



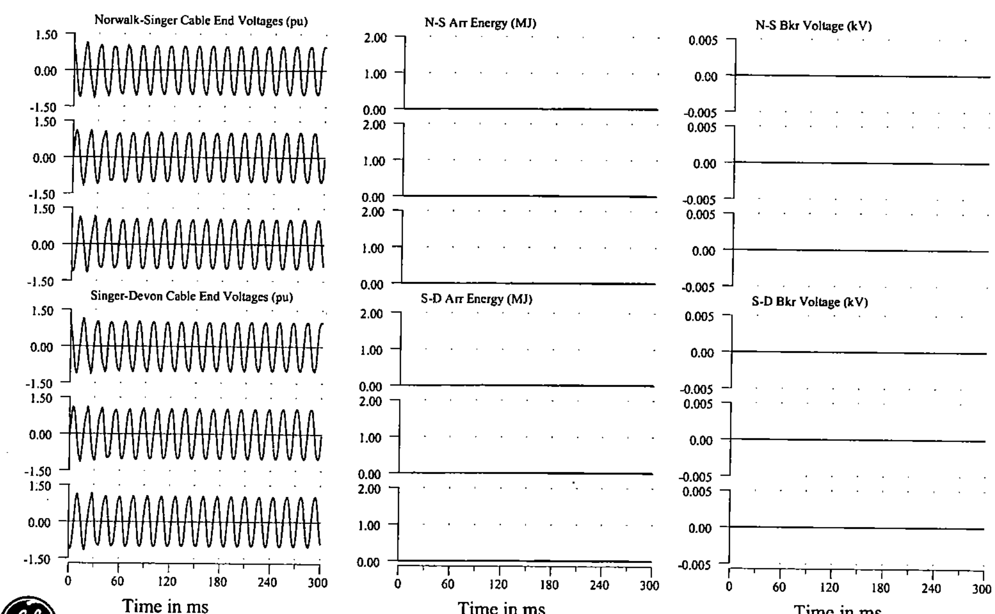
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_08
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_09
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



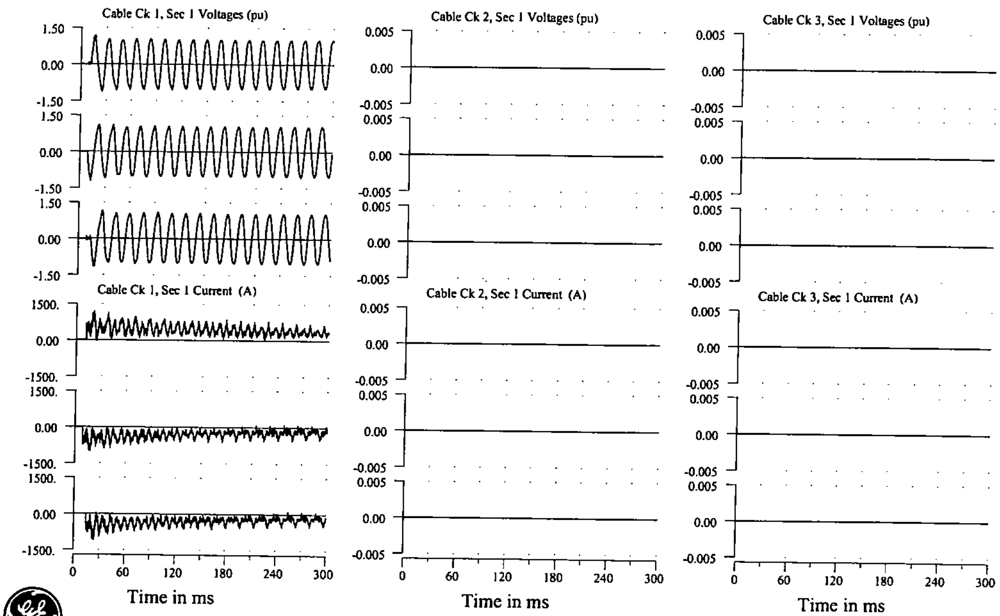
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_09
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_09

Devon-Beseck 345 kV Cables



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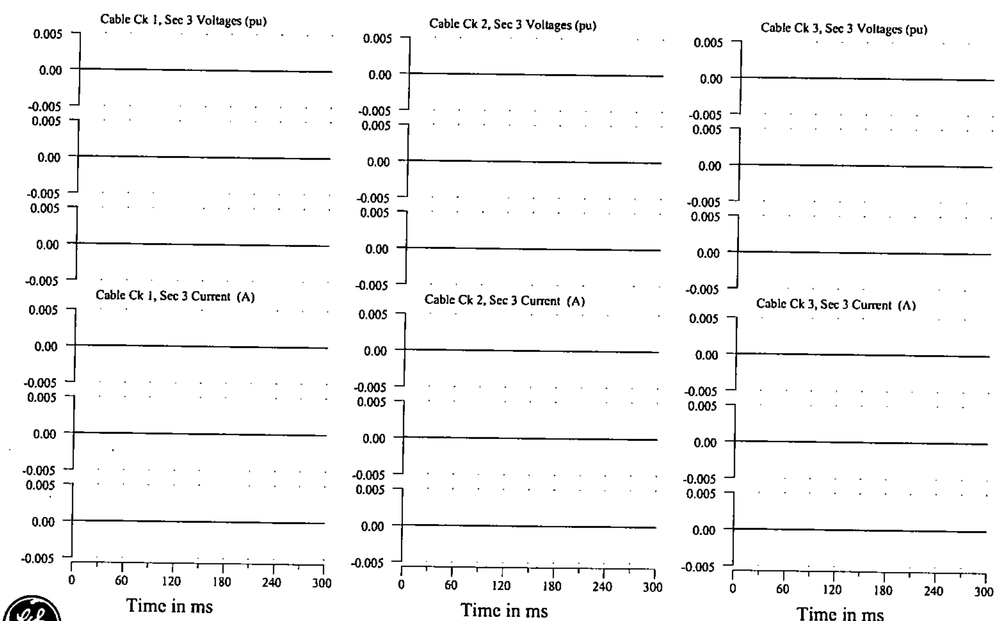
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_09

Devon-Beseck 345 kV Cables



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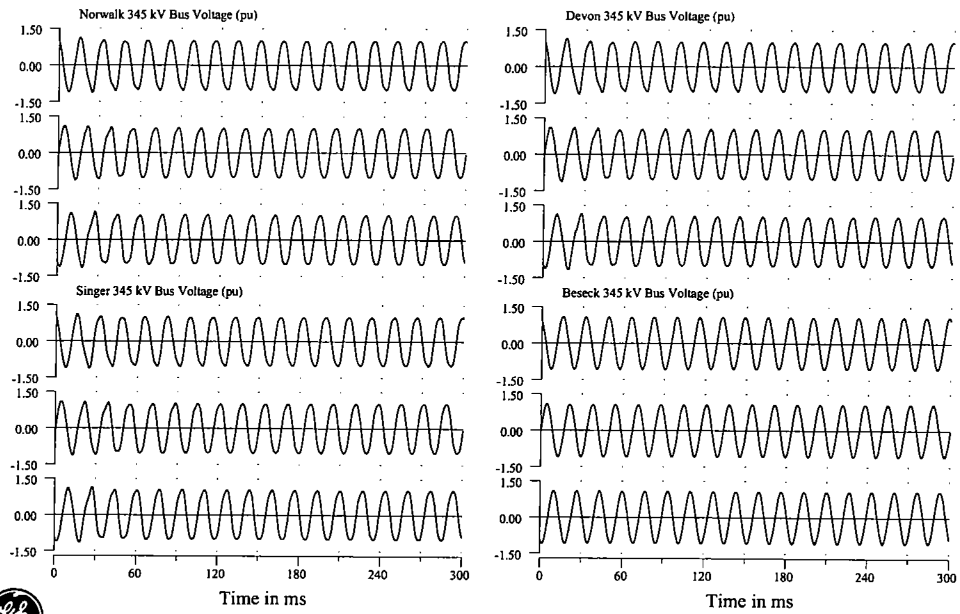
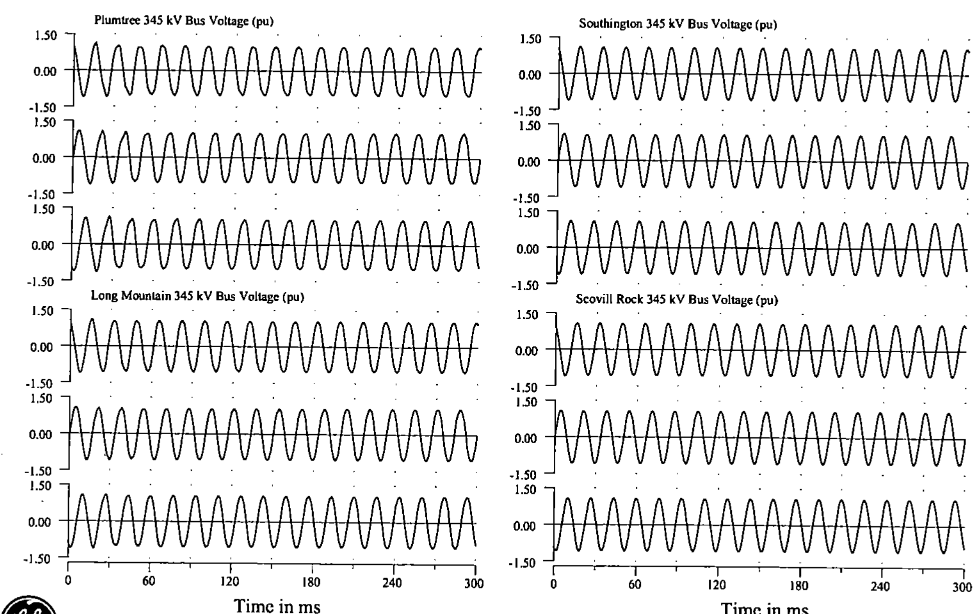
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_09
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_09
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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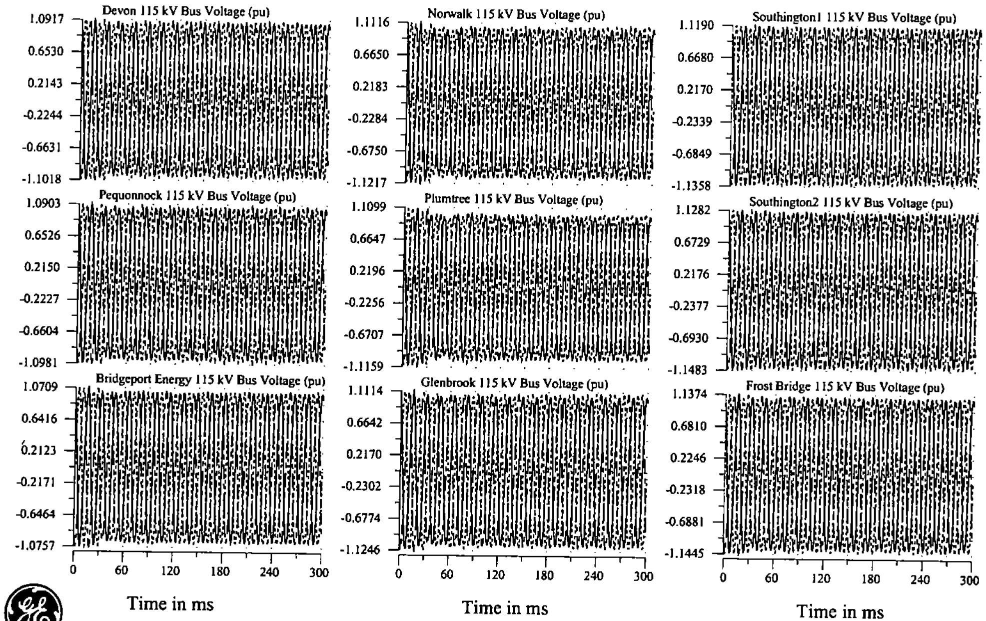
115 kV Bus Voltages and Capacitor Bank Locations



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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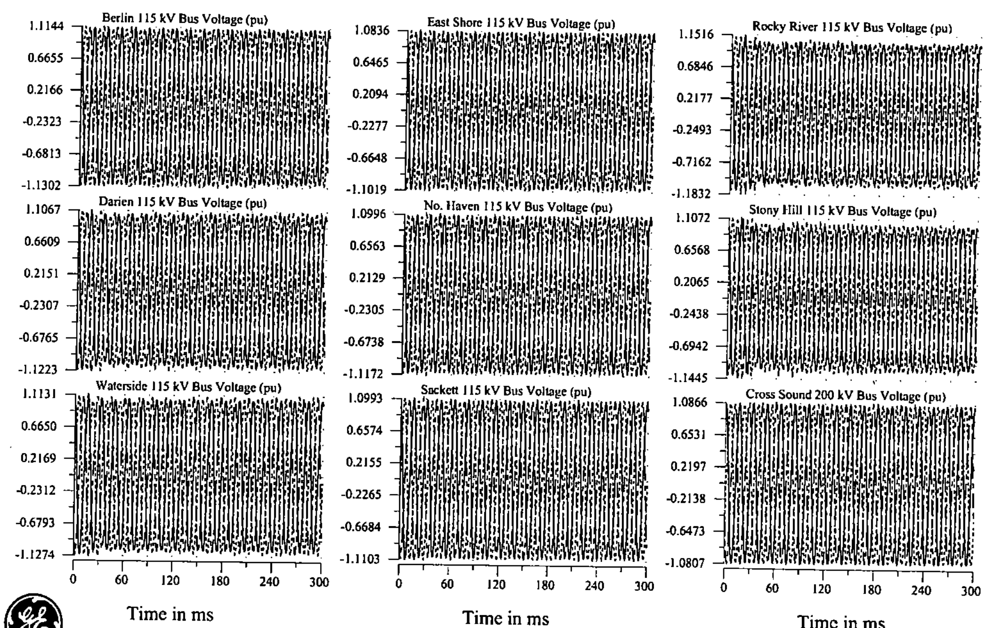
115 kV Bus Voltages and Capacitor Bank Locations



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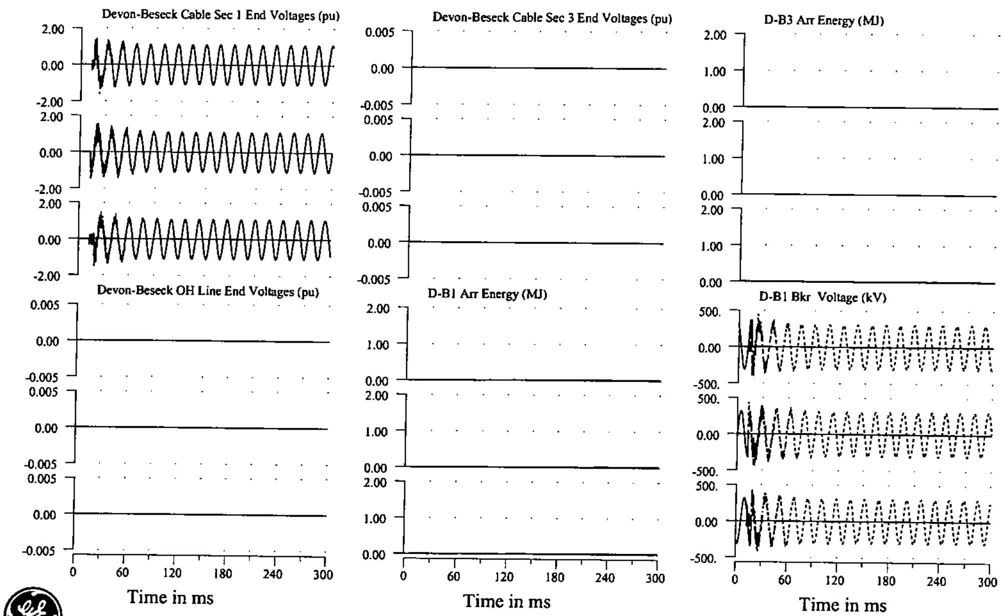
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_09A
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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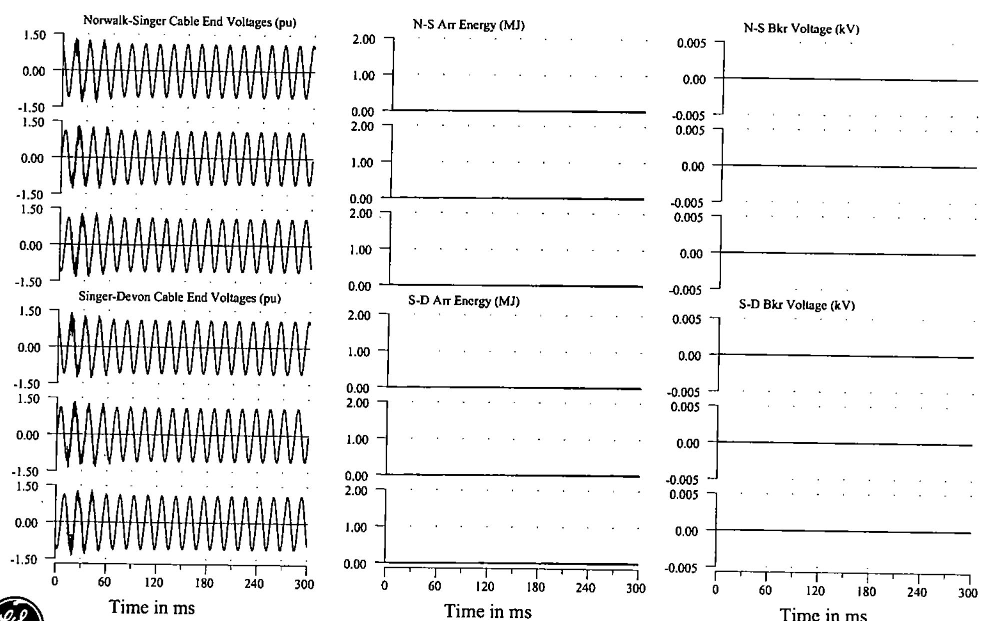
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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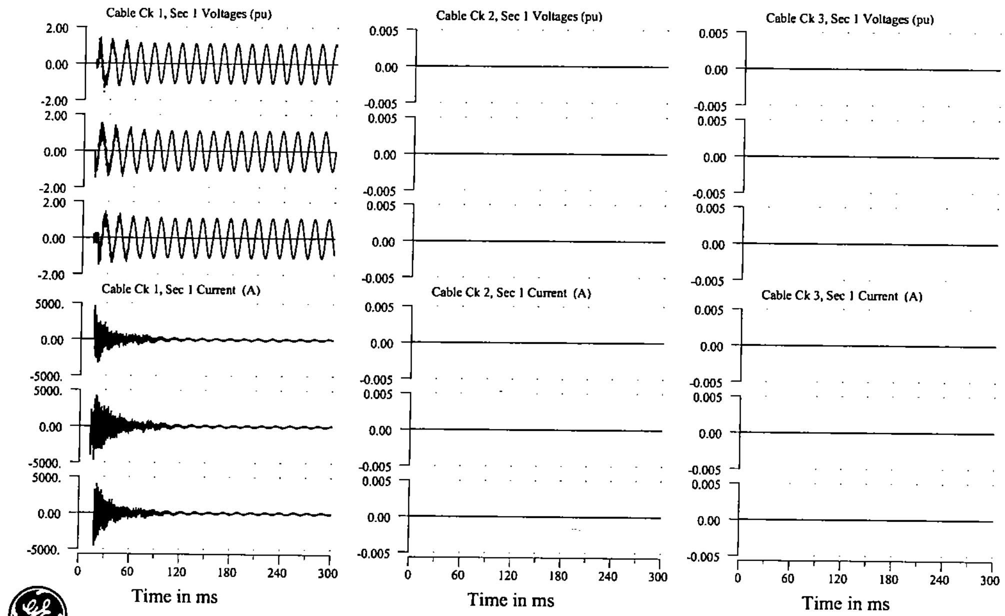
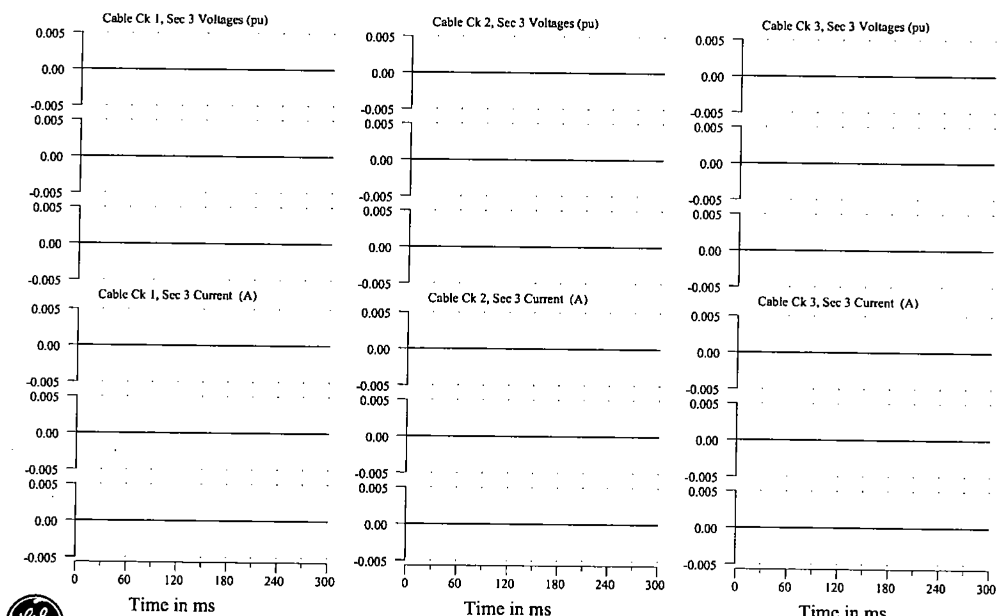
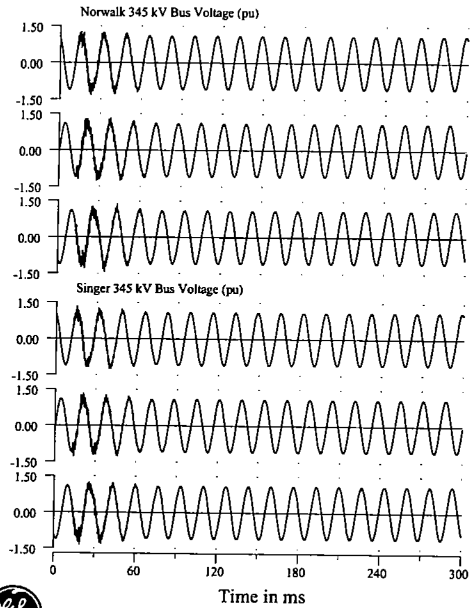
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_09A
Devon-Beseck 345 kV Cables

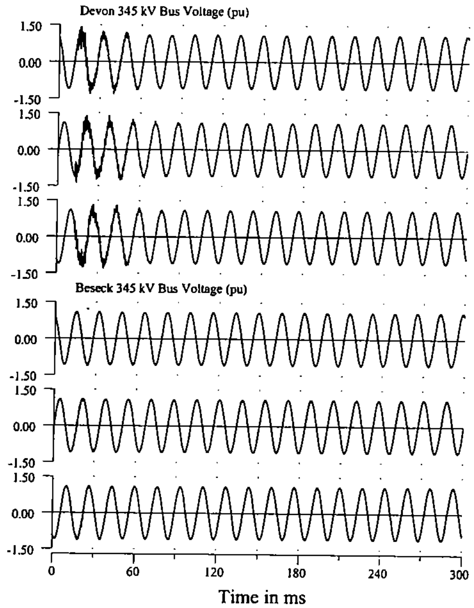


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_09A
Devon-Beseck 345 kV Cables

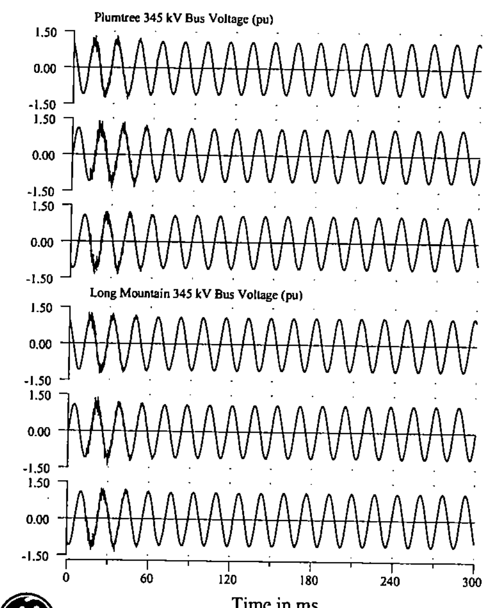


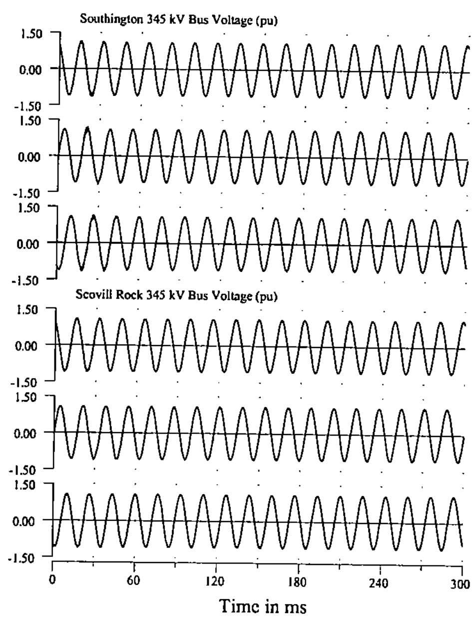
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_09A
345 kV Bus Voltages



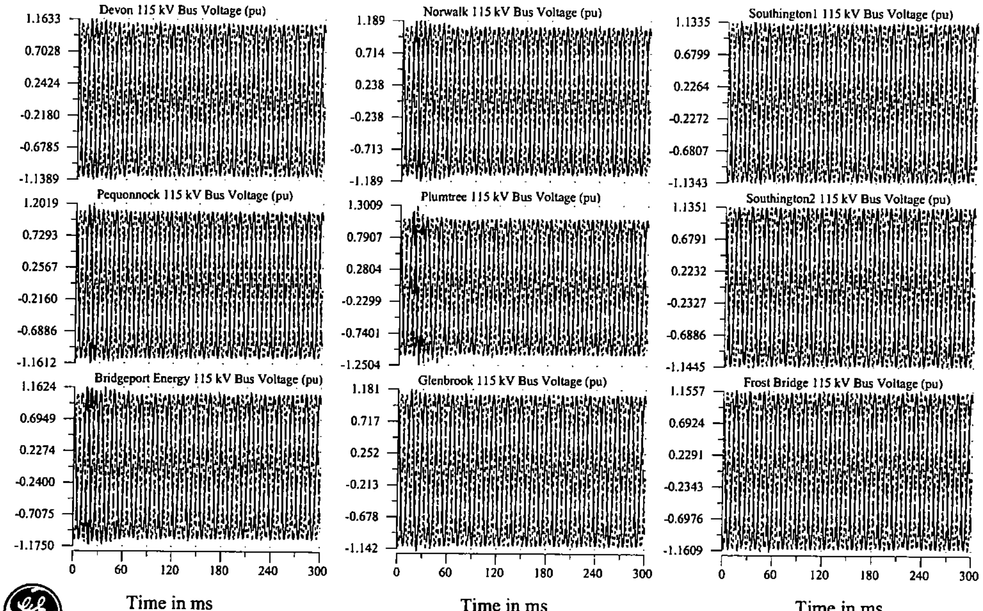


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_09A
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_09A
115 kV Bus Voltages and Capacitor Bank Locations



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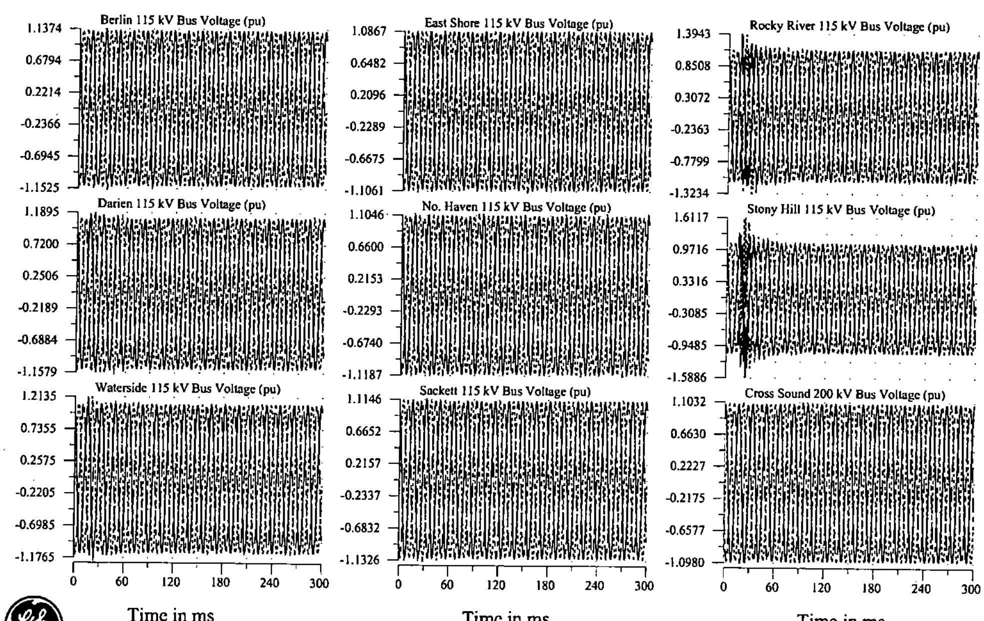
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_09A
115 kV Bus Voltages and Capacitor Bank Locations



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

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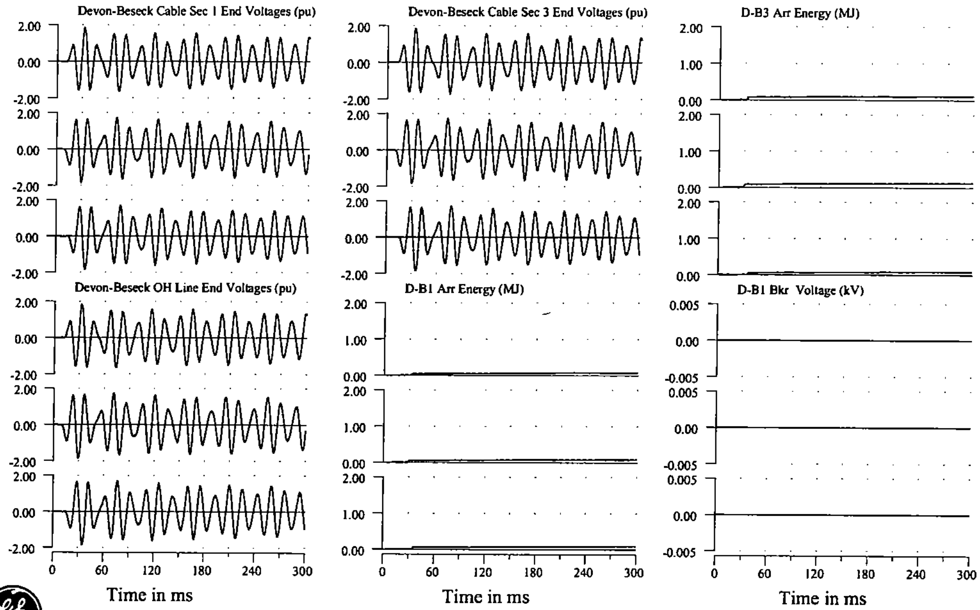
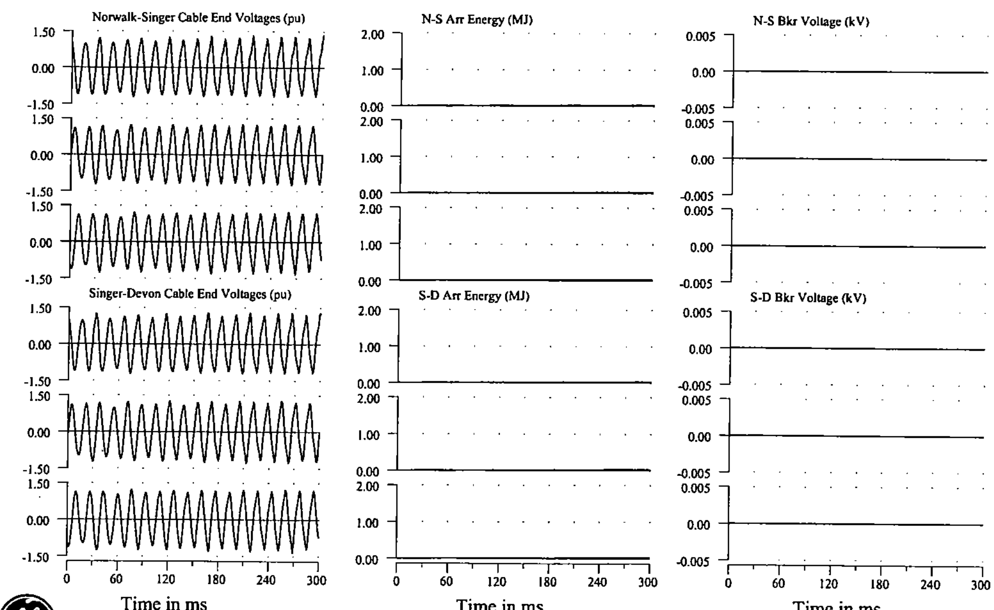
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



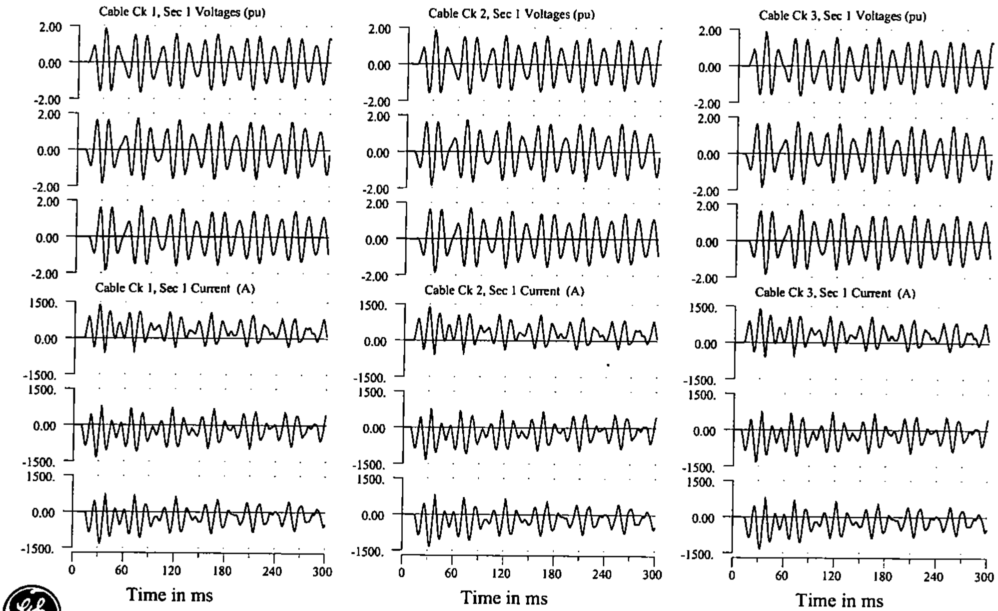
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_10

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10
Devon-Beseck 345 kV Cables



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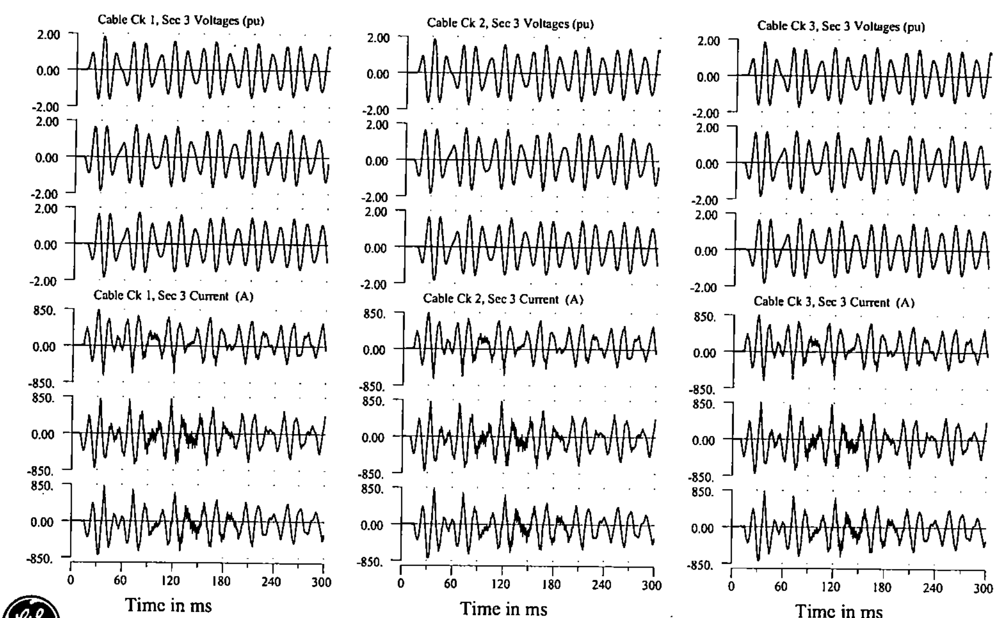
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10
Devon-Beseck 345 kV Cables



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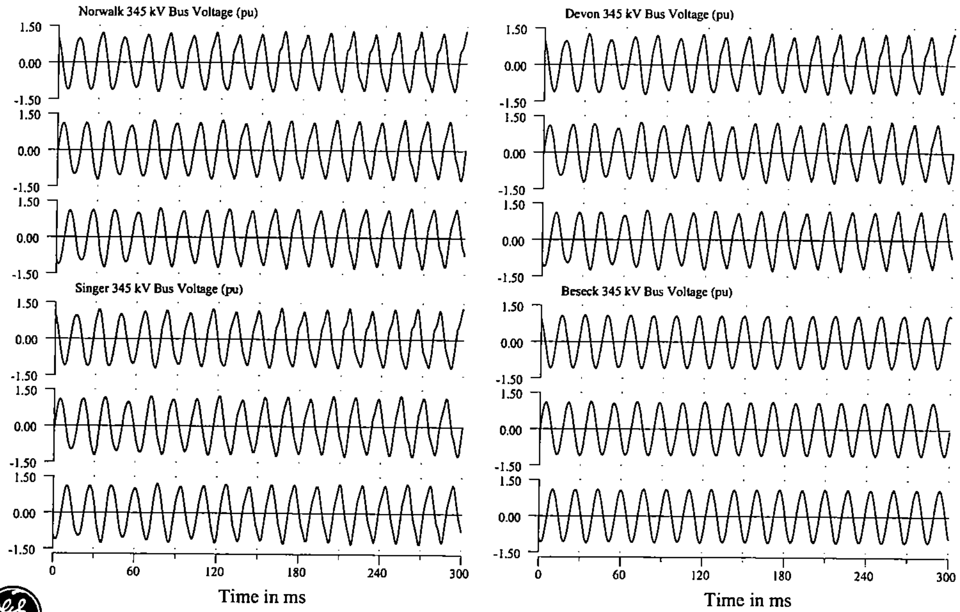
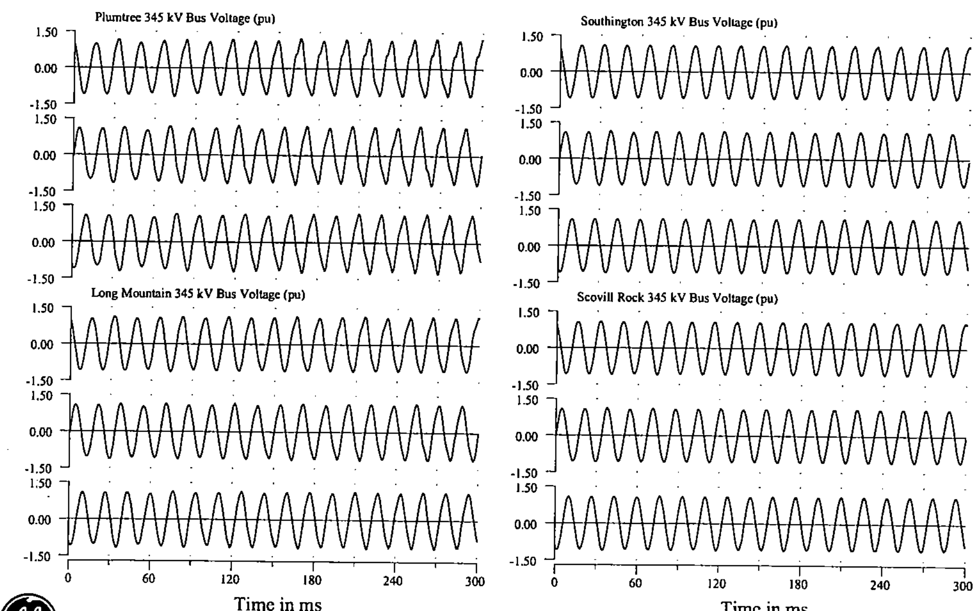
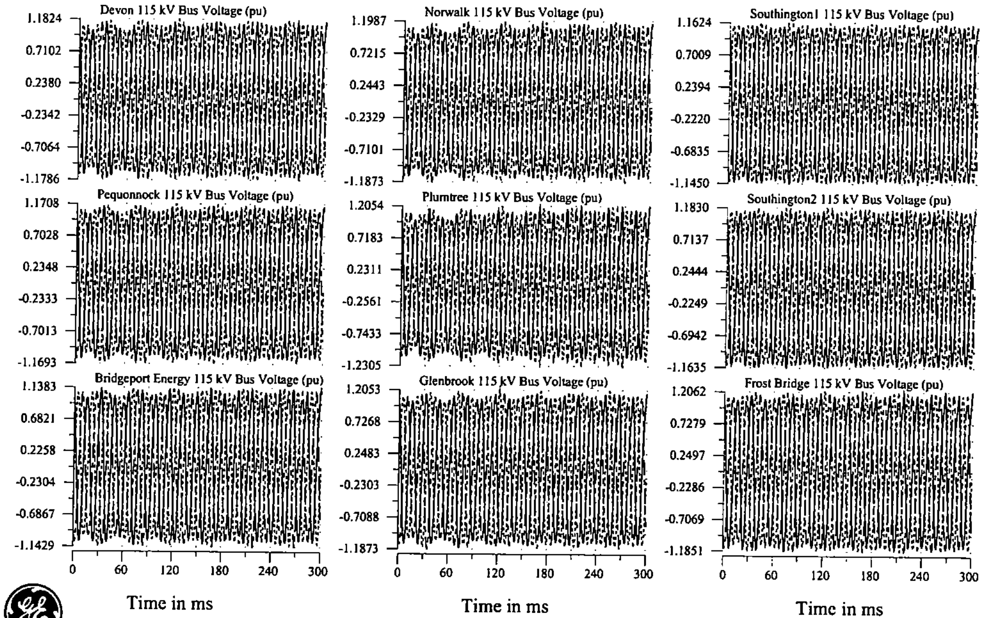
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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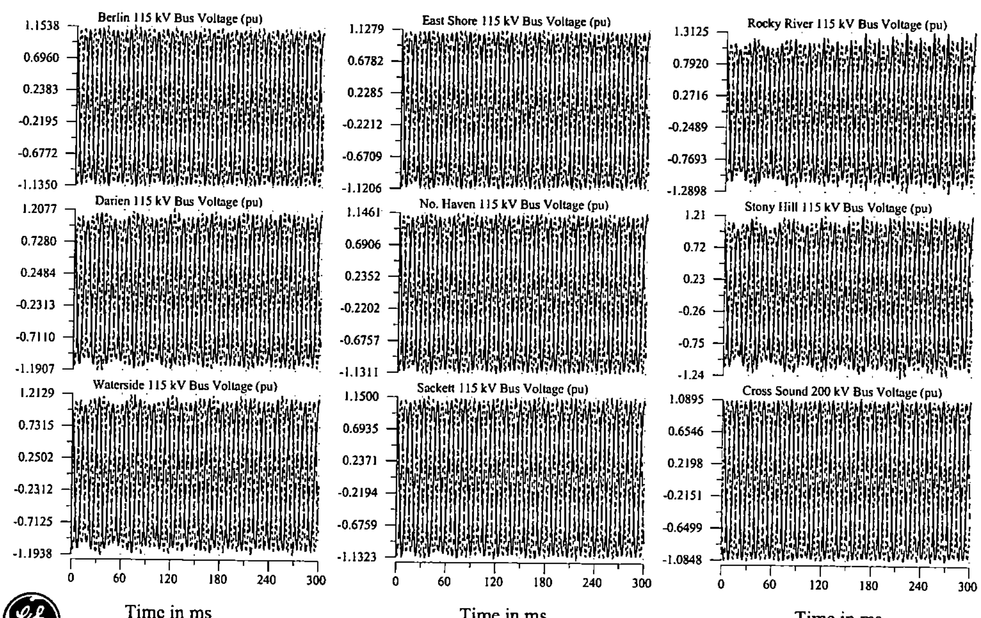
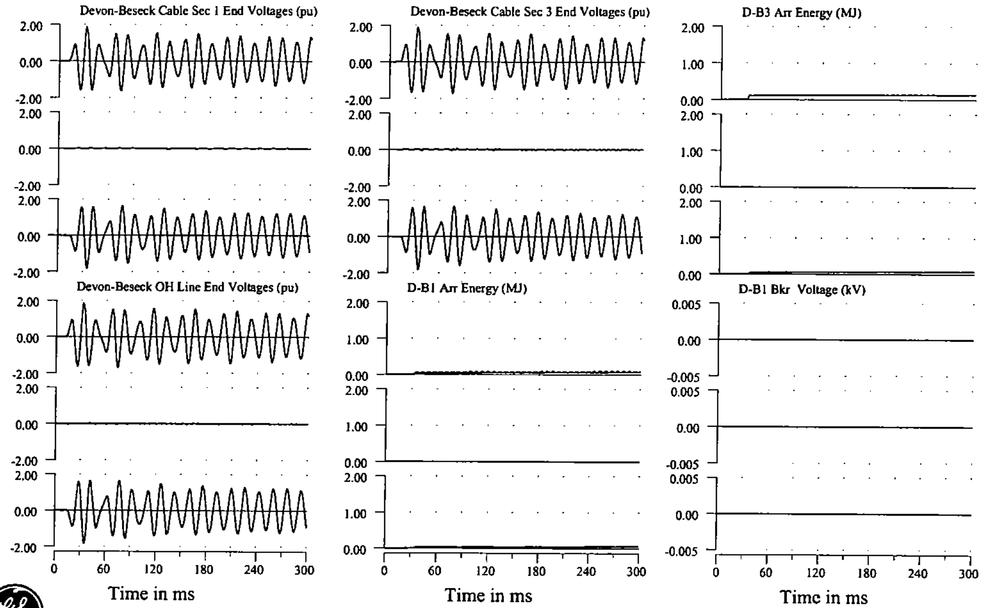
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10A
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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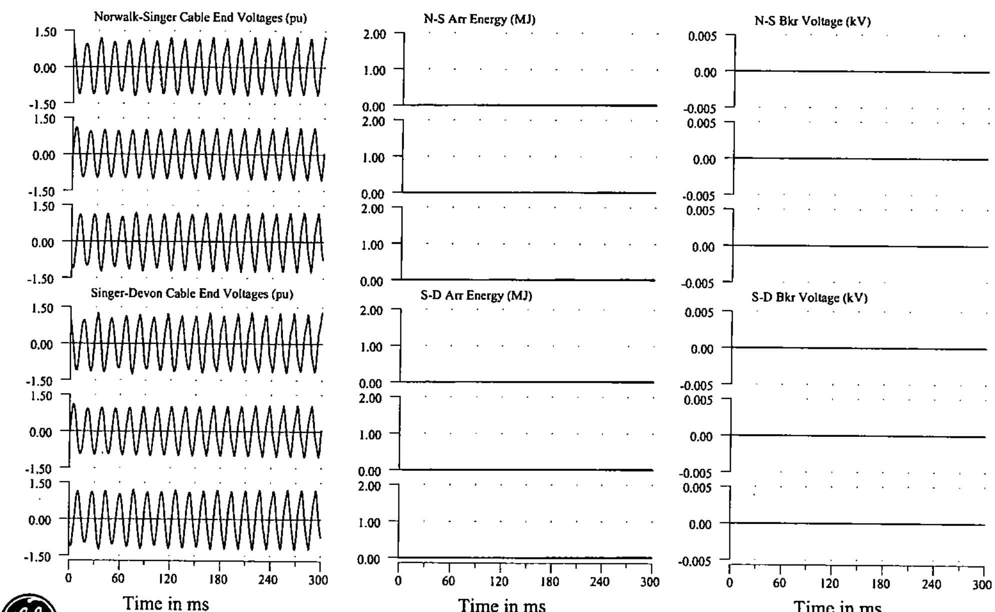
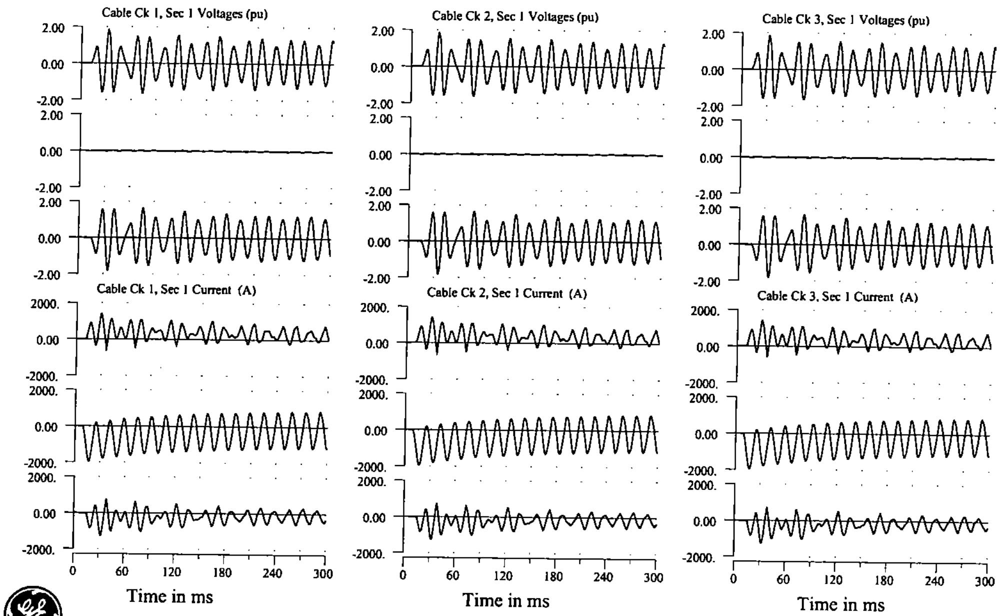
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10A
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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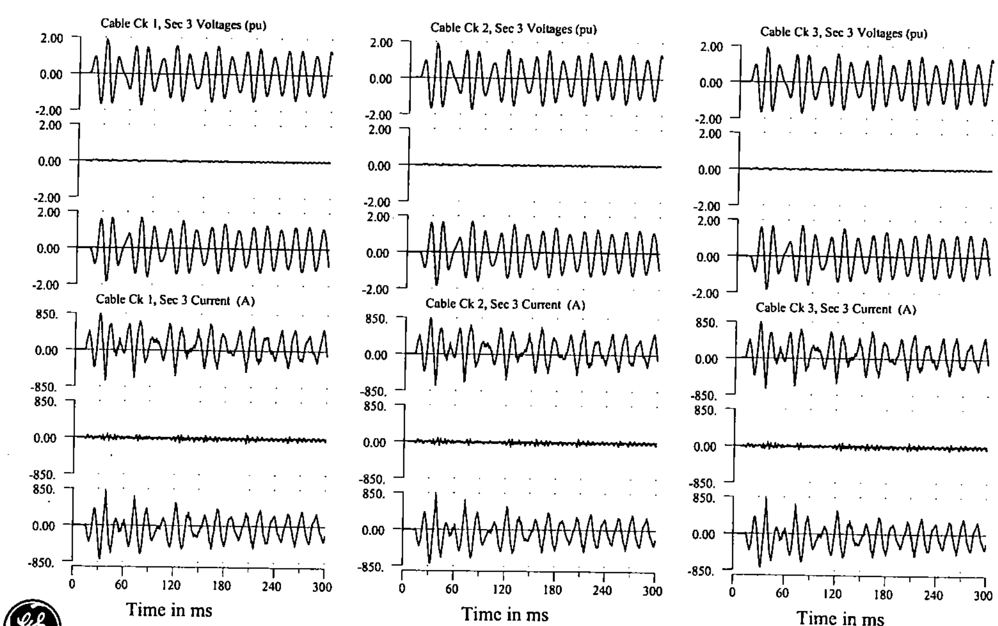
Devon-Beseck 345 kV Cables



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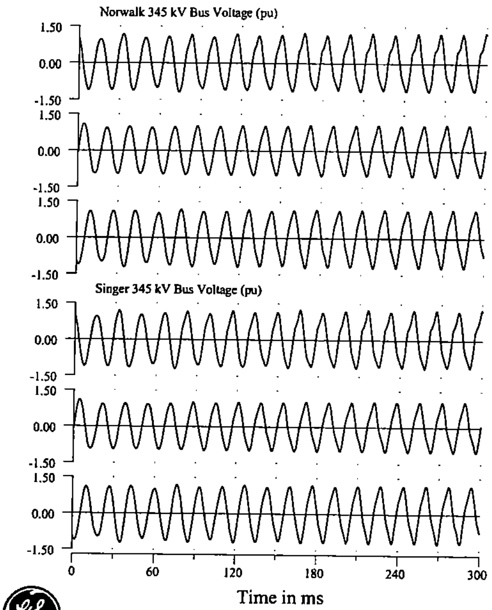
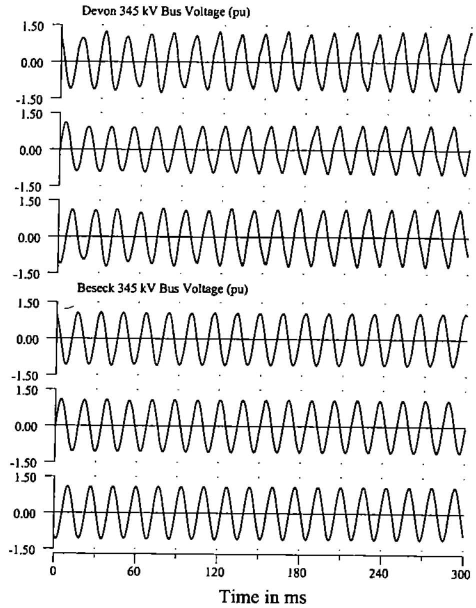
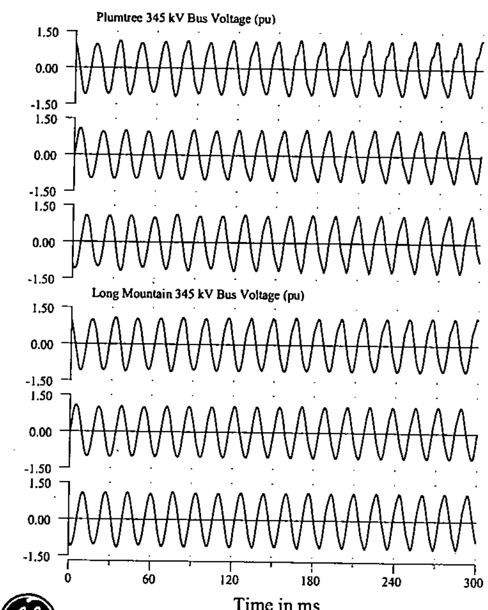
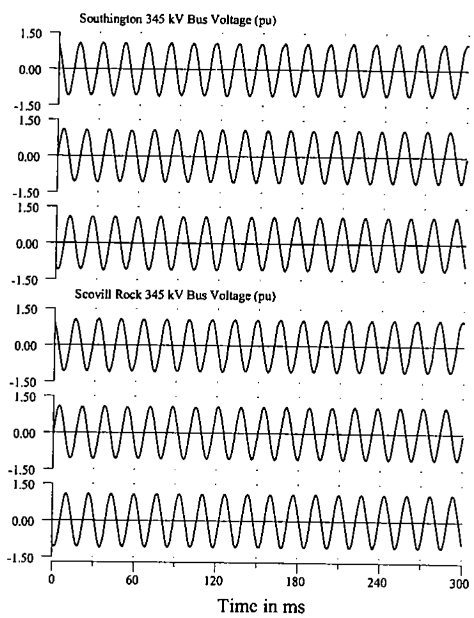
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10A
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10A
345 kV Bus Voltages

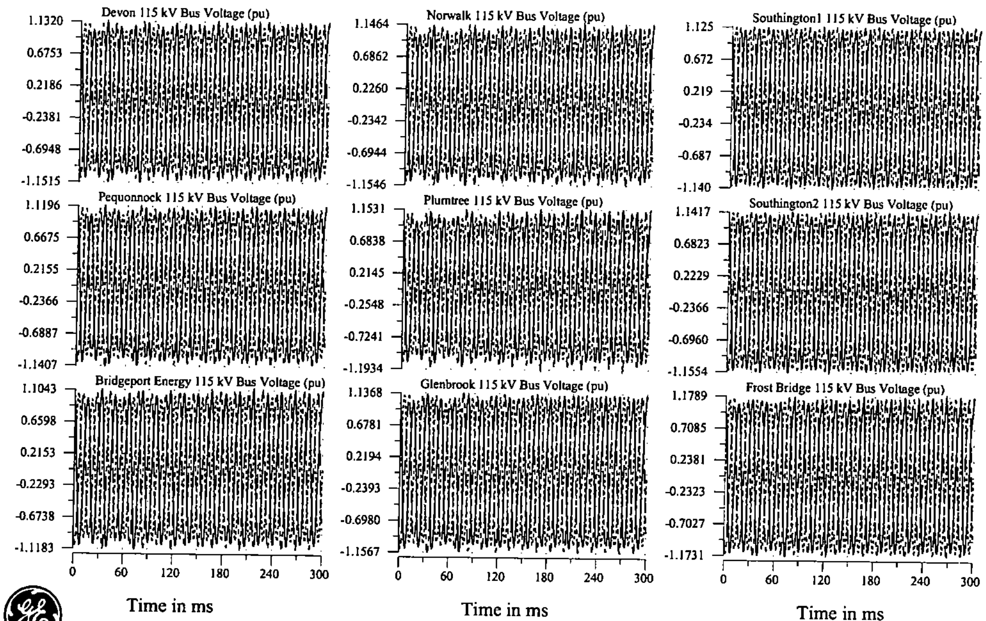




Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_10A

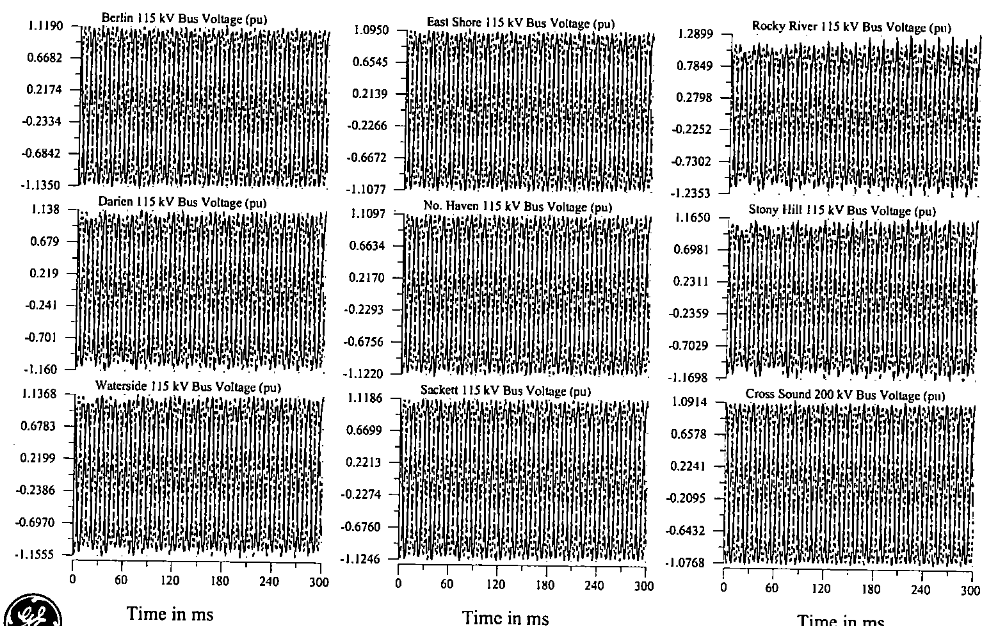
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_10A

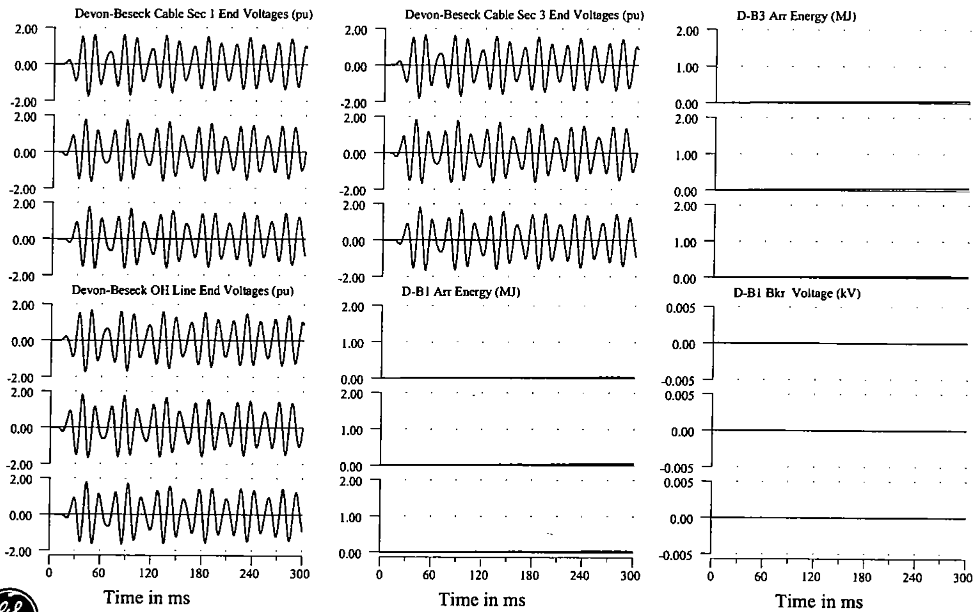
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_10R

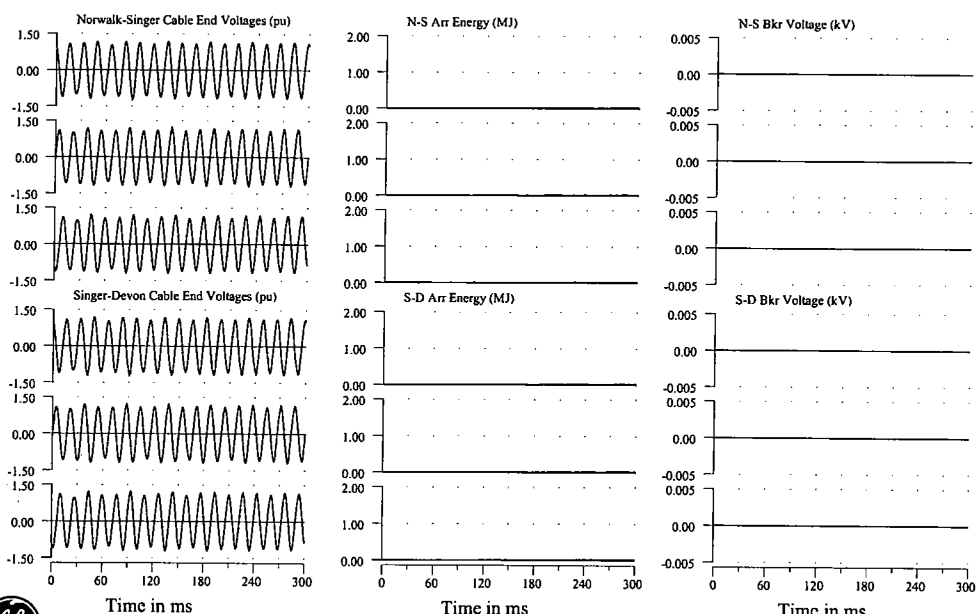
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



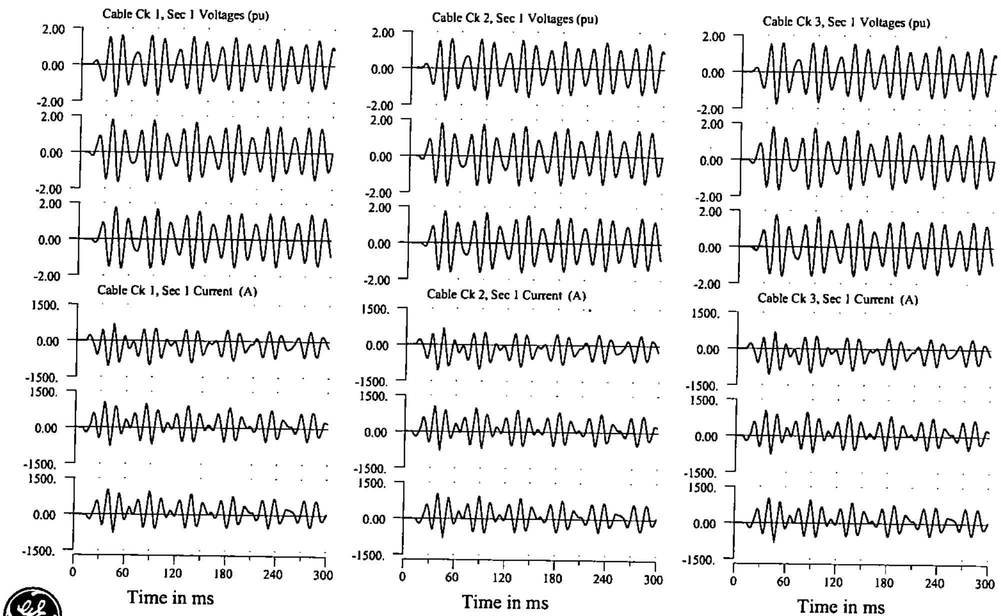
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FED_10R

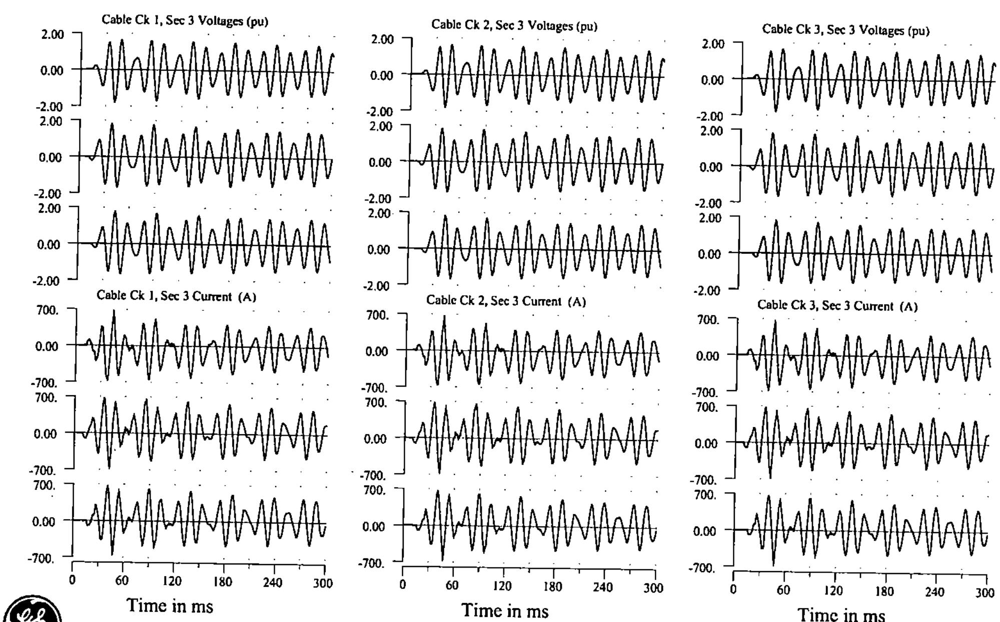
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



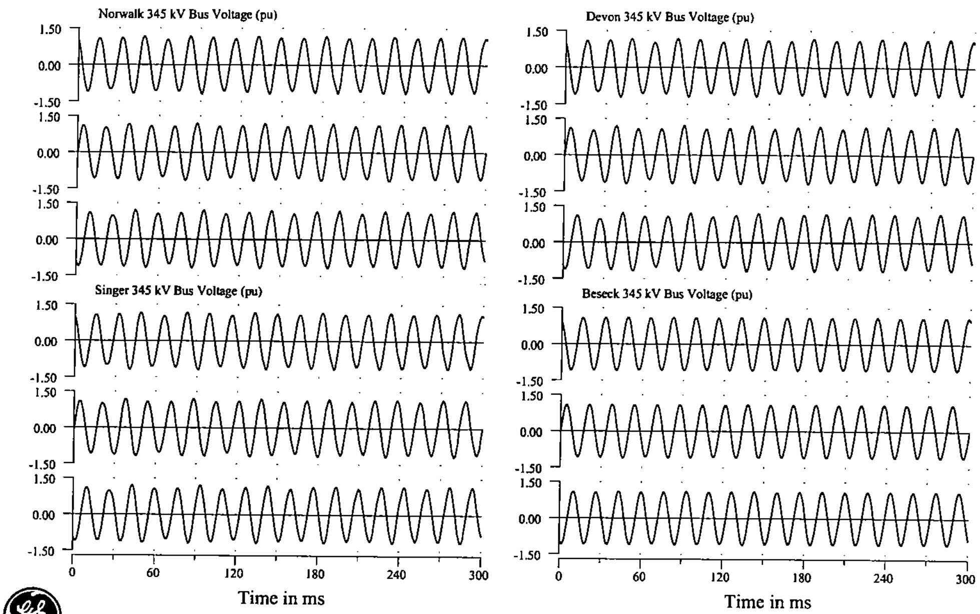
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10R
Devon-Beseck 345 kV Cables



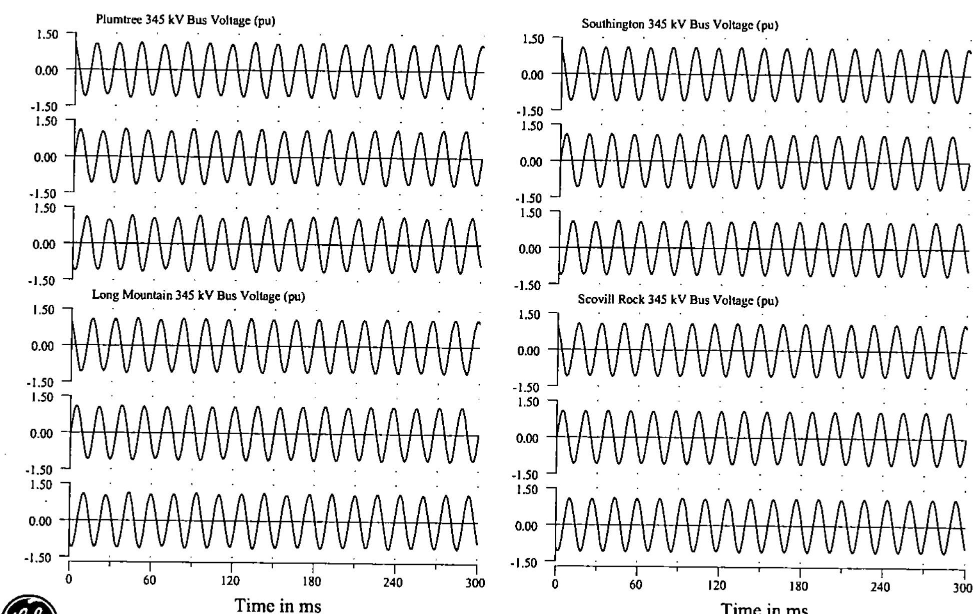
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10R
Devon-Beseck 345 kV Cables



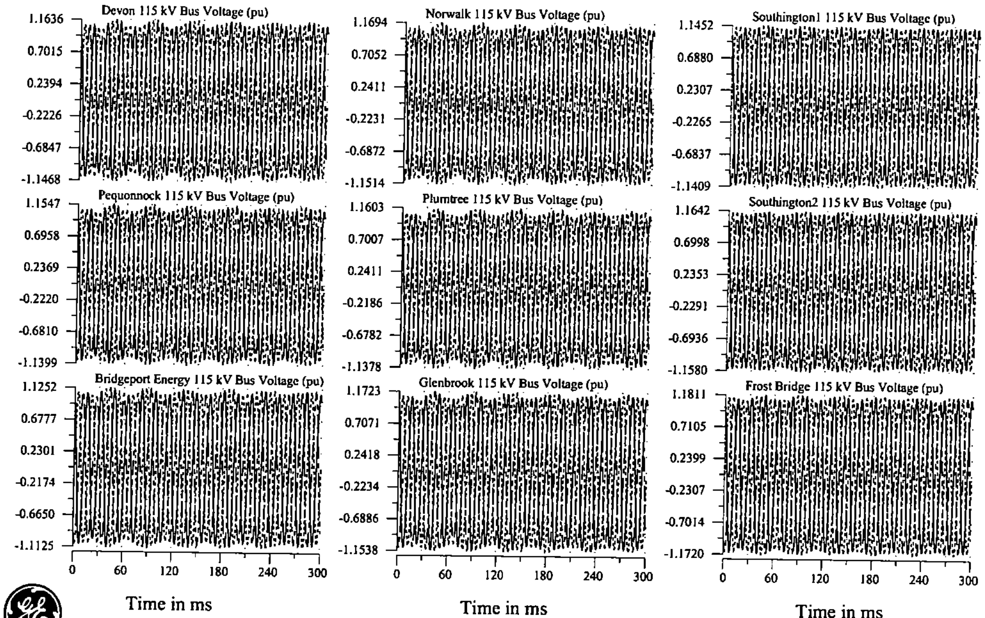
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10R
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10R
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10R
115 kV Bus Voltages and Capacitor Bank Locations



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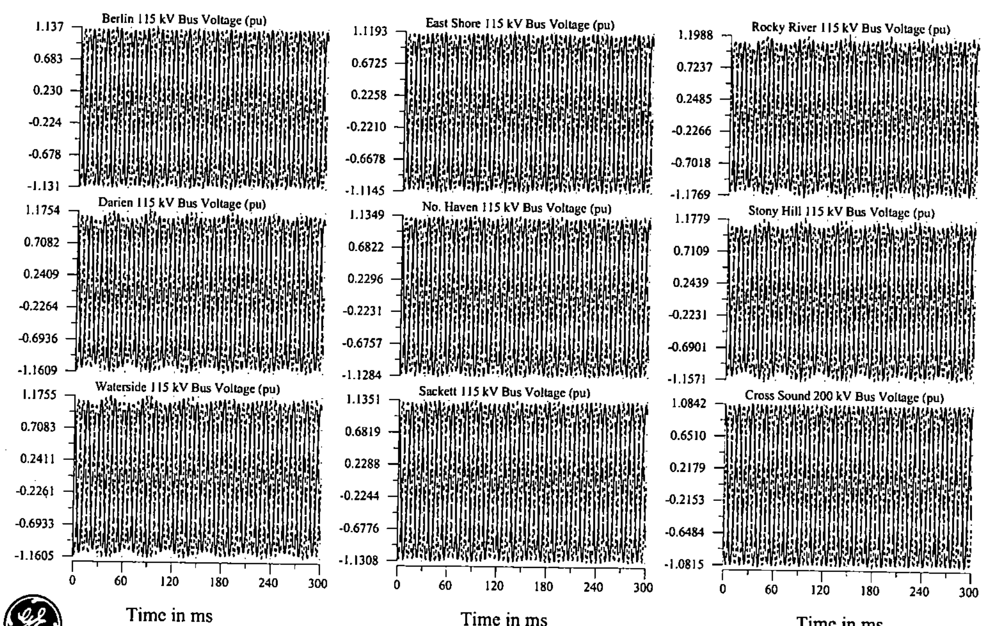
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_10R
115 kV Bus Voltages and Capacitor Bank Locations



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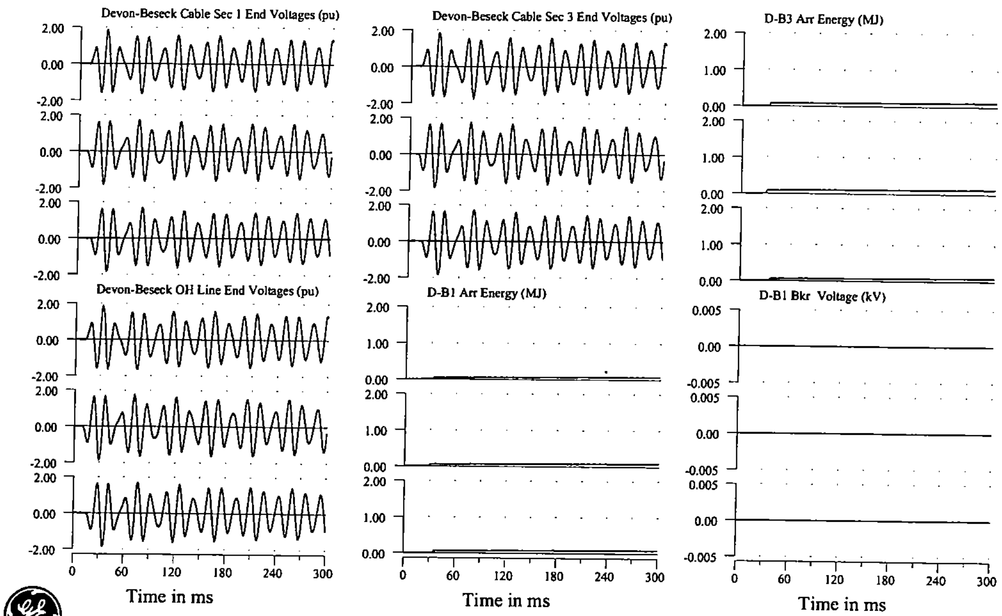
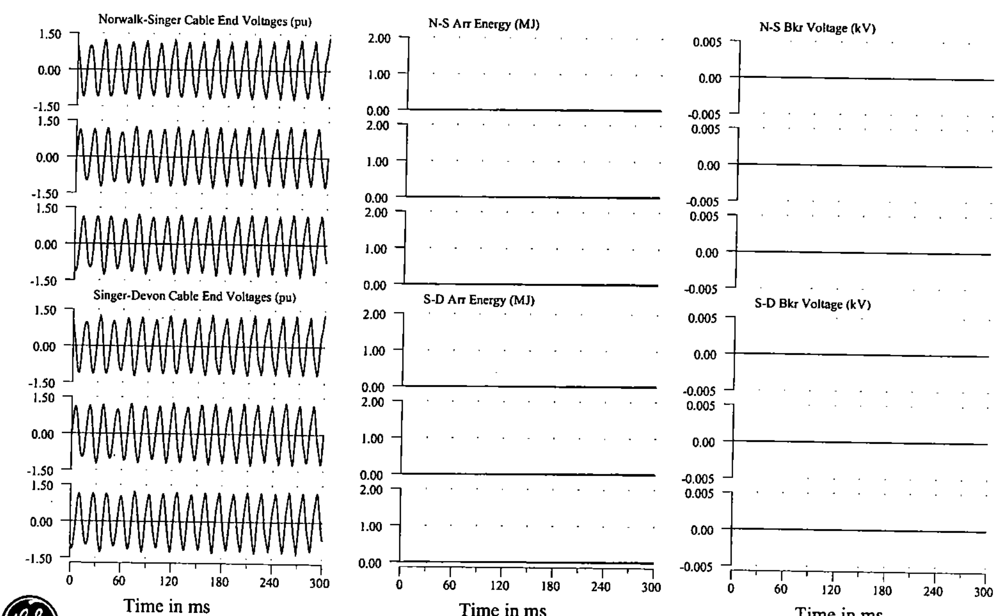
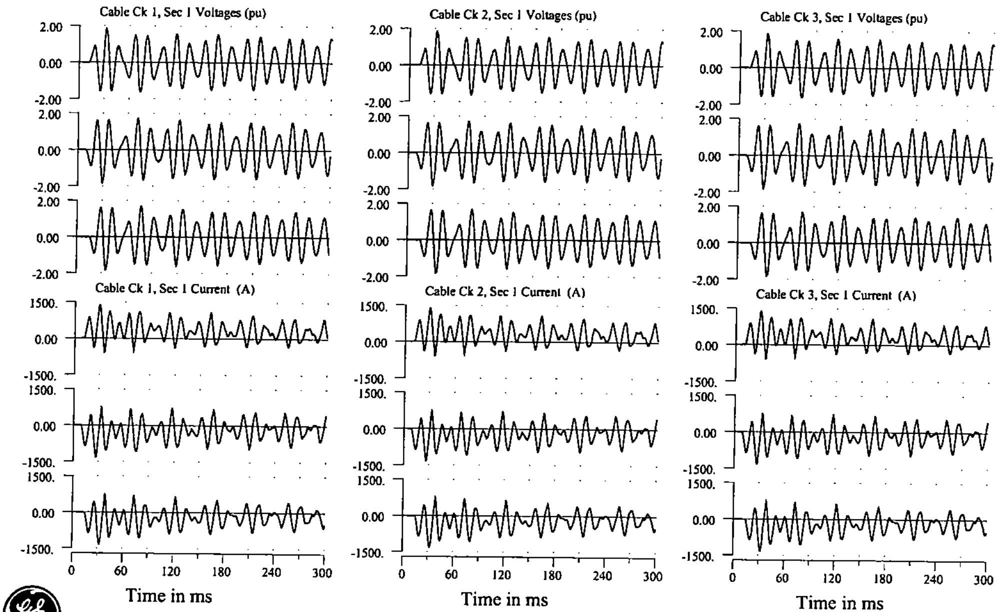
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



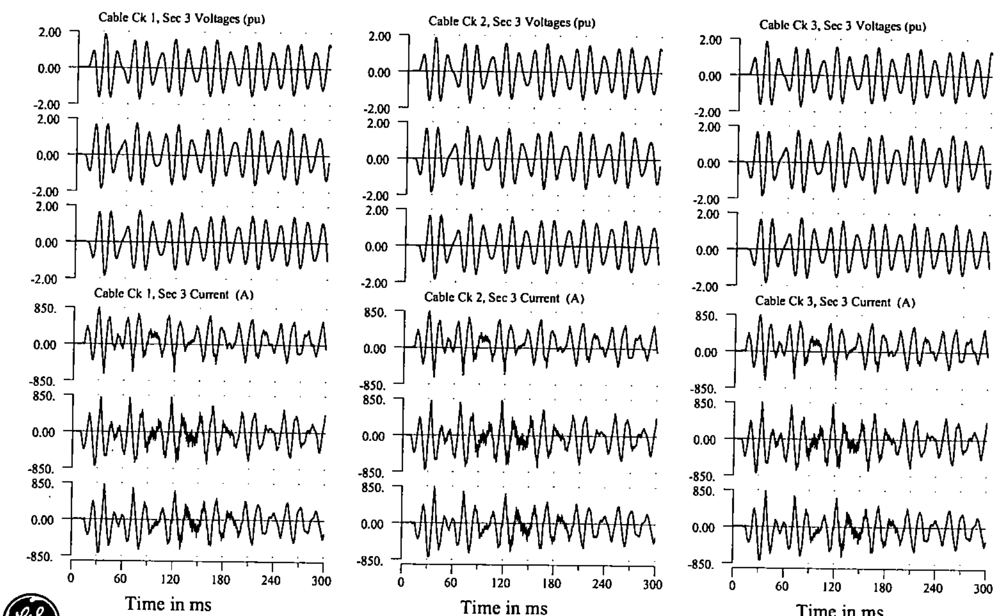
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



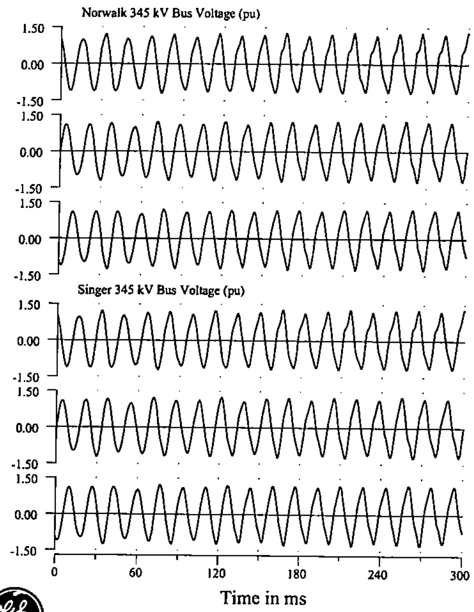
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11
Devon-Beseck 345 kV Cables

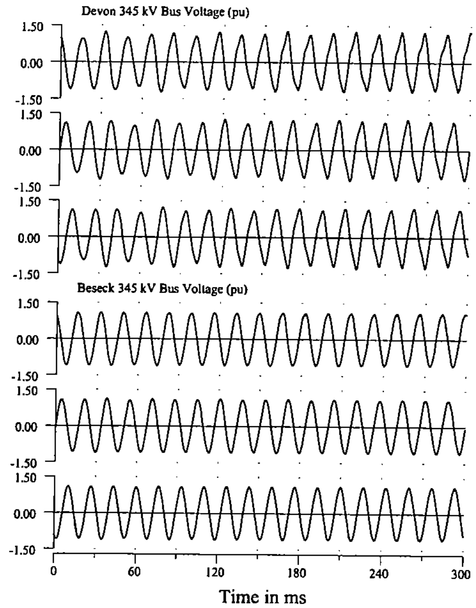


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11
345 kV Bus Voltages





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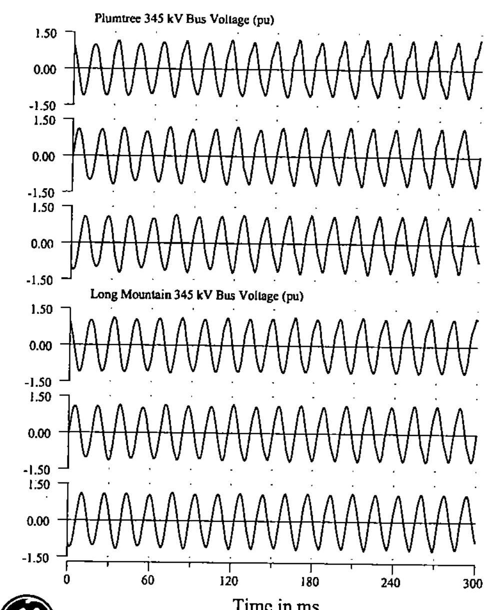
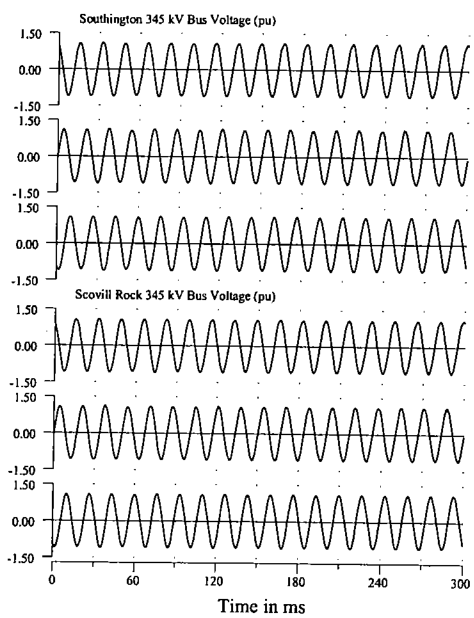
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11
345 kV Bus Voltages





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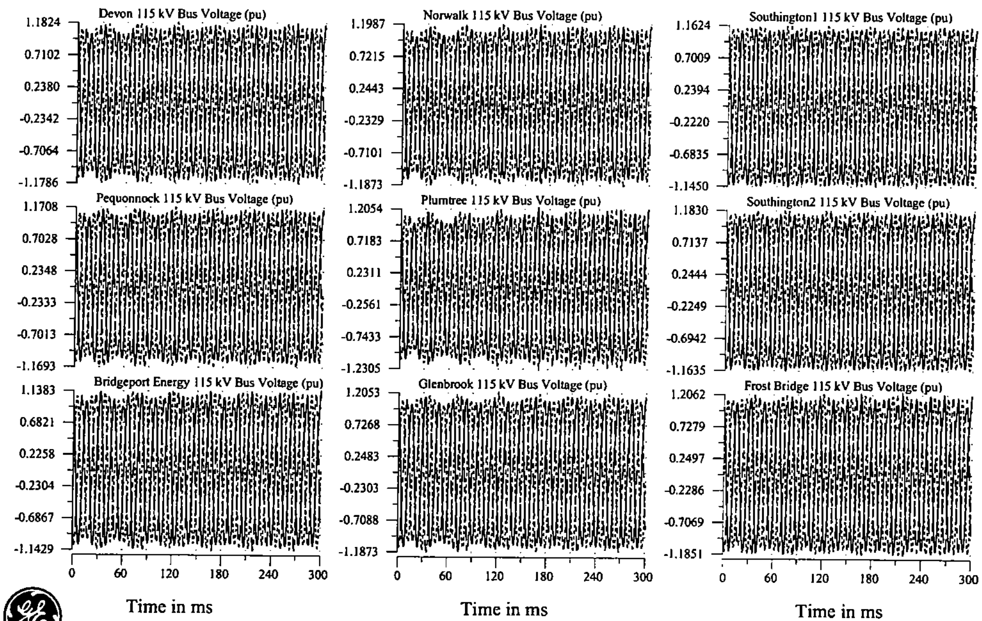
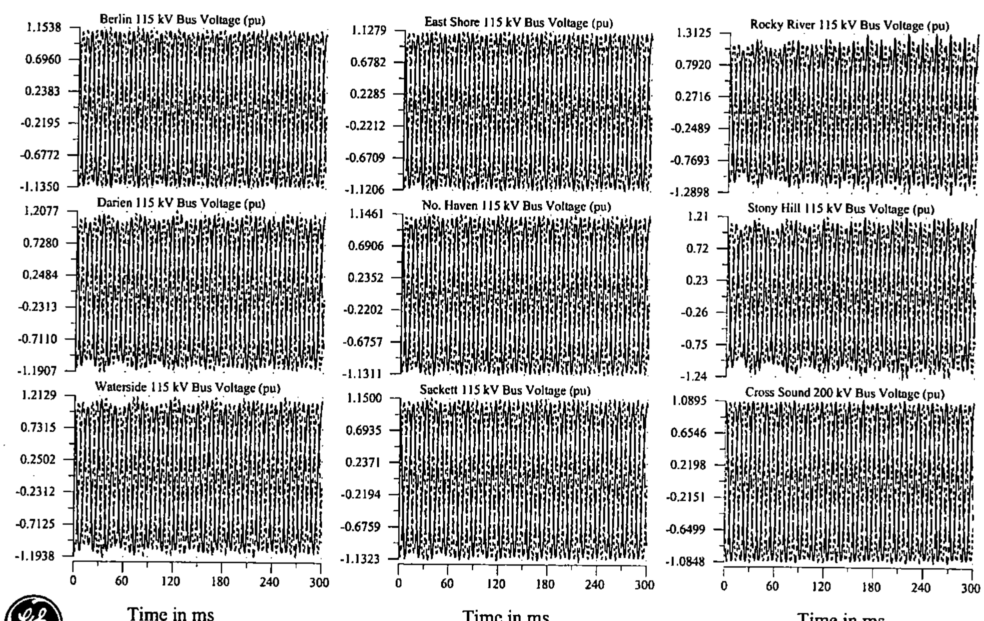
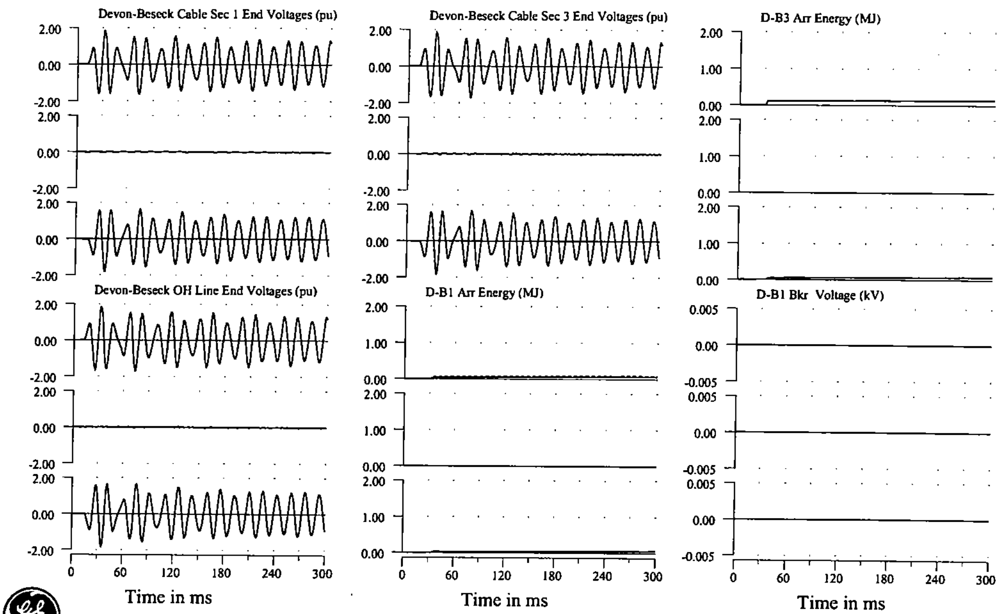
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11
115 kV Bus Voltages and Capacitor Bank Locations



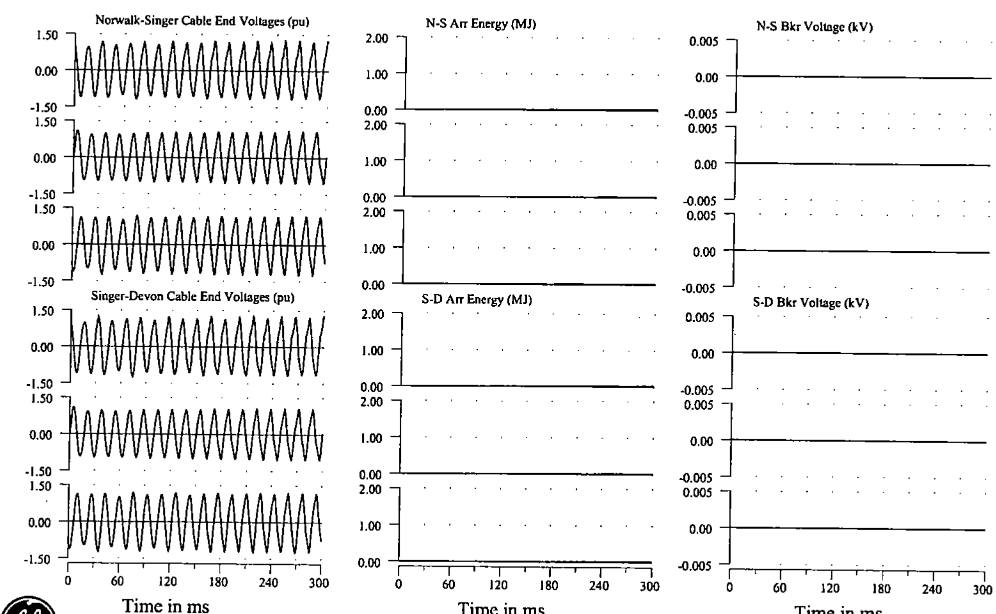
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11
115 kV Bus Voltages and Capacitor Bank Locations



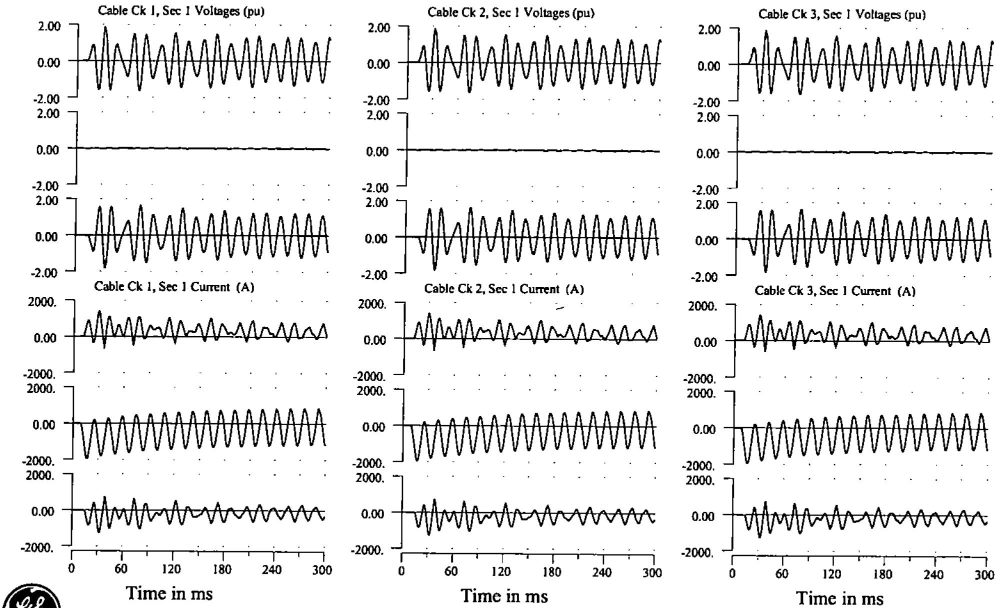
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11A
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11A
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11A
Devon-Beseck 345 kV Cables



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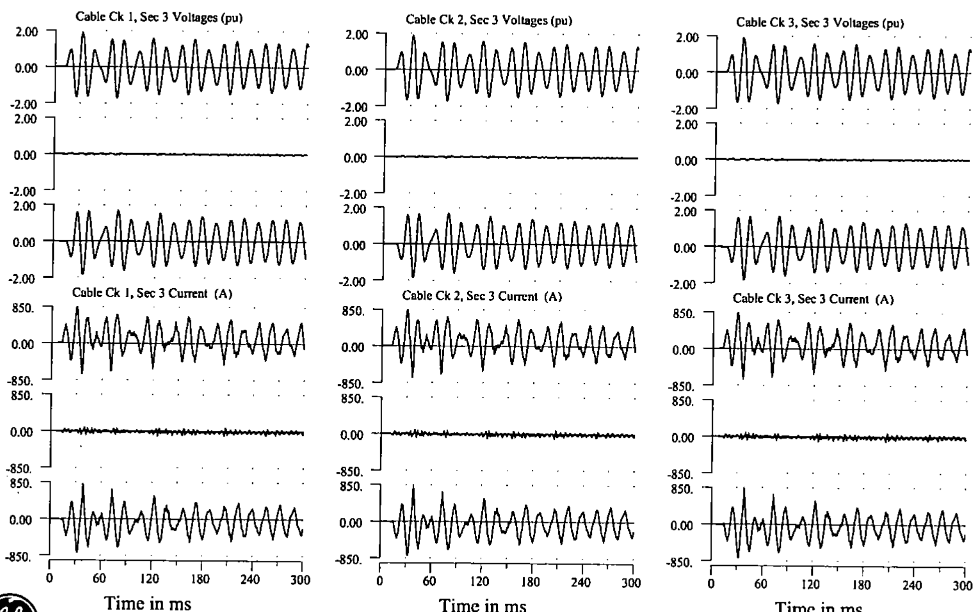
Page 3

Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11A
Devon-Beseck 345 kV Cables



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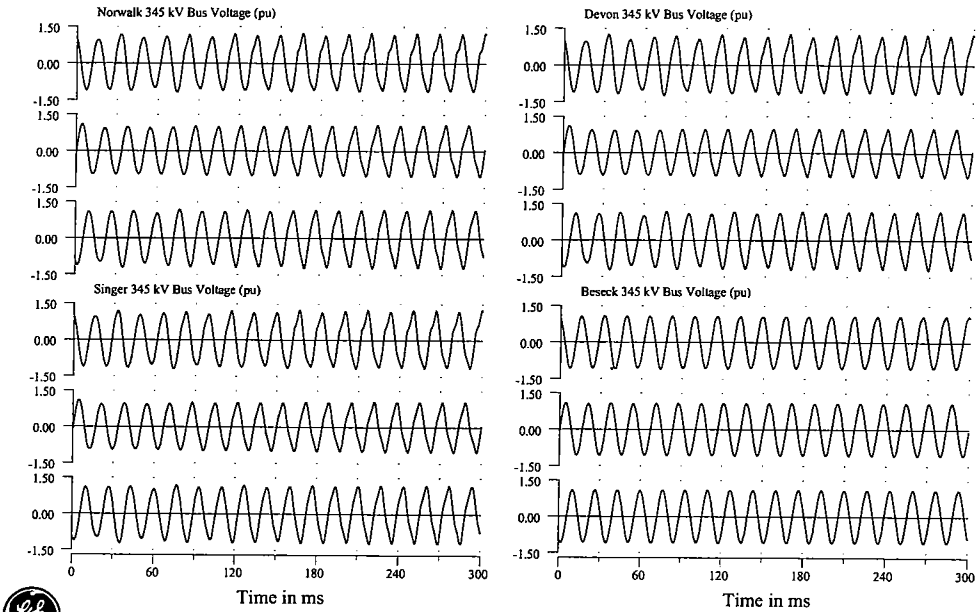
Page 4

Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11A
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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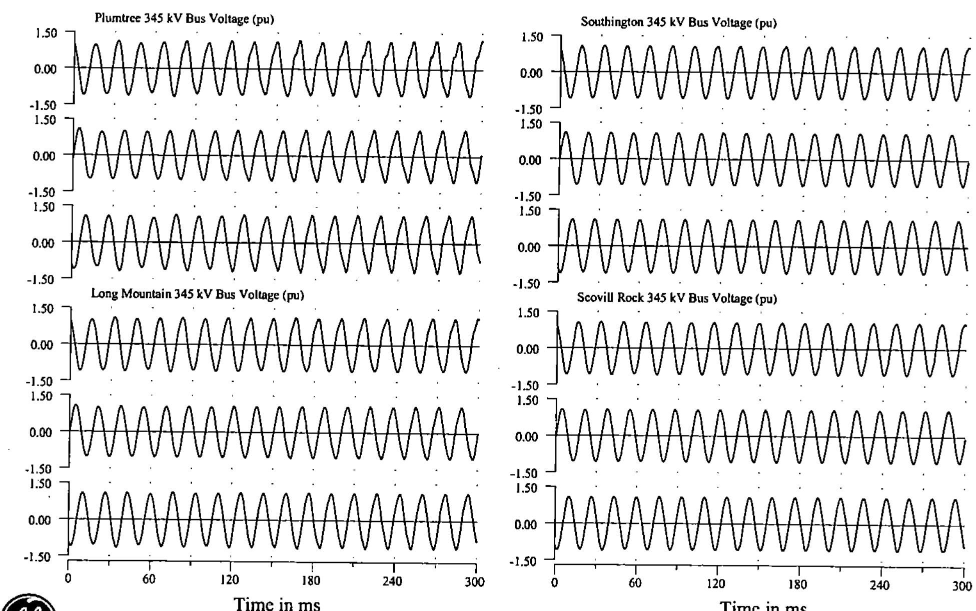
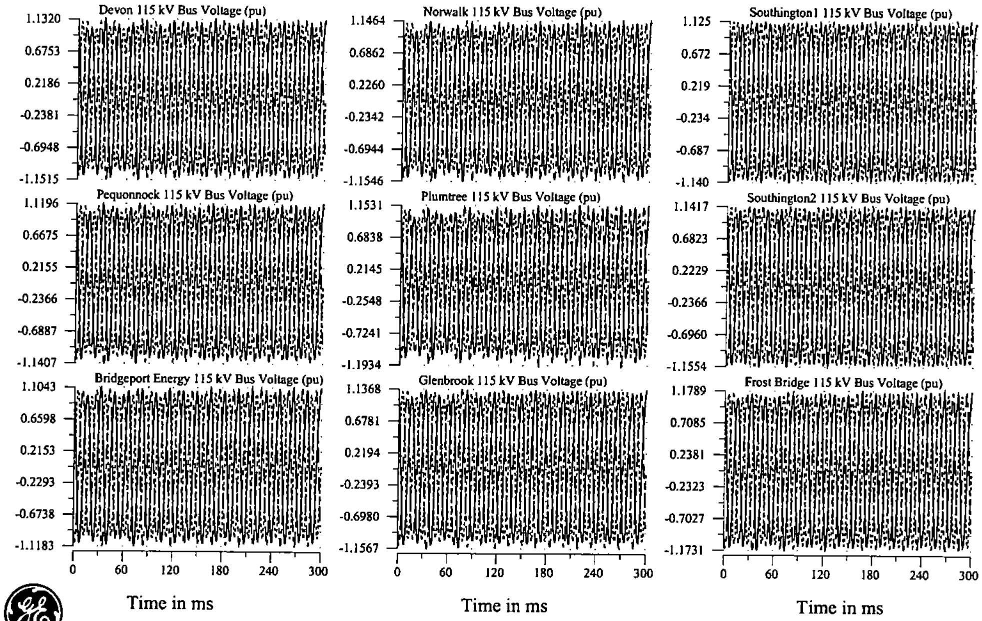
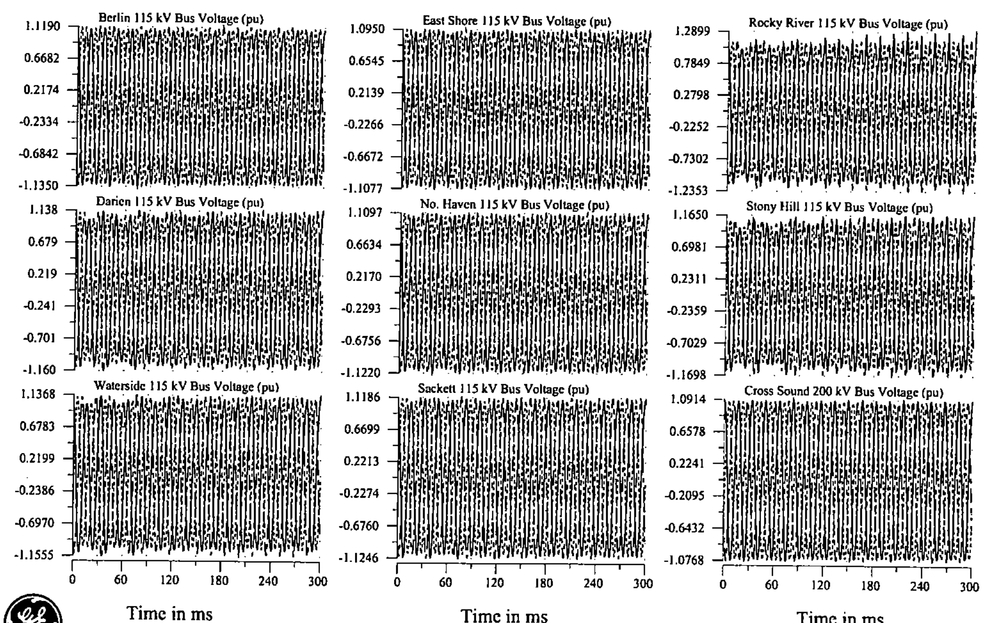
345 kV Bus Voltages



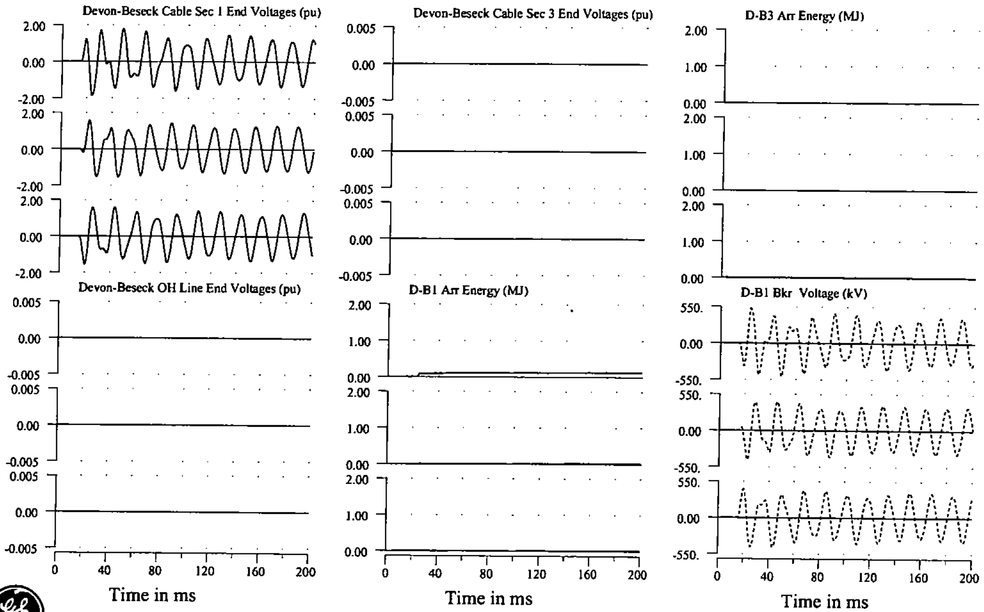
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11A
11A5 kV Bus Voltages and Capacitor Bank Locations



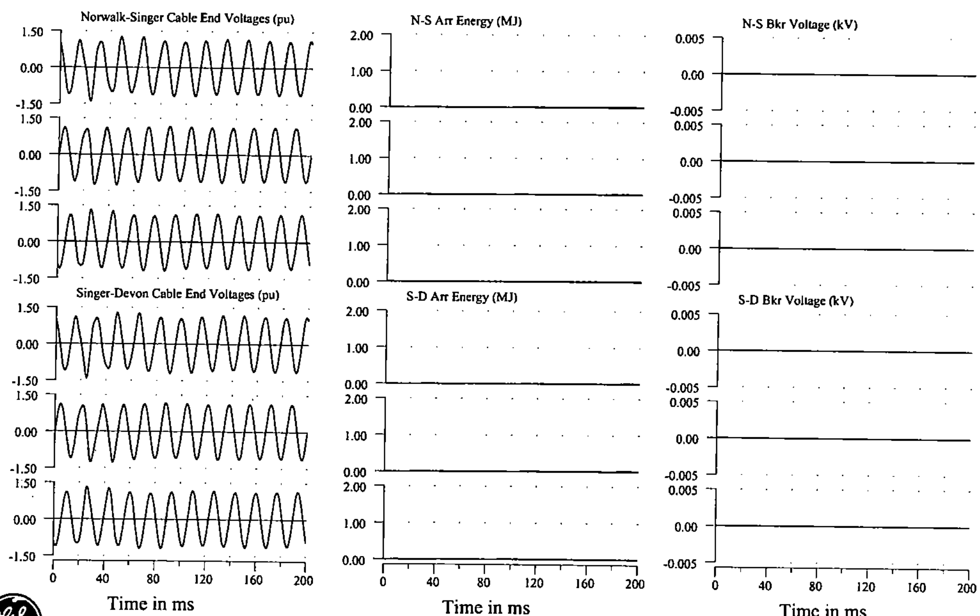
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_11A
11A5 kV Bus Voltages and Capacitor Bank Locations



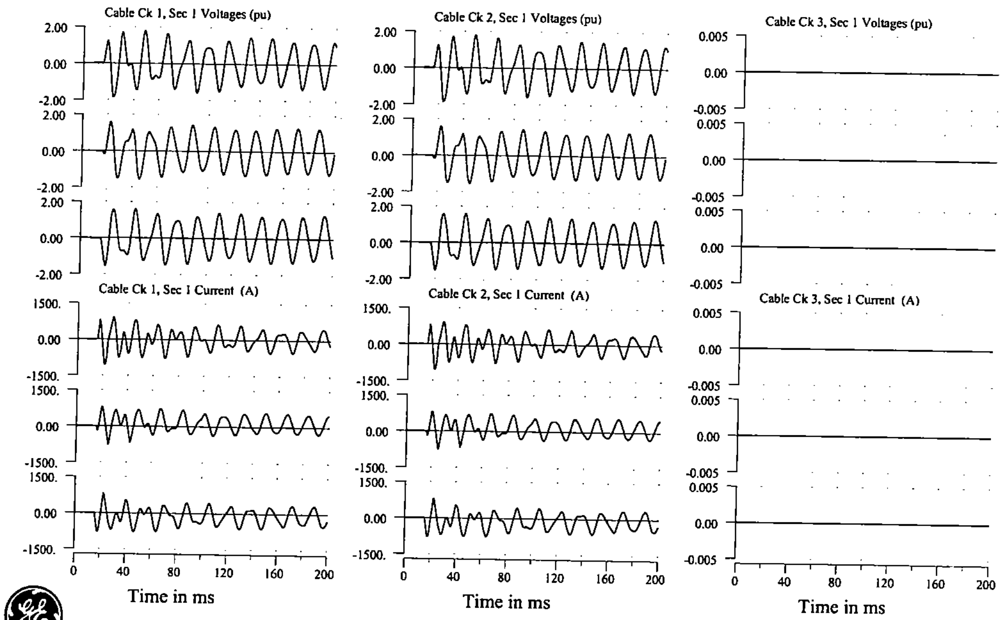
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



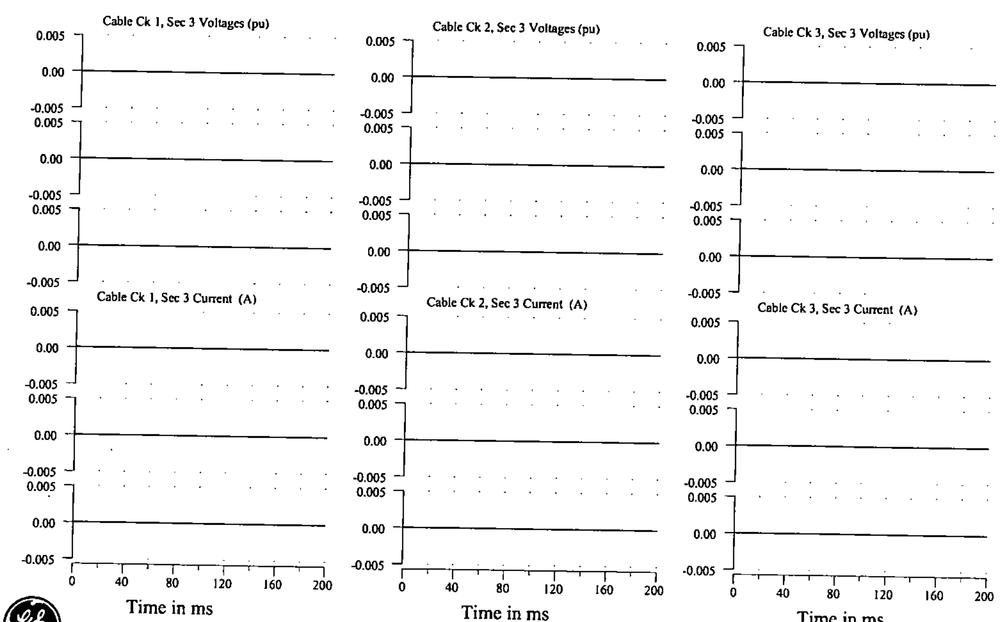
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



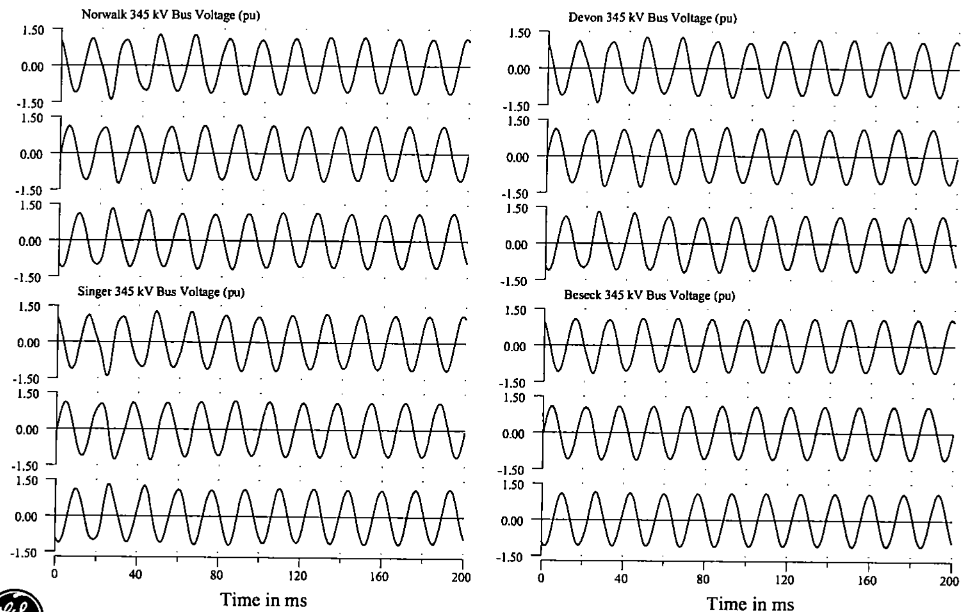
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12
Devon-Beseck 345 kV Cables



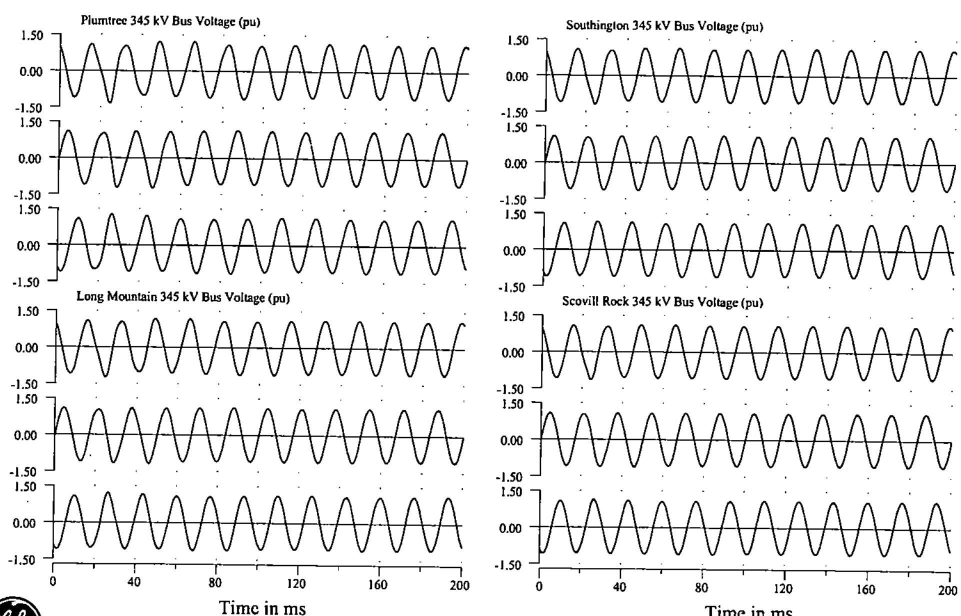
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12
Devon-Beseck 345 kV Cables



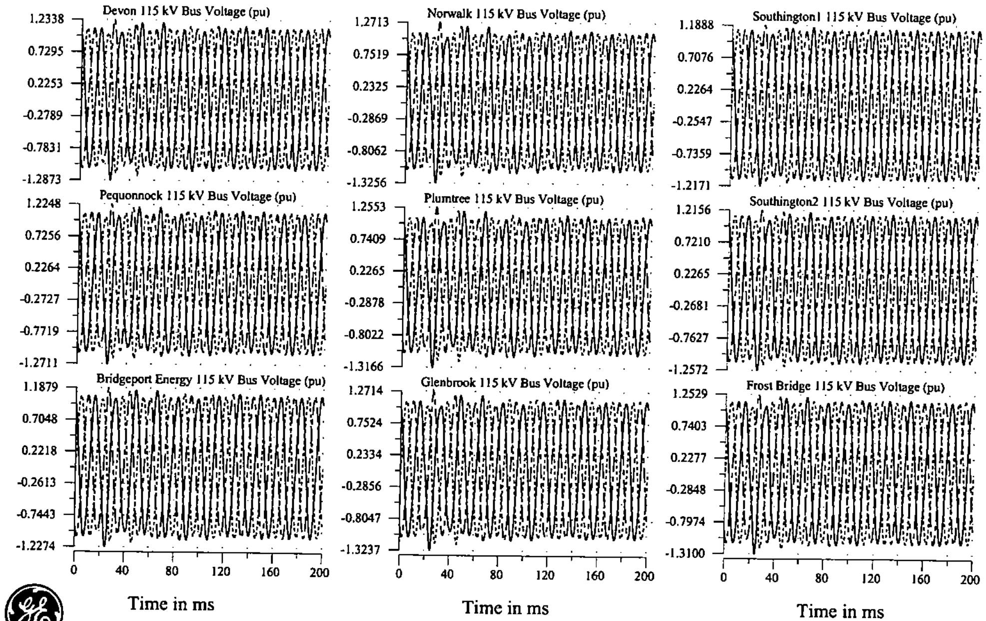
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12
345 kV Bus Voltages



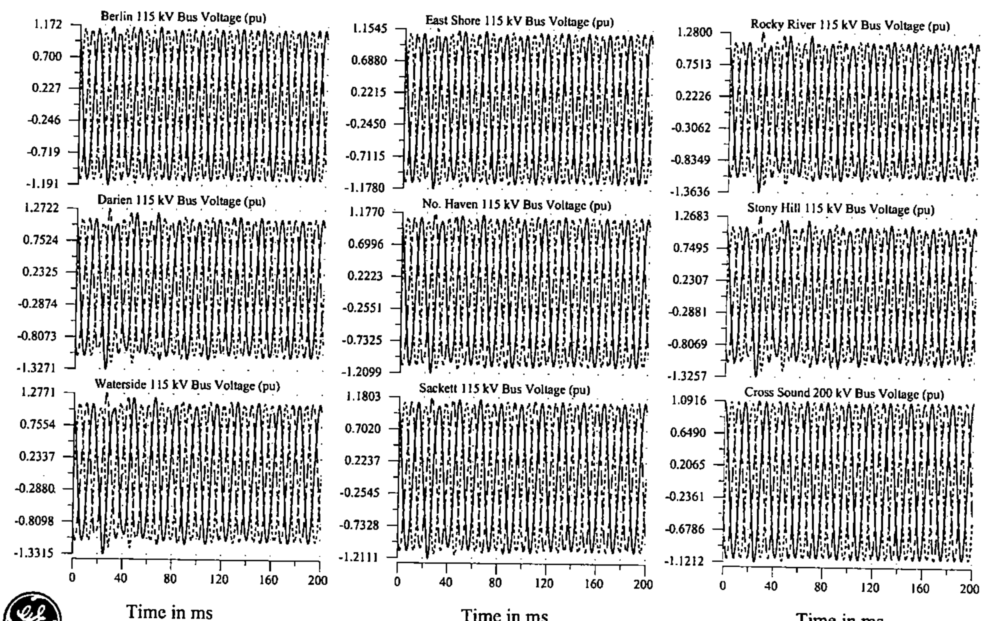
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12
345 kV Bus Voltages



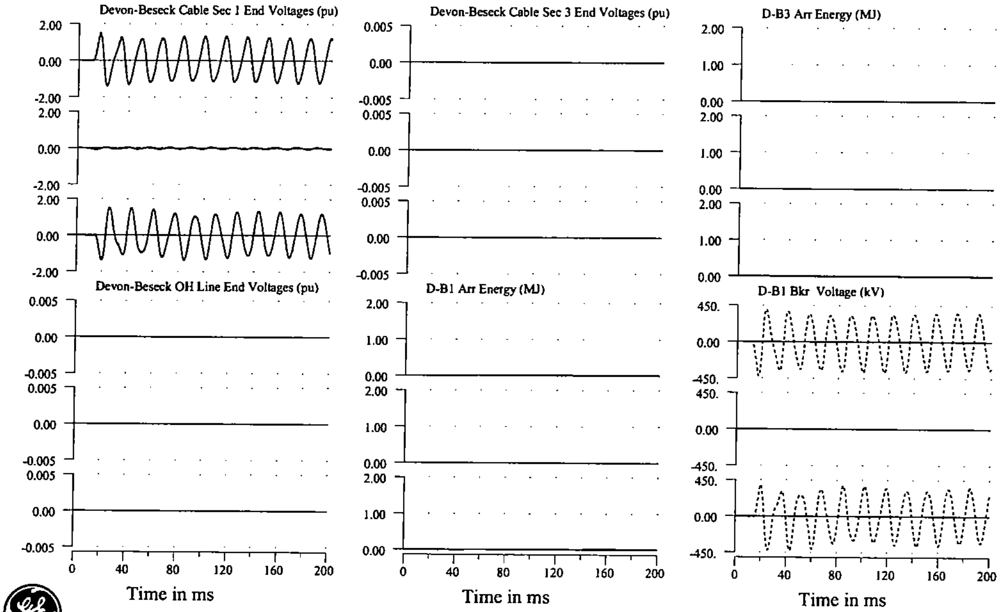
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12A
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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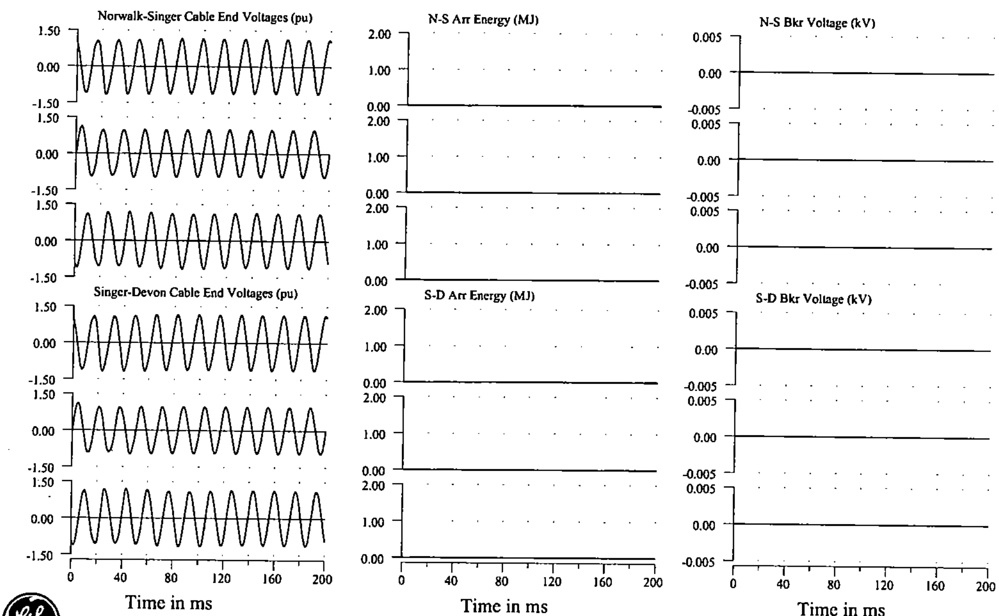
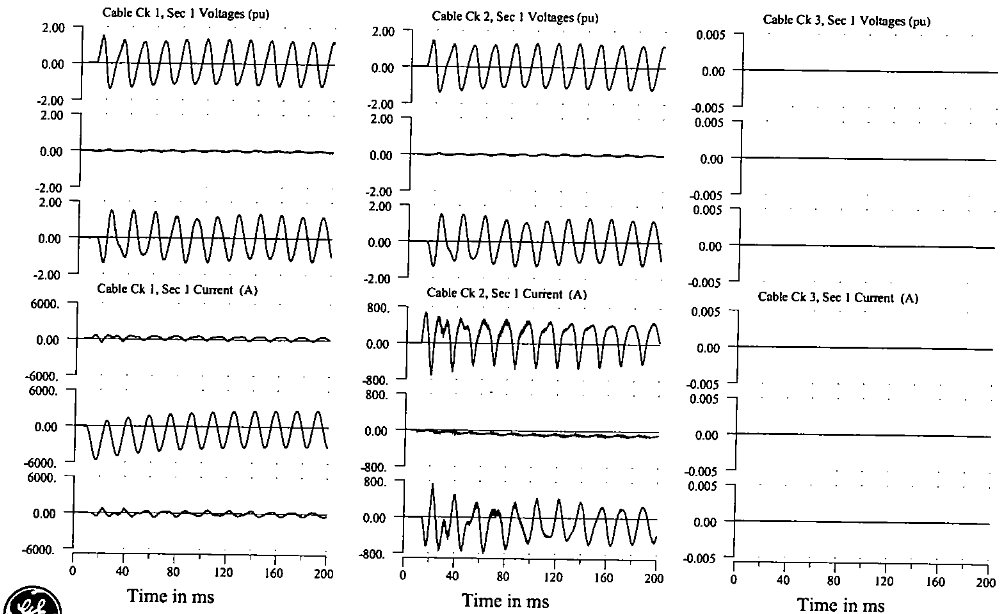
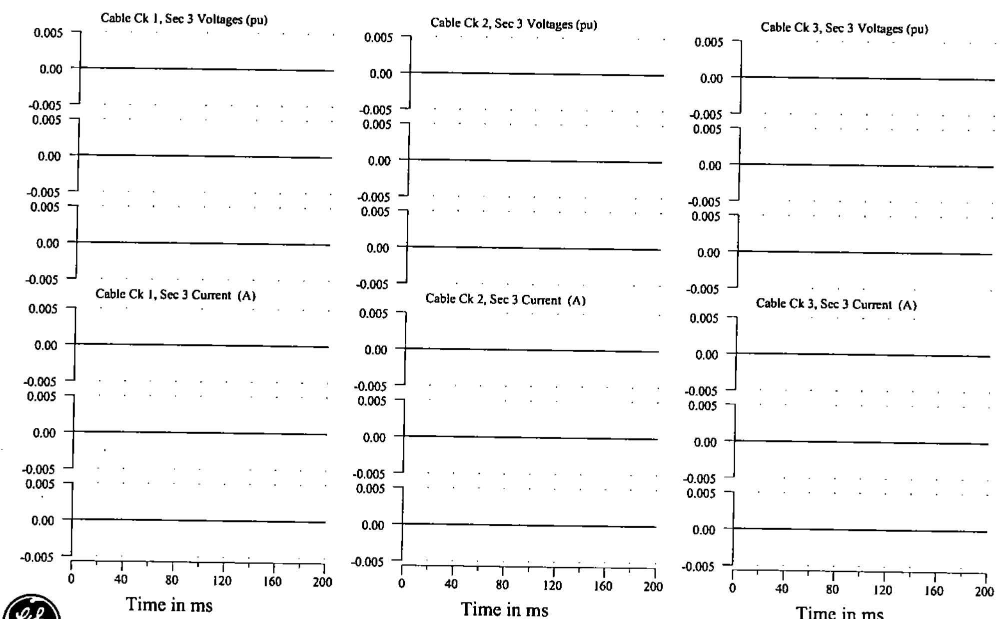
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



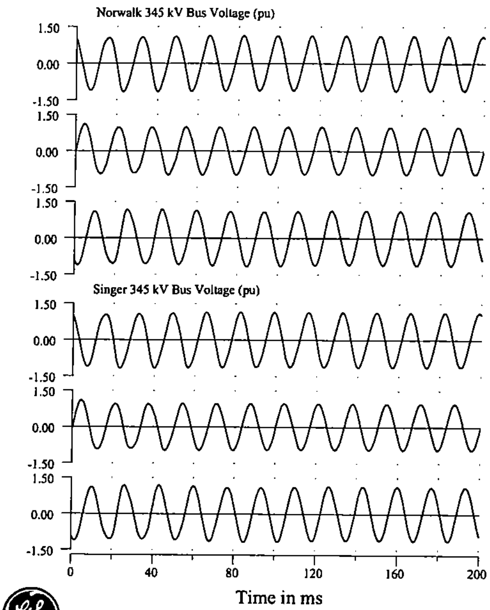
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12A
Devon-Beseck 345 kV Cables

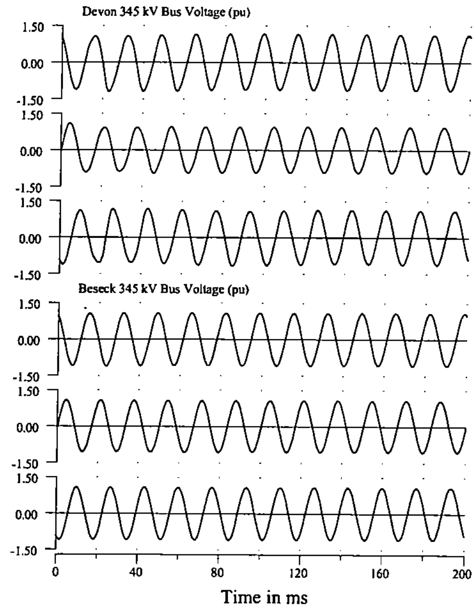


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12A
Devon-Beseck 345 kV Cables

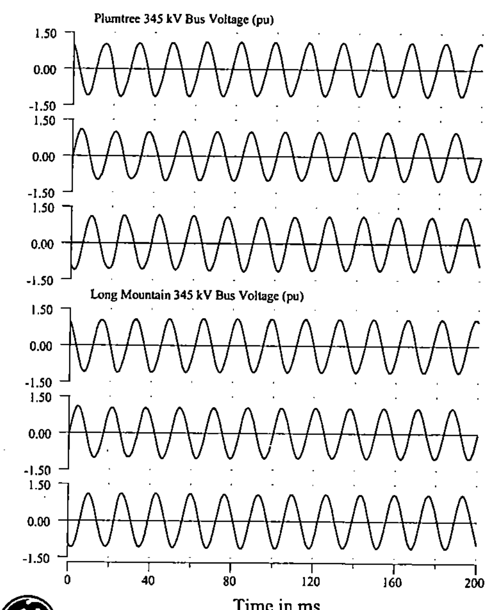


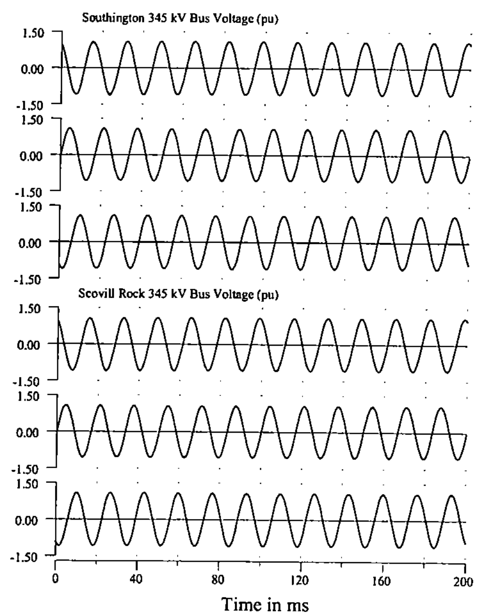
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12A
345 kV Bus Voltages



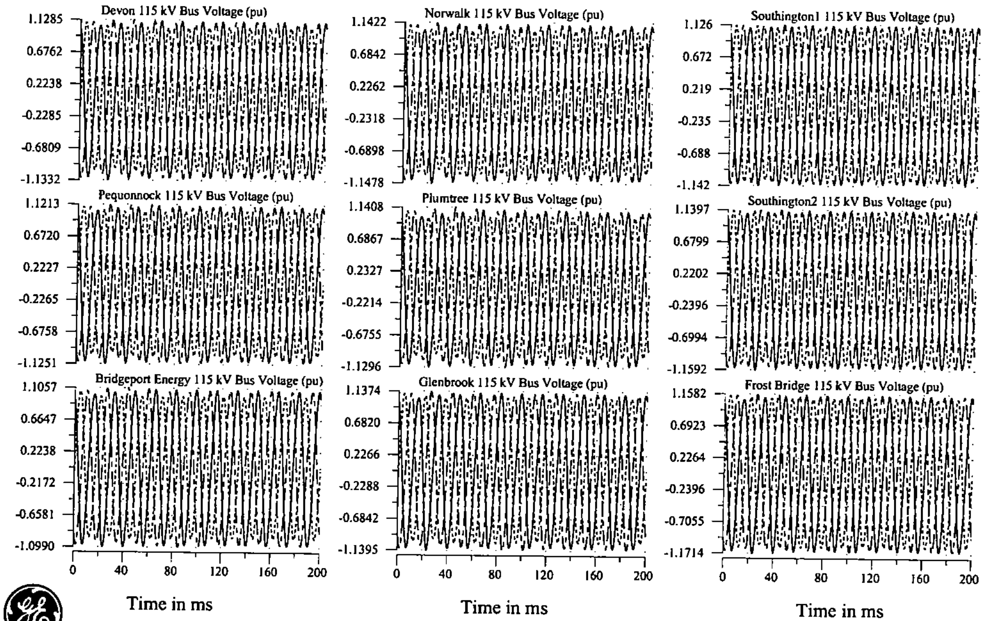


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12A
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FED_12A
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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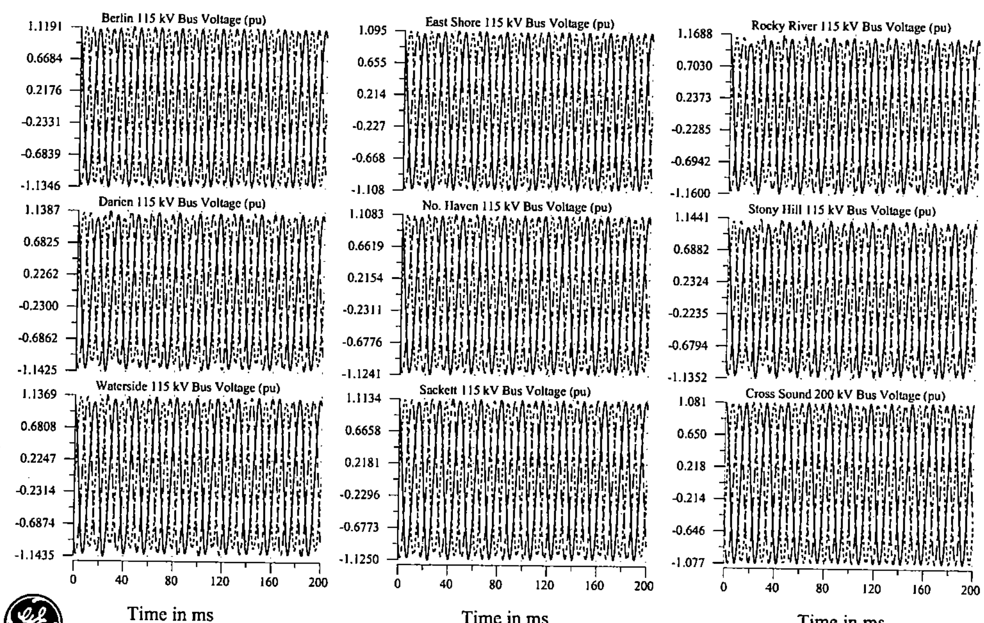
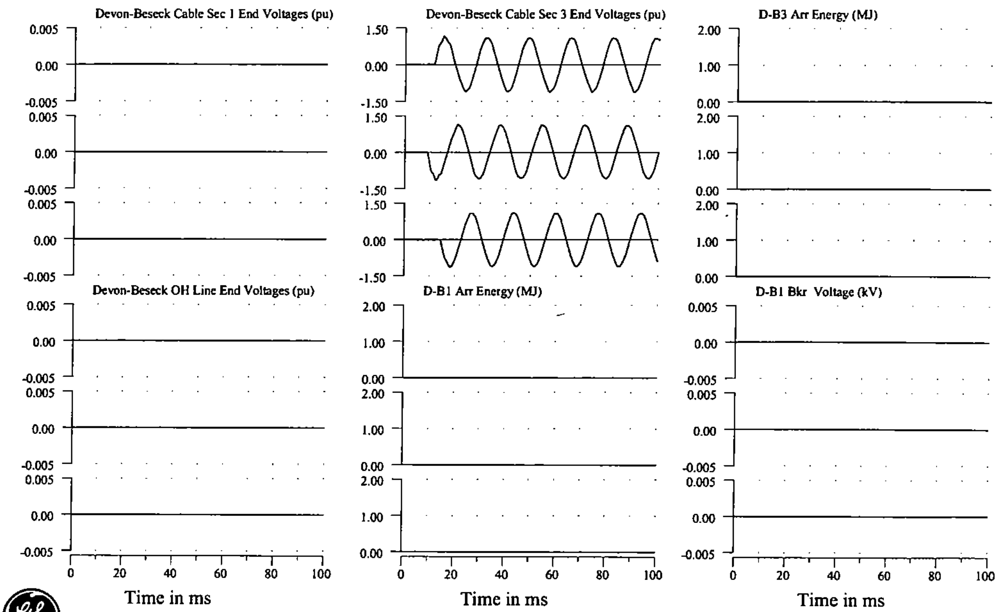
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FEB_01

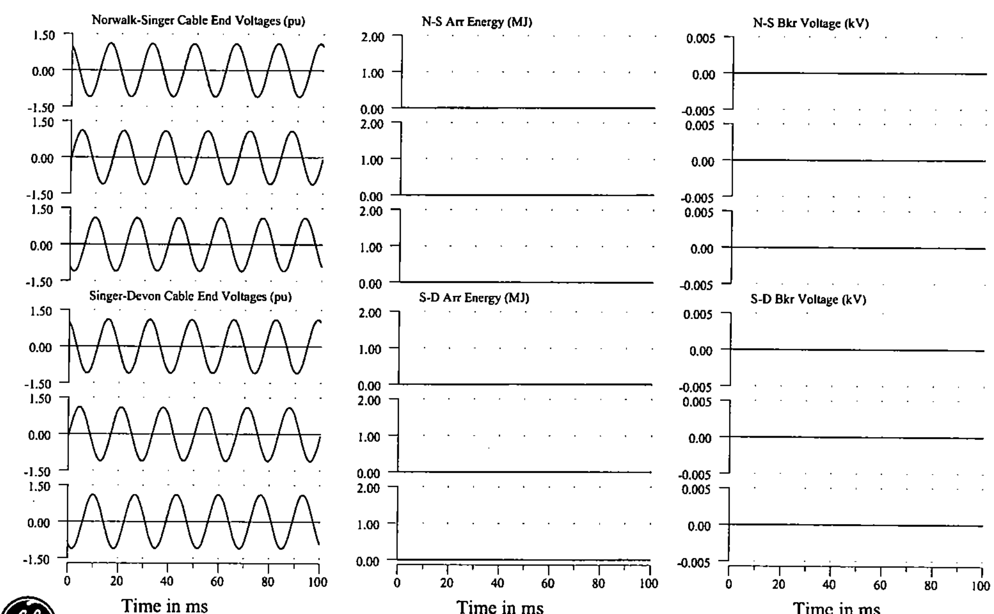
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



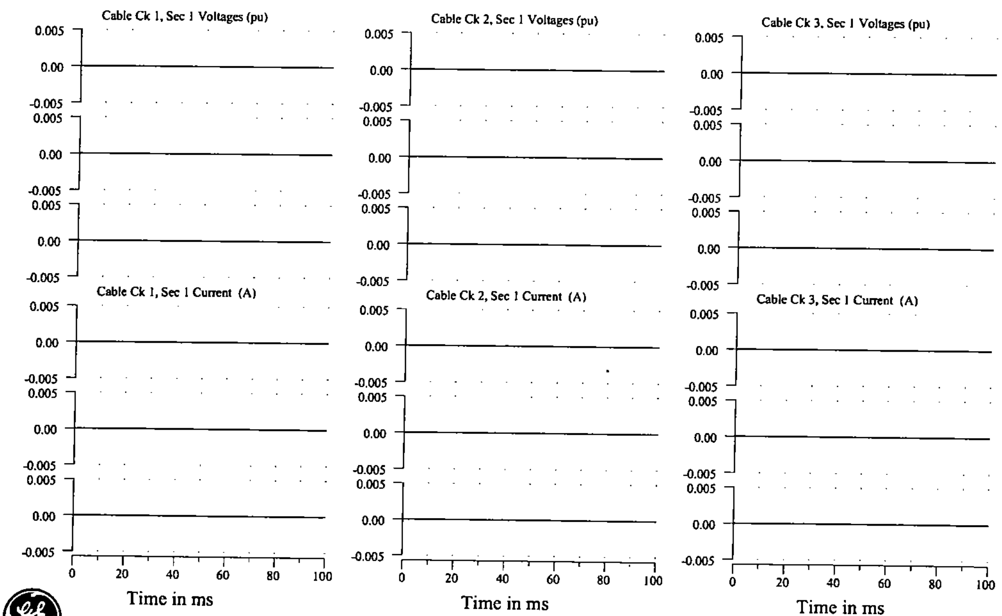
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FEB_01

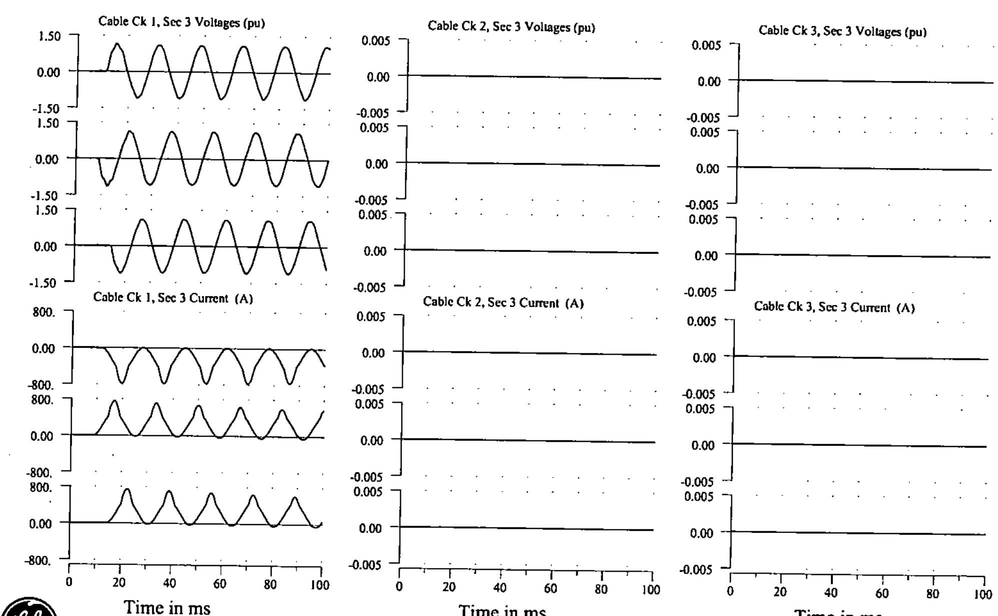
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



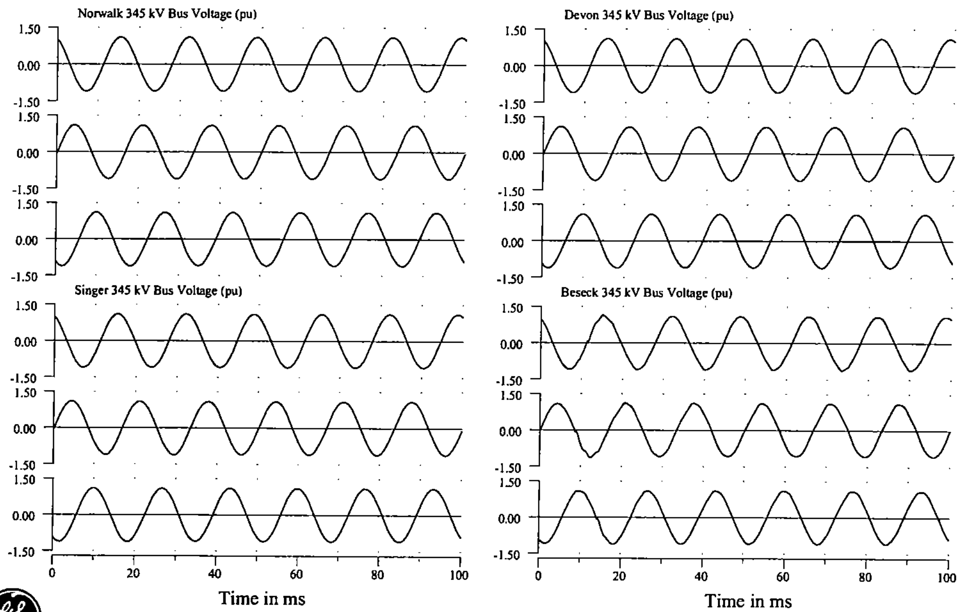
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_01
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_01
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_01
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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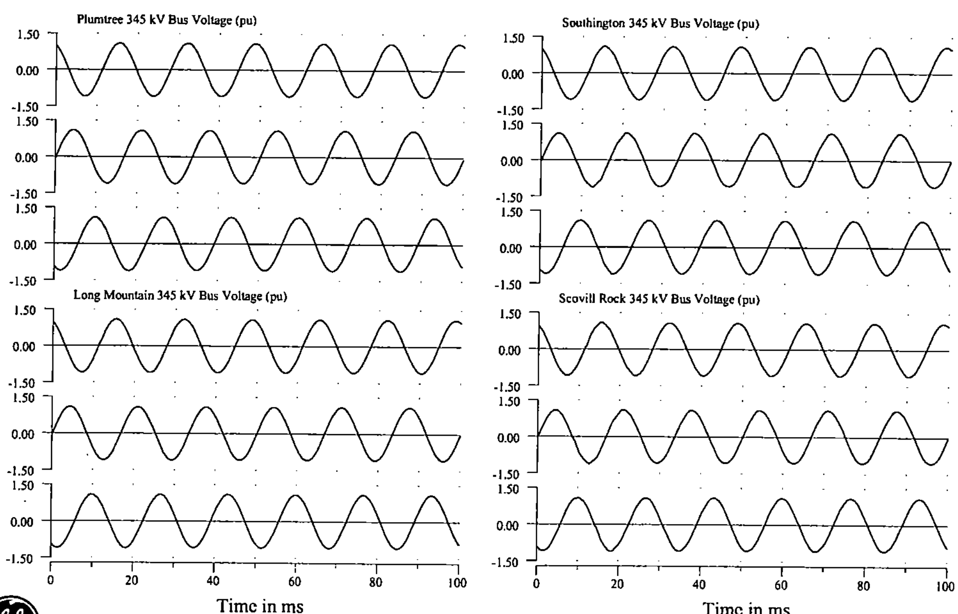
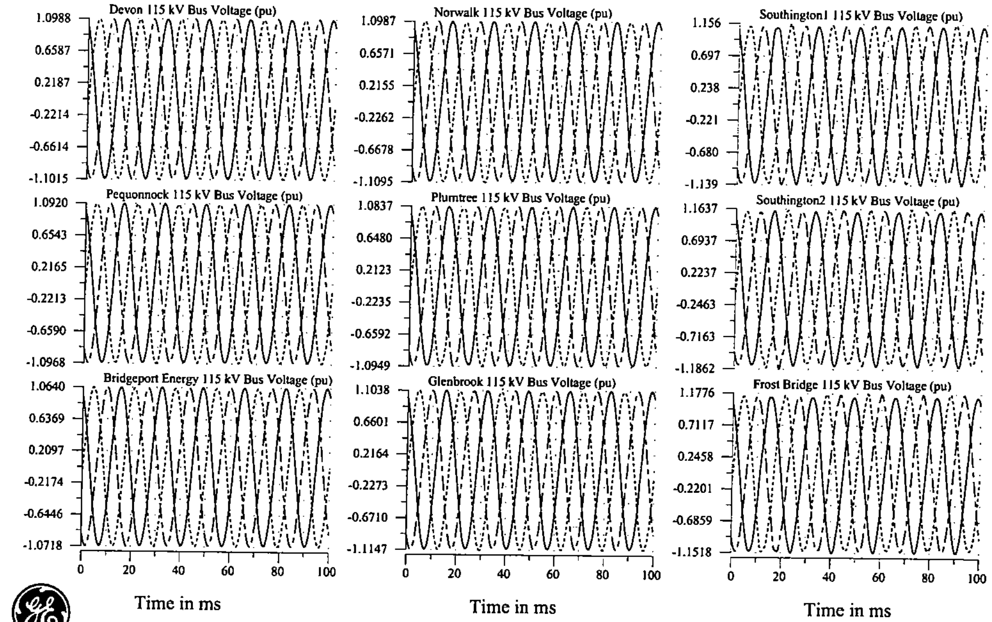
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_01
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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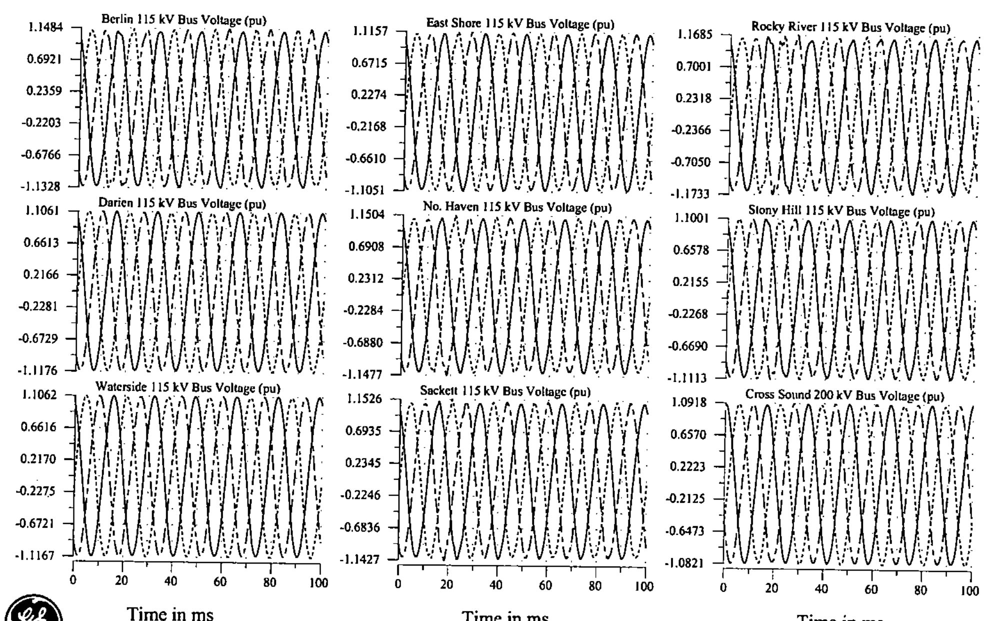
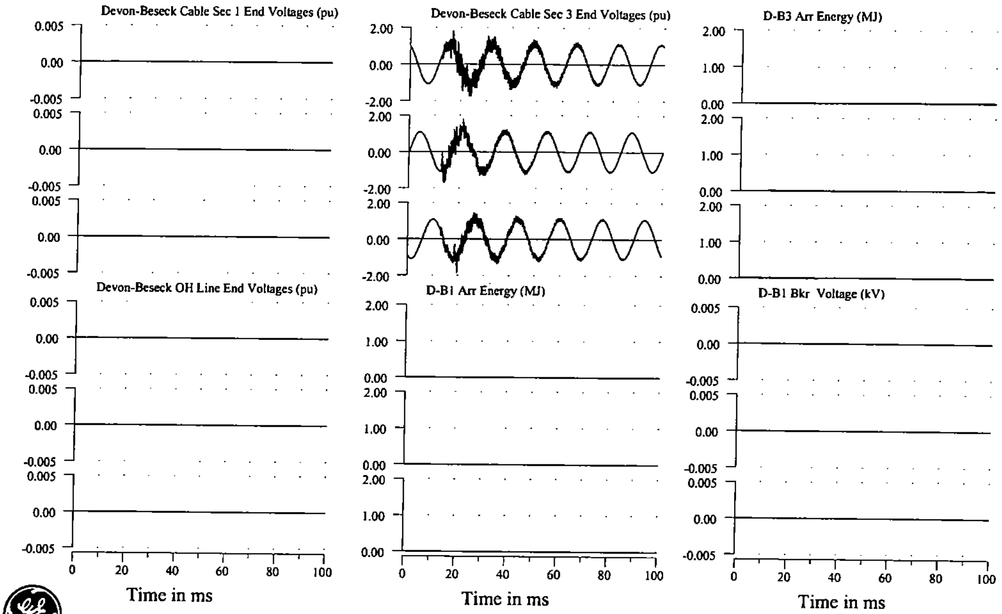
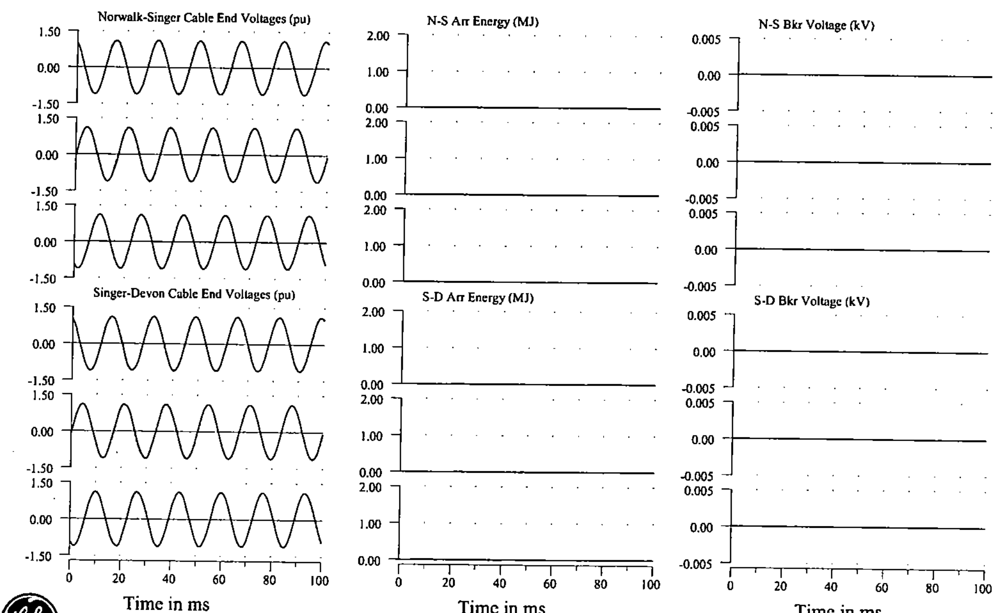
115 kV Bus Voltages and Capacitor Bank Locations



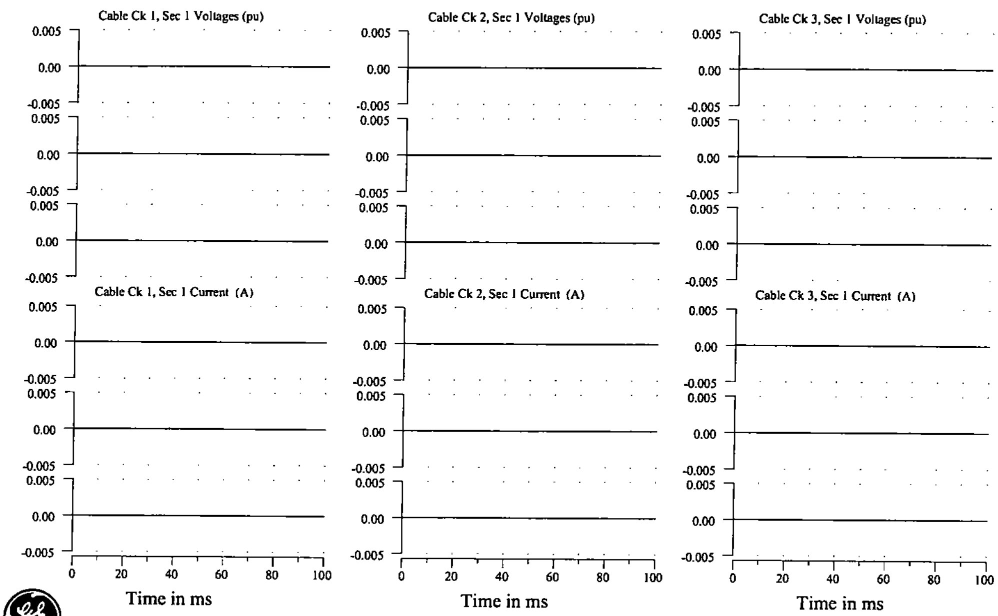
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_02
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_02
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_02
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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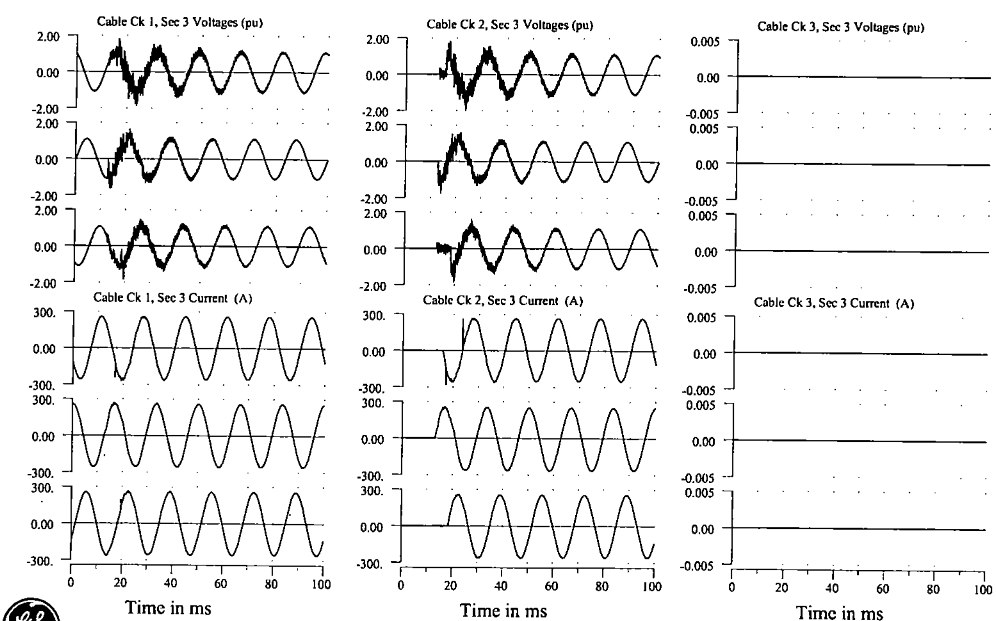

Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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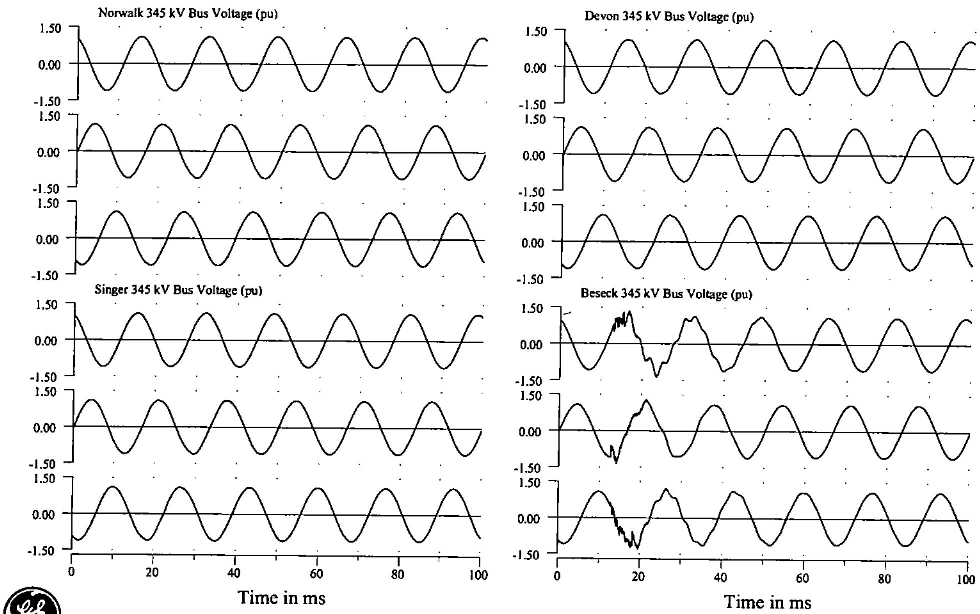
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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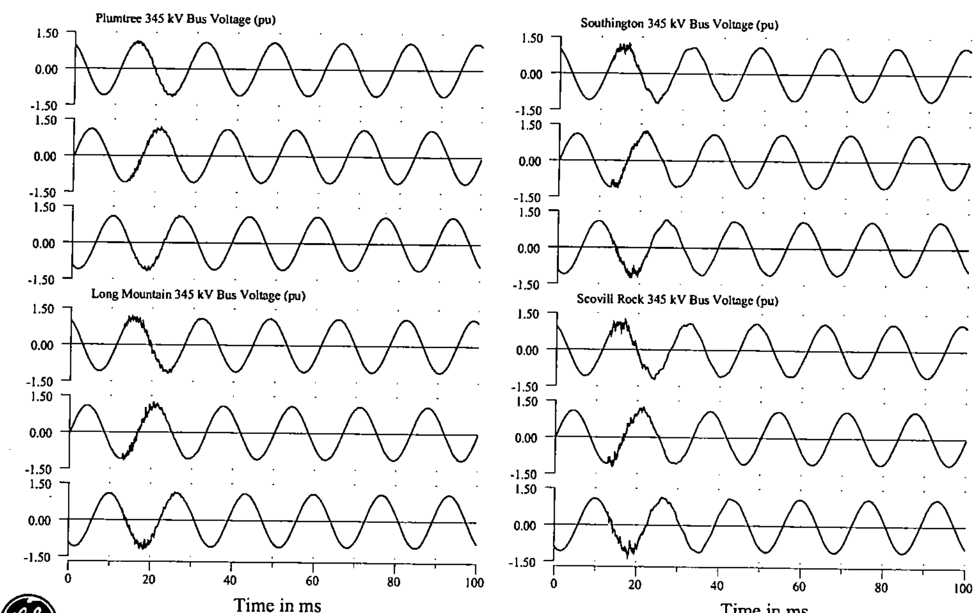
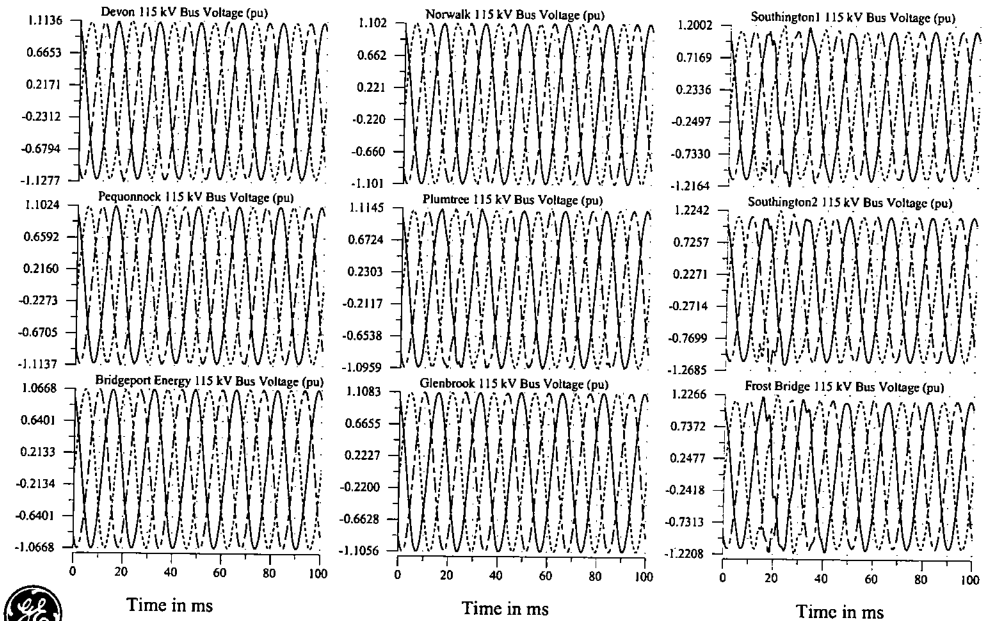
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FEB_02

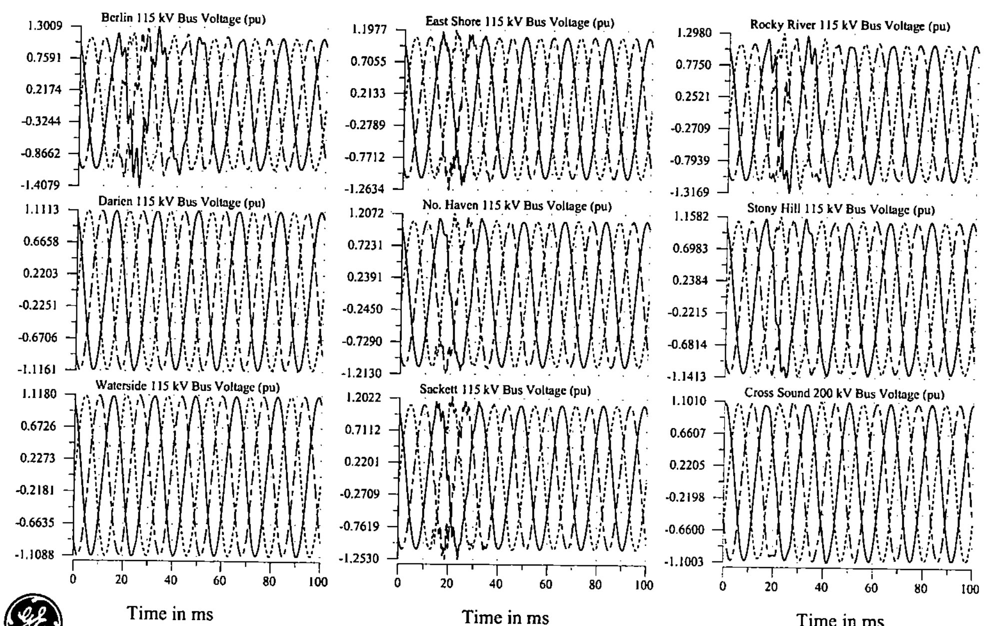
115 kV Bus Voltages and Capacitor Bank Locations



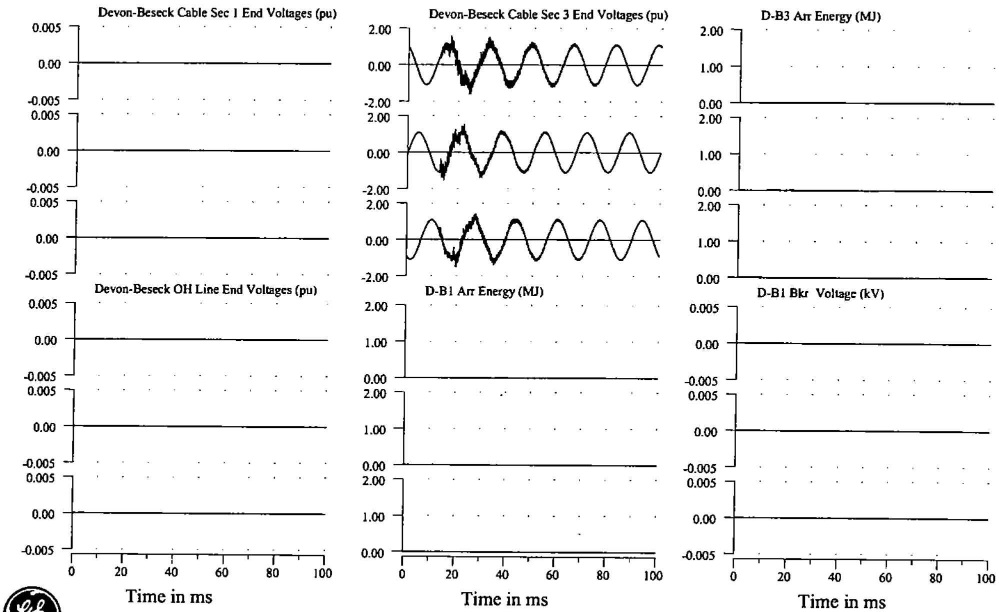
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FEB_02

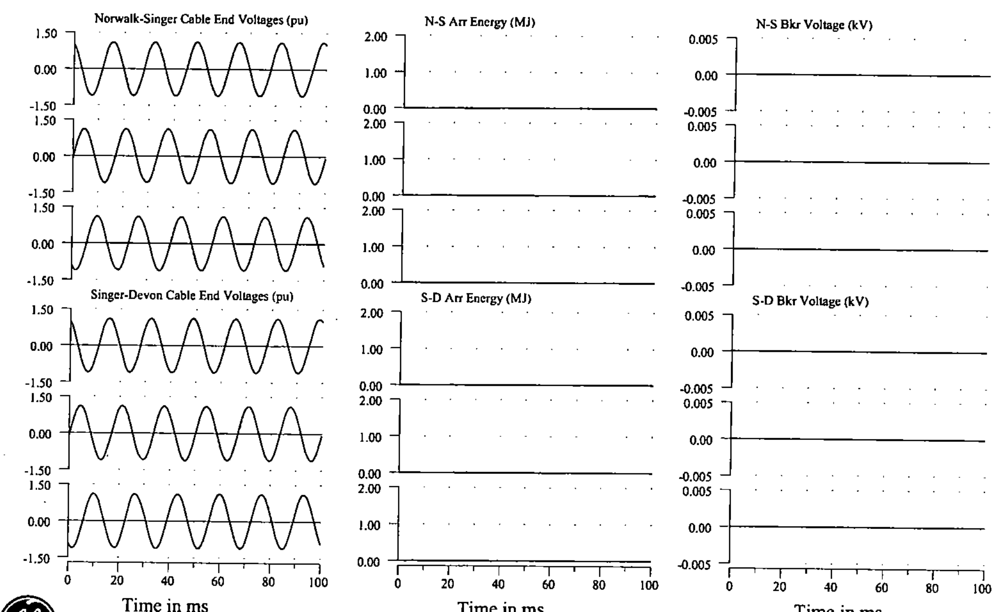
115 kV Bus Voltages and Capacitor Bank Locations



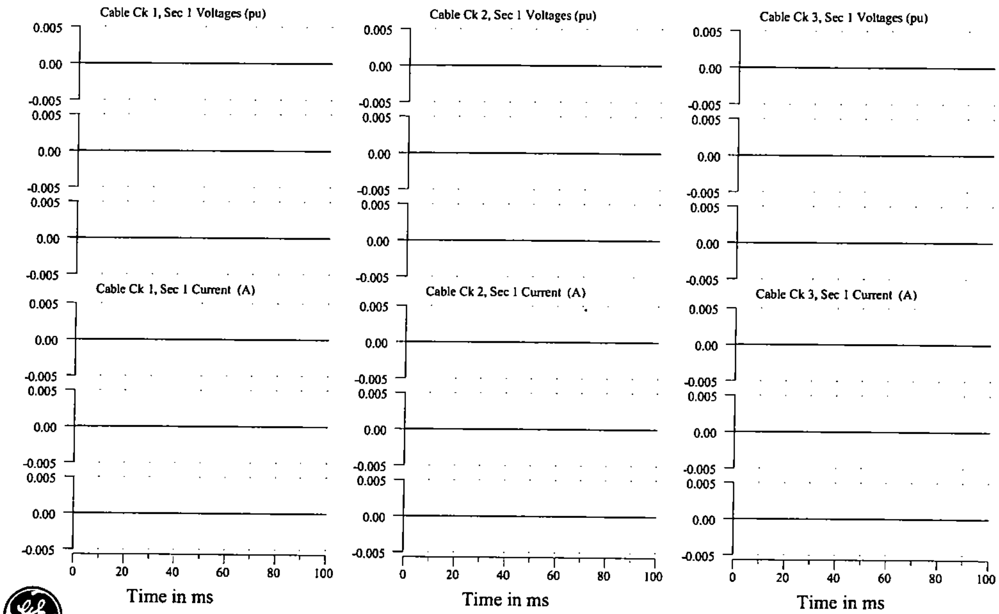
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_03
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_03
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_03
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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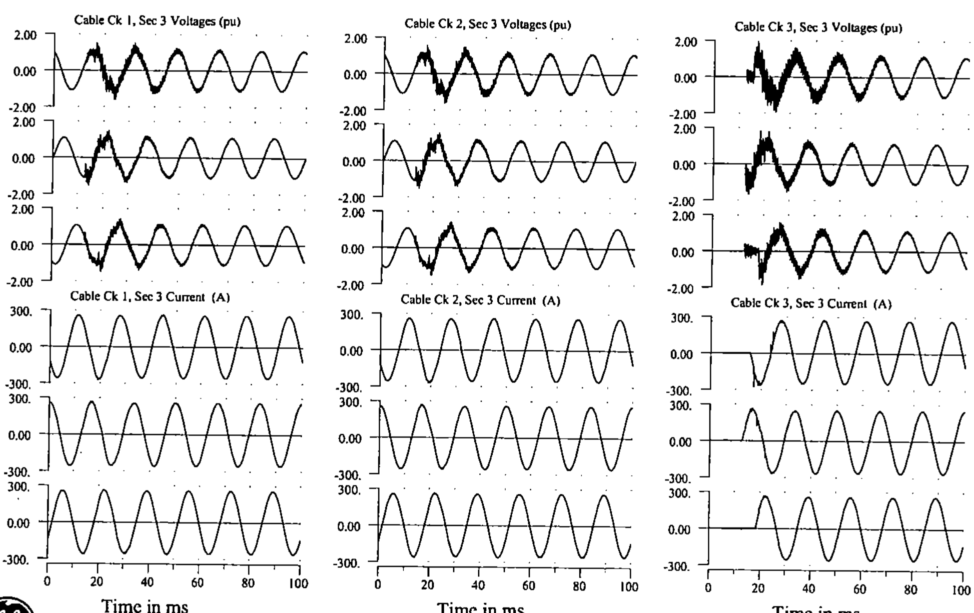
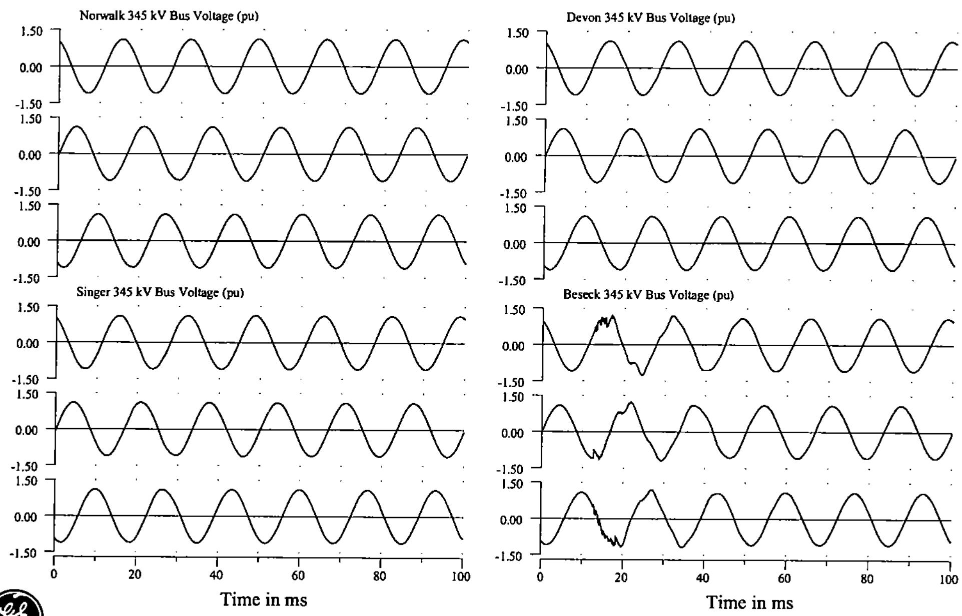
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_03
345 kV Bus Voltages



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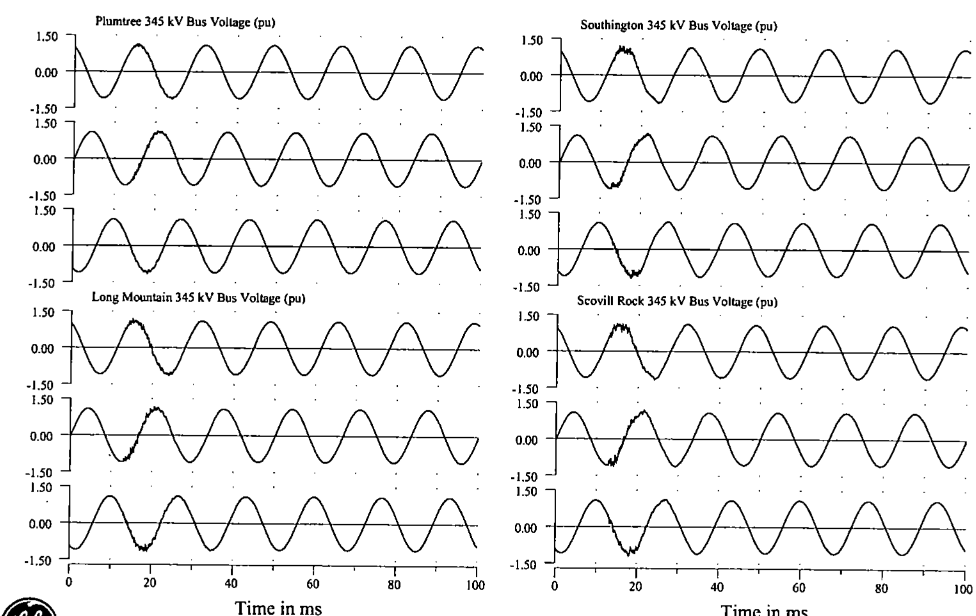
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_03
345 kV Bus Voltages



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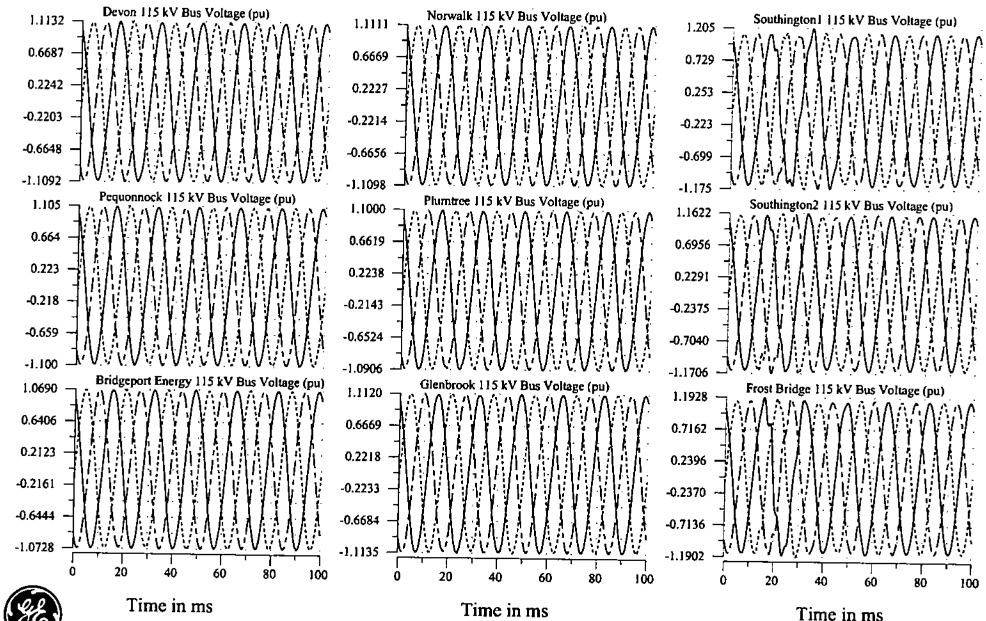
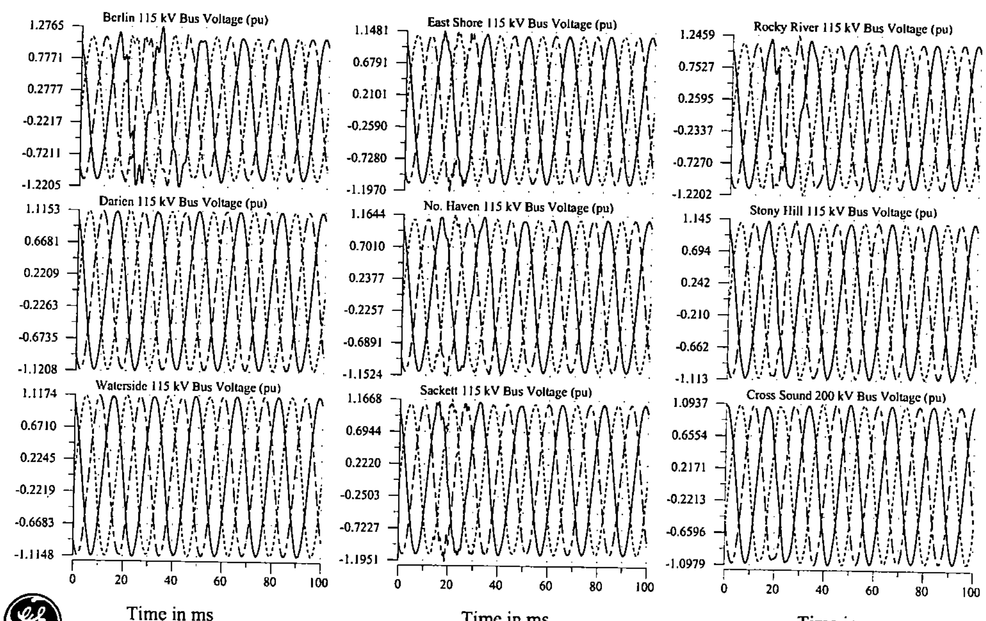
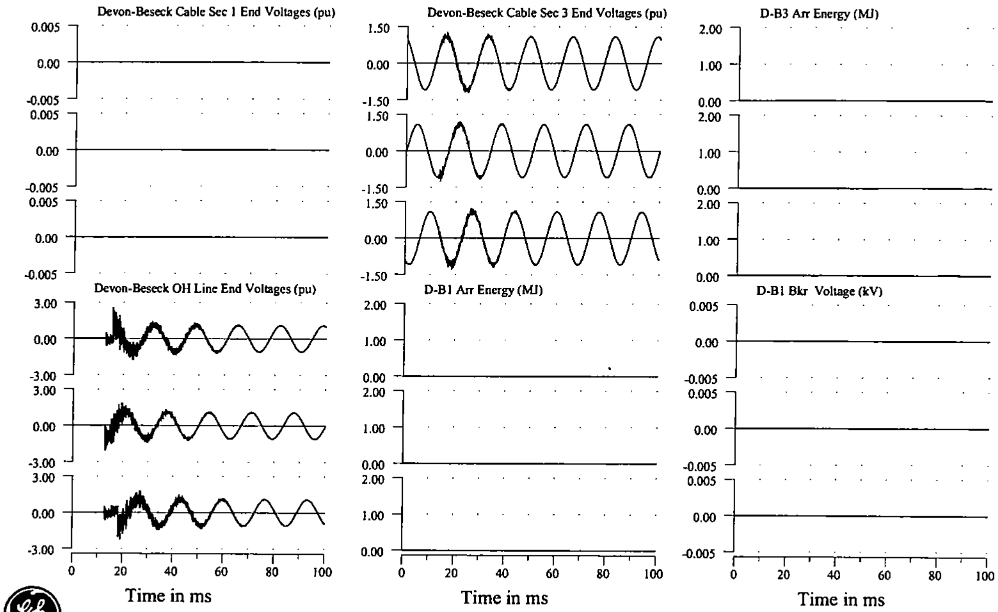
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_03
115 kV Bus Voltages and Capacitor Bank Locations



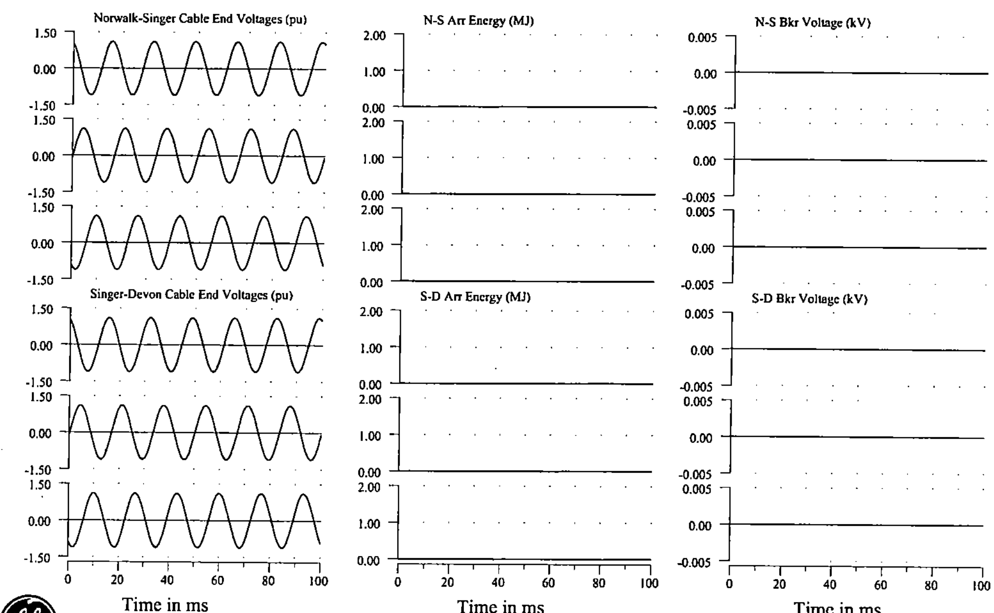
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_03
115 kV Bus Voltages and Capacitor Bank Locations



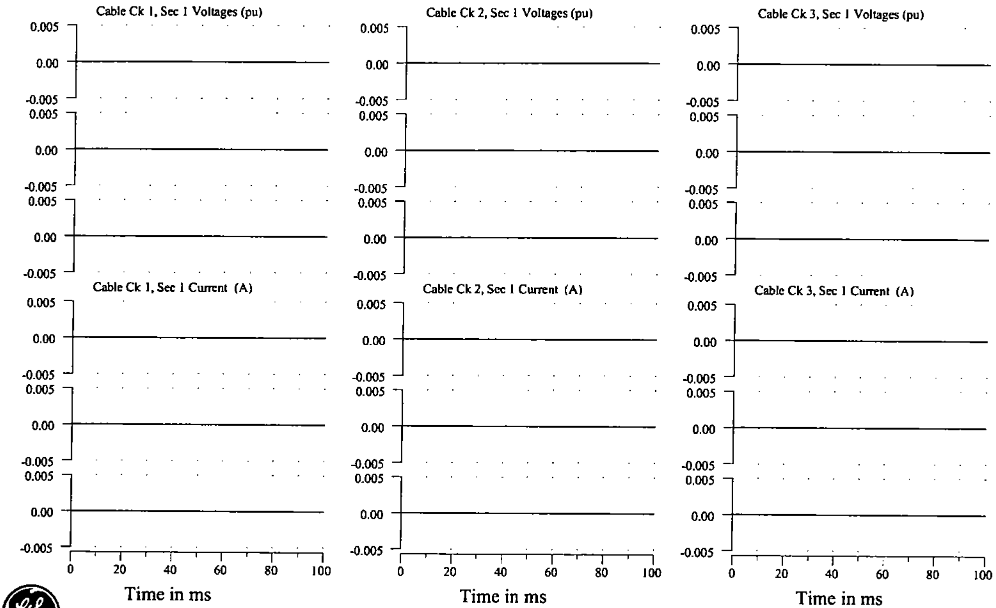
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_04
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



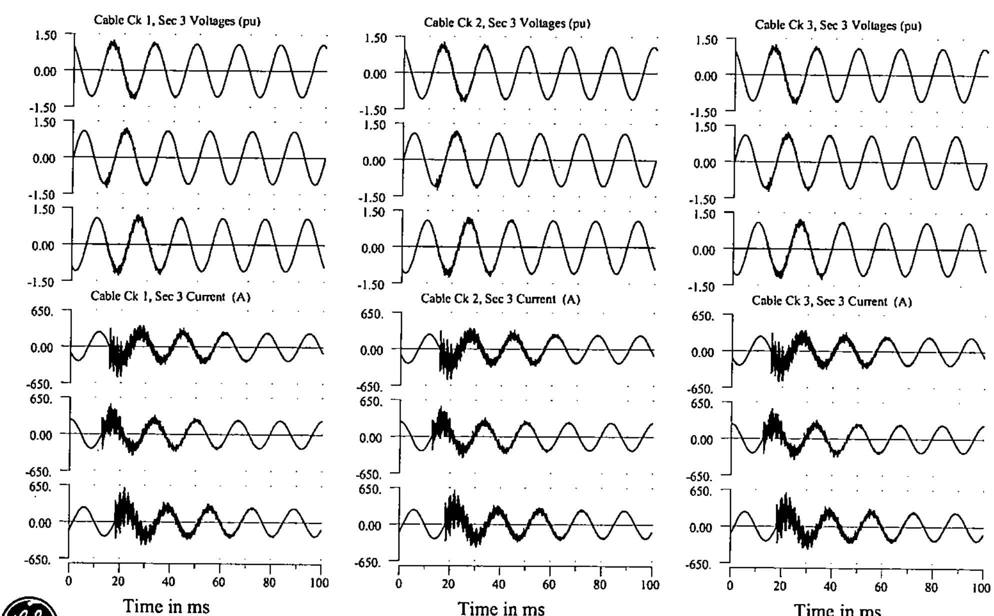
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_04
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



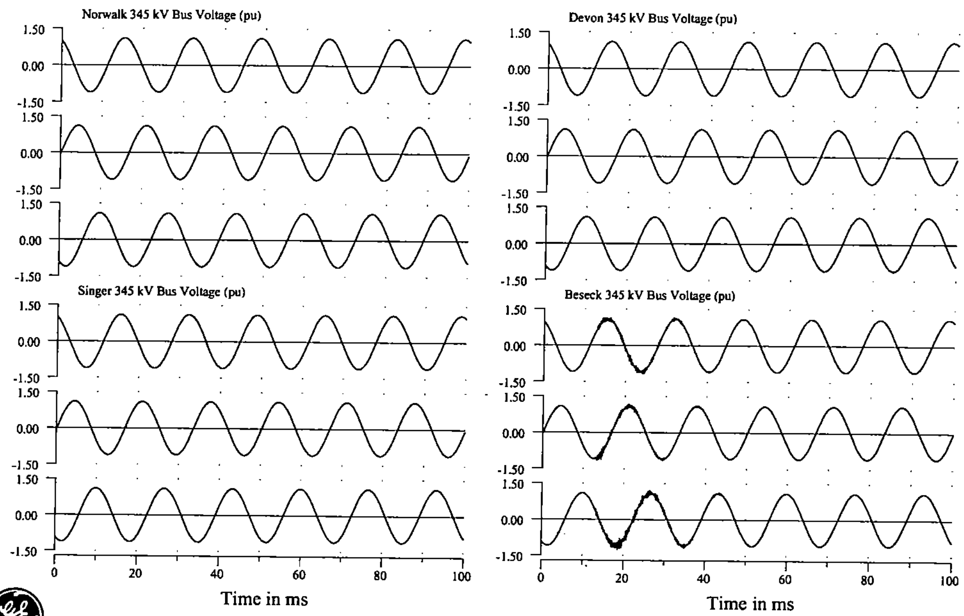
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_04
Devon-Beseck 345 kV Cables



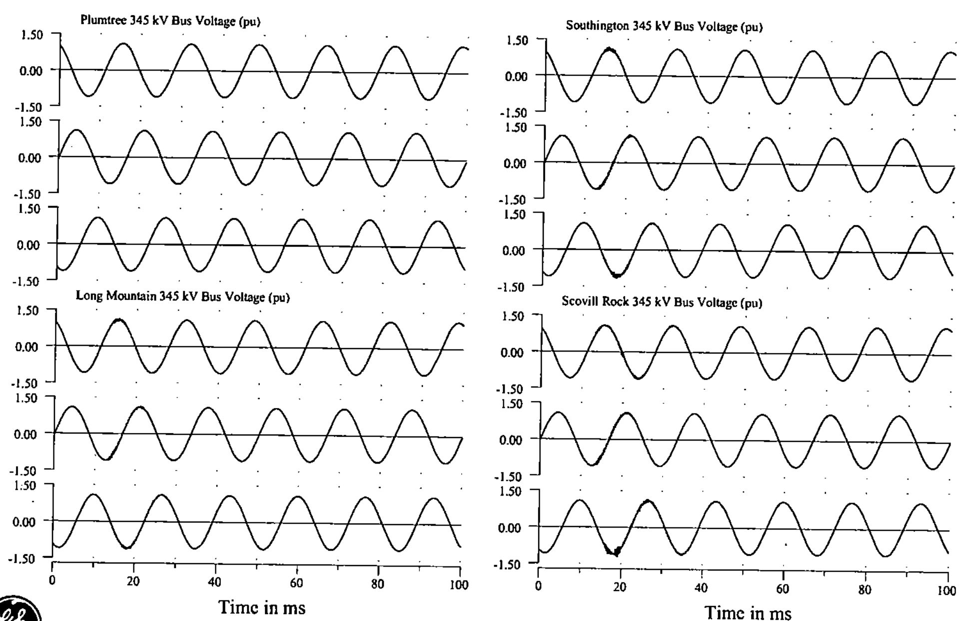
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_04
Devon-Beseck 345 kV Cables



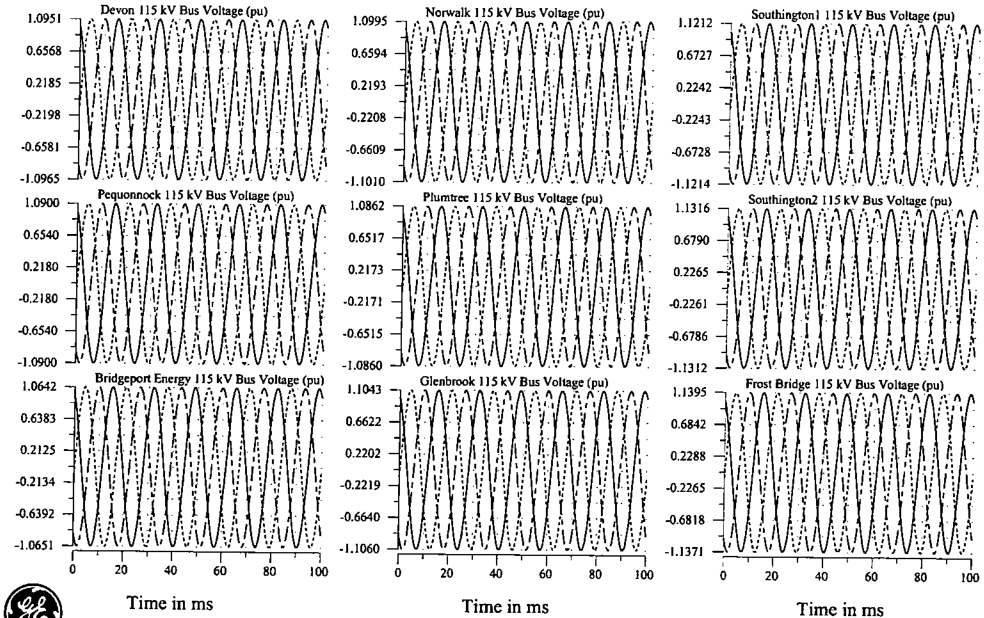
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_04
345 kV Bus Voltages



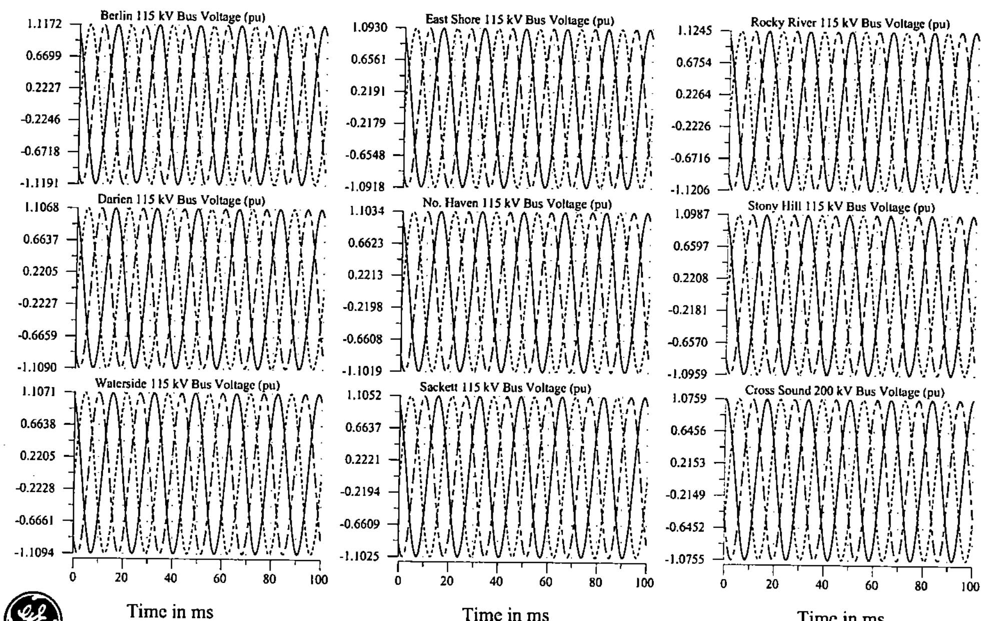
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_04
345 kV Bus Voltages



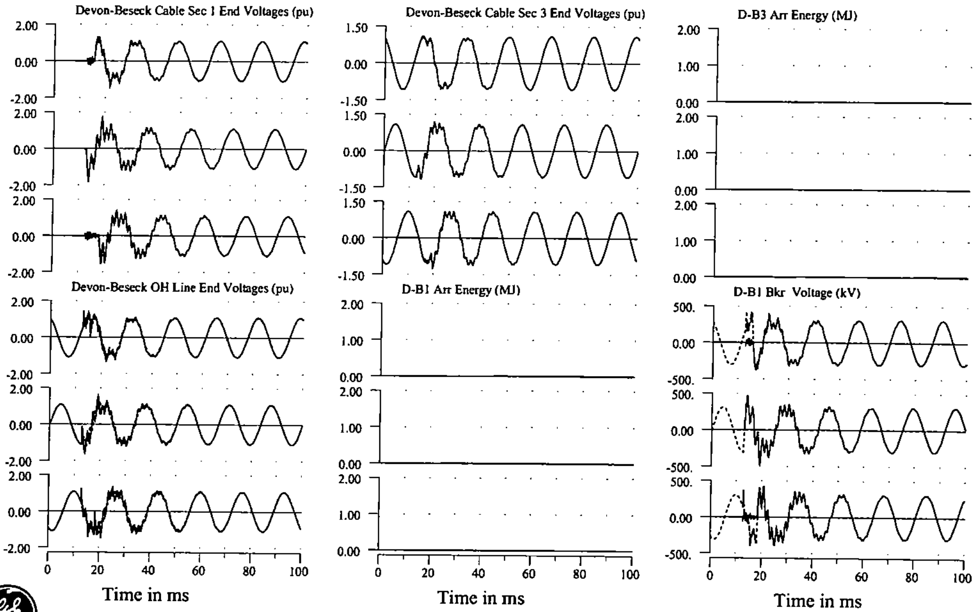
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_04
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_04
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_05
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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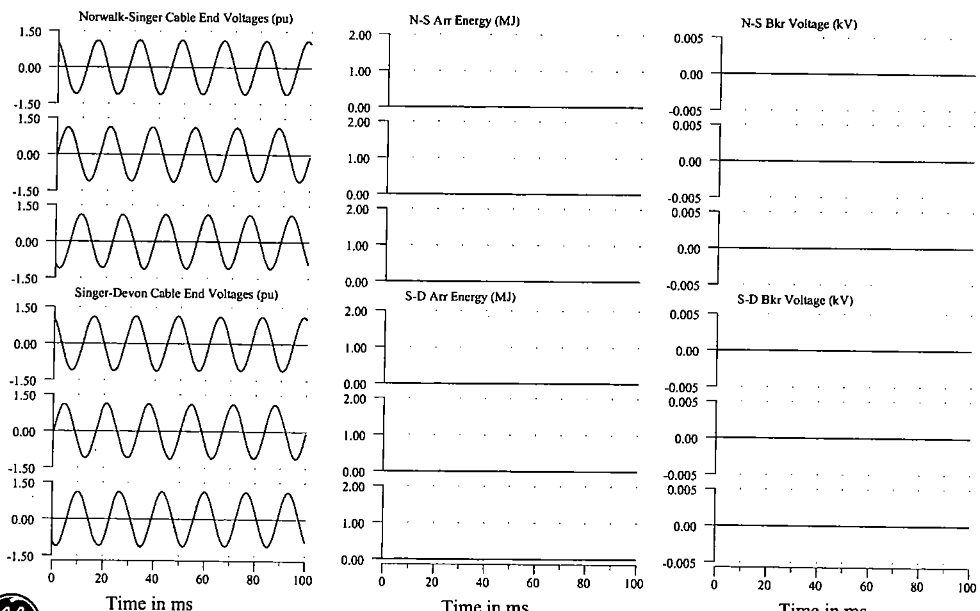
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_05
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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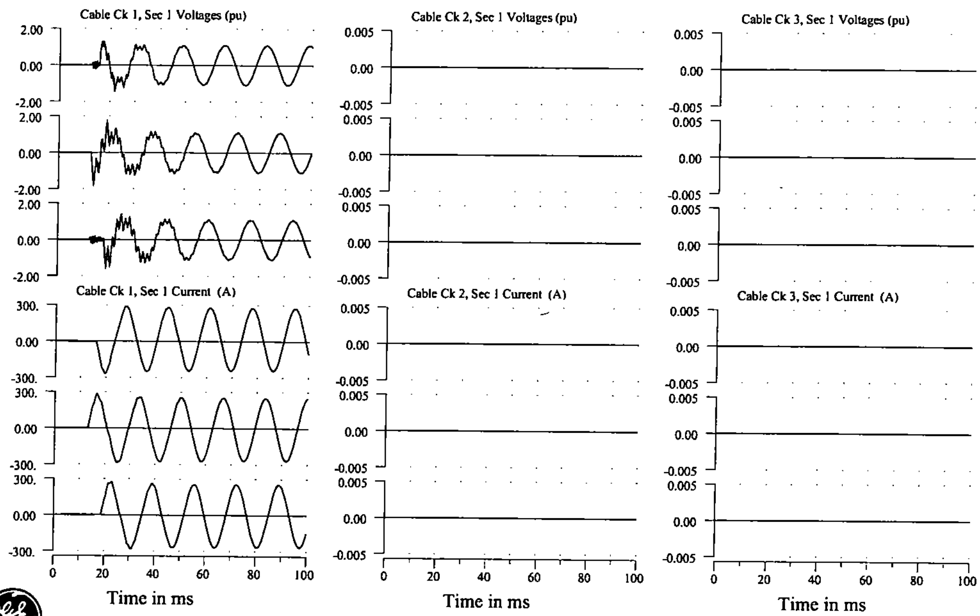
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_05
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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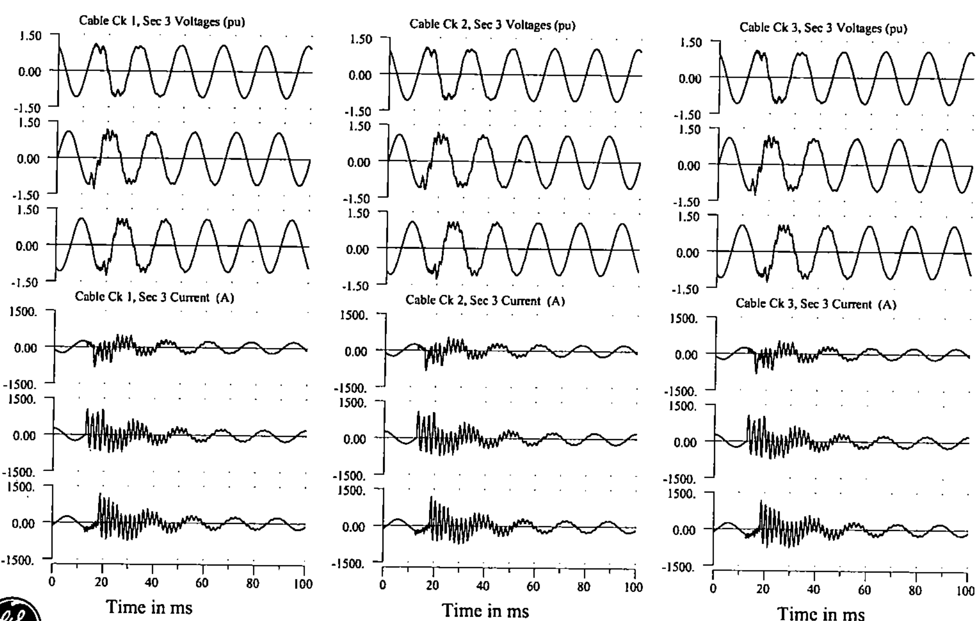
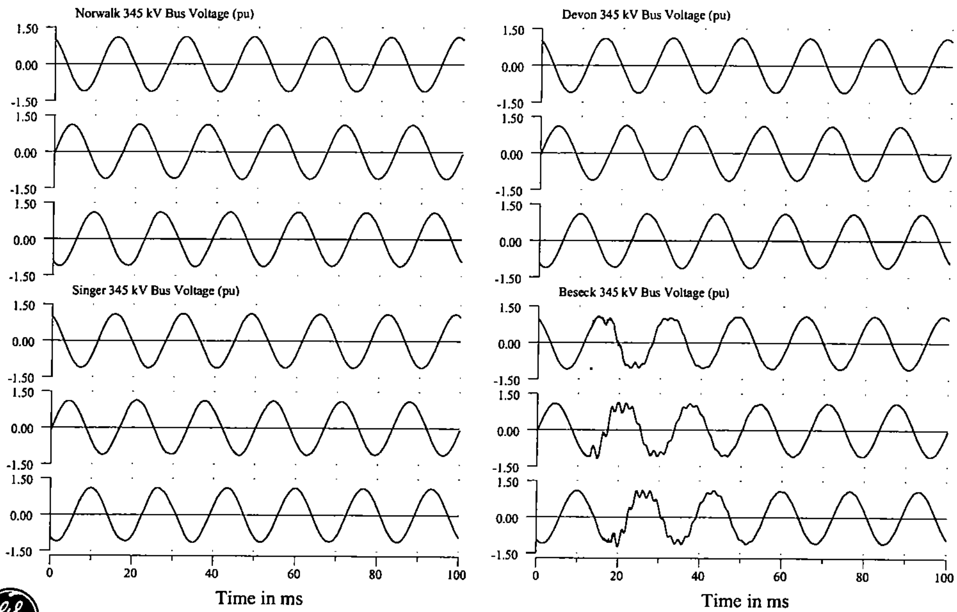
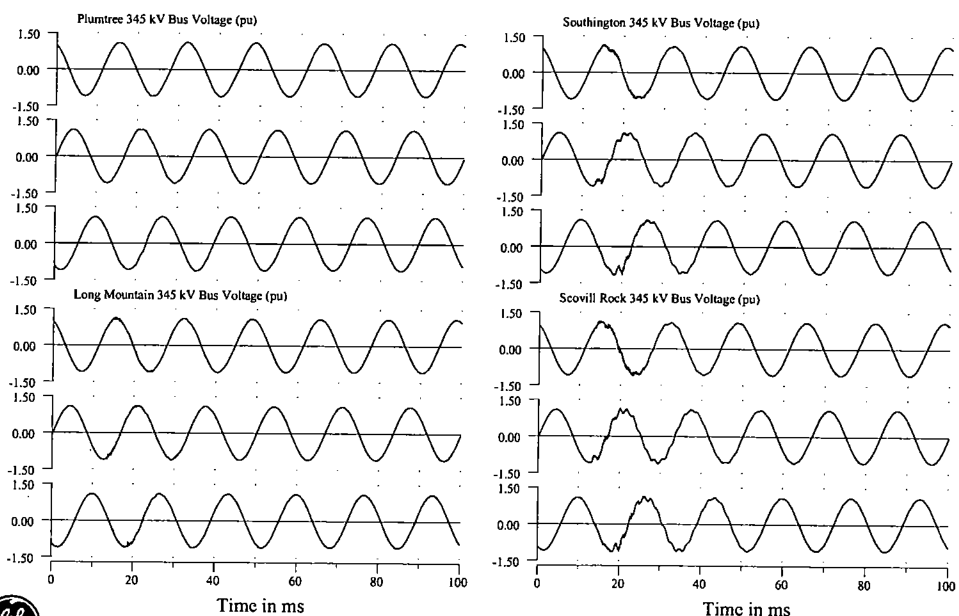
Devon-Beseck 345 kV Cables



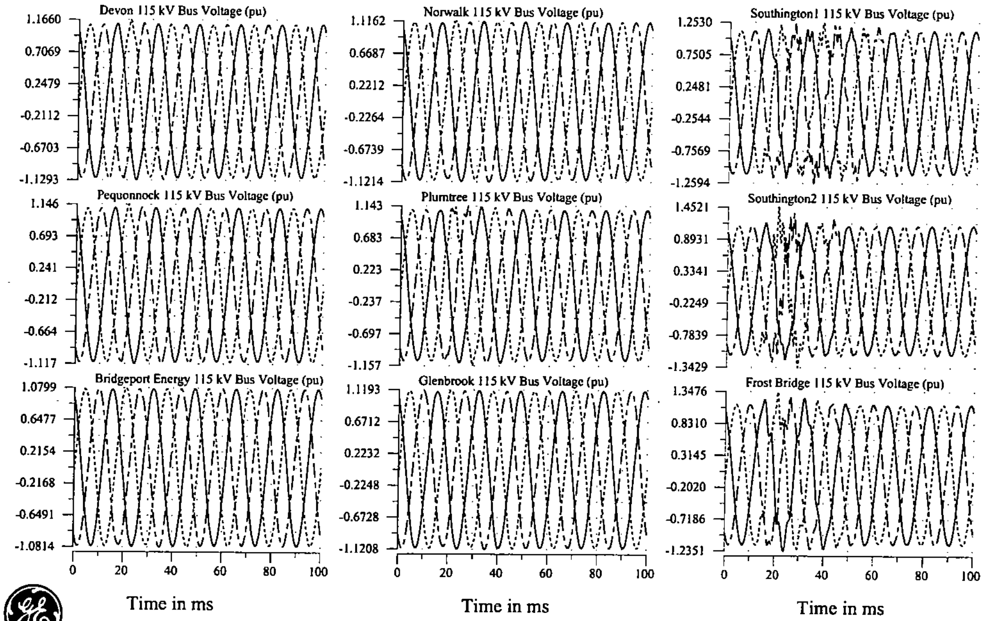
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_05
345 kV Bus Voltages



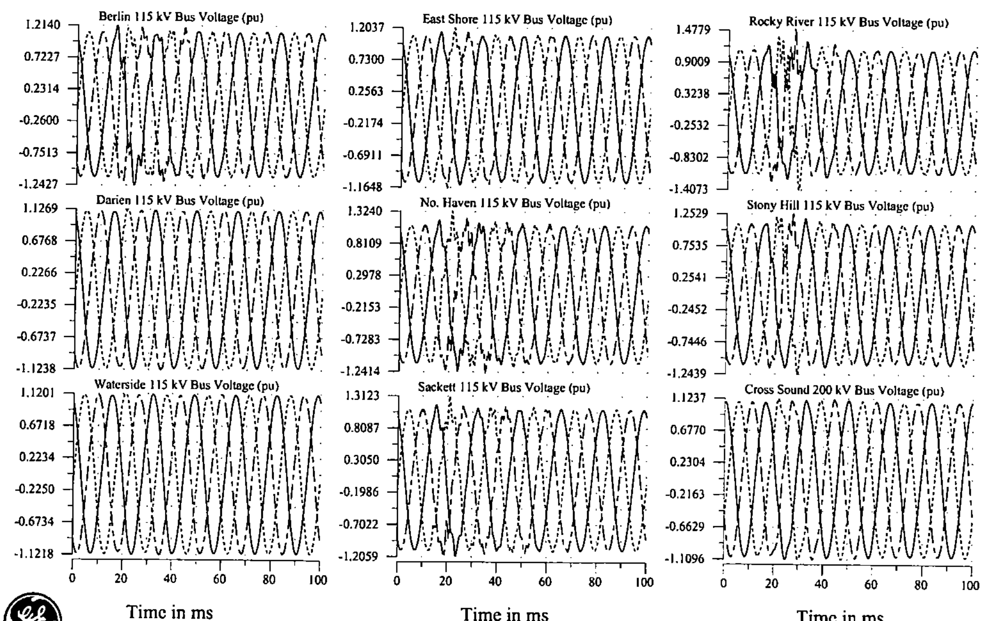
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_05
345 kV Bus Voltages



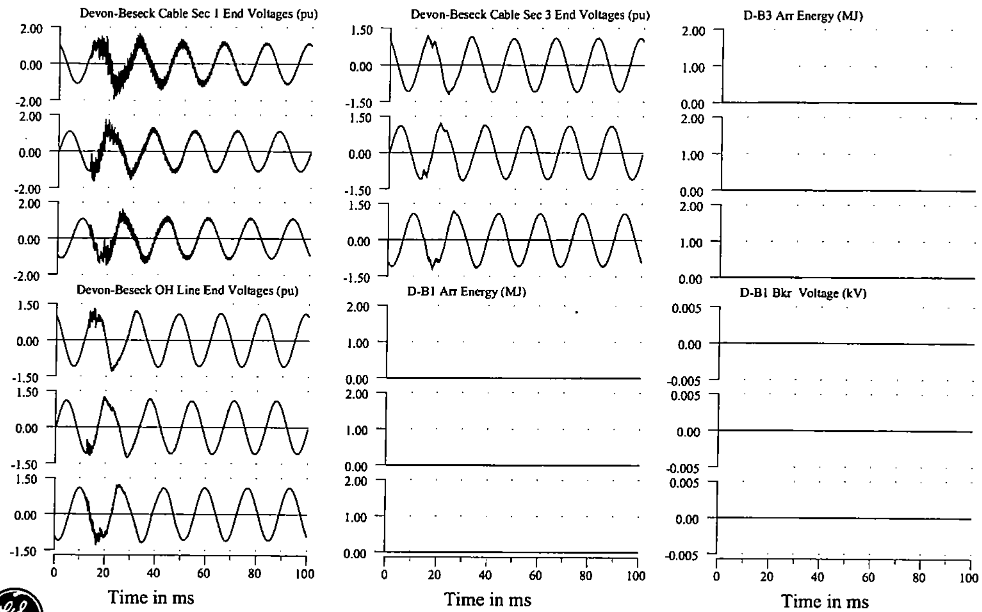
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_05
115 kV Bus Voltages and Capacitor Bank Locations



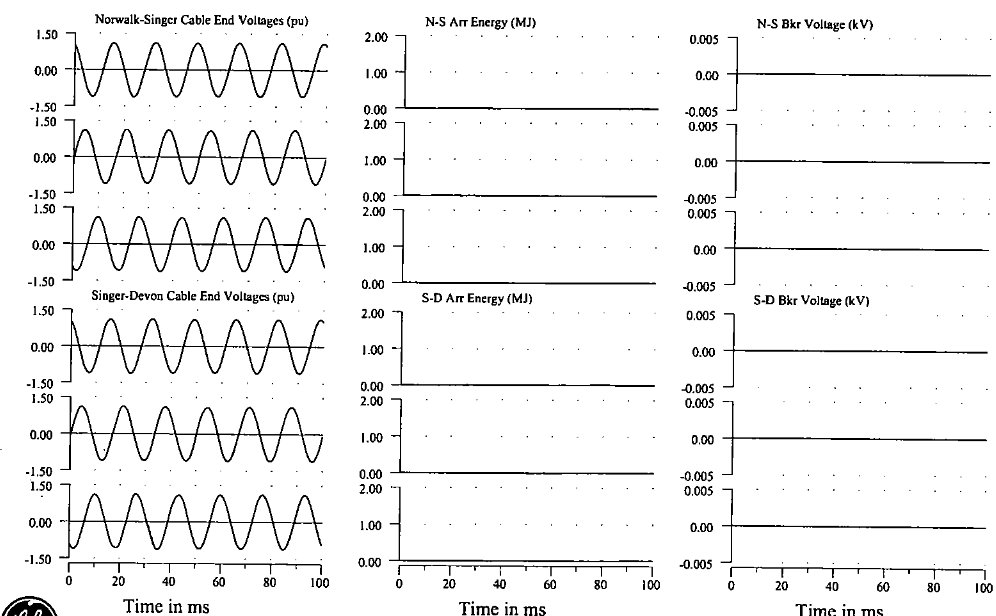
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_05
115 kV Bus Voltages and Capacitor Bank Locations



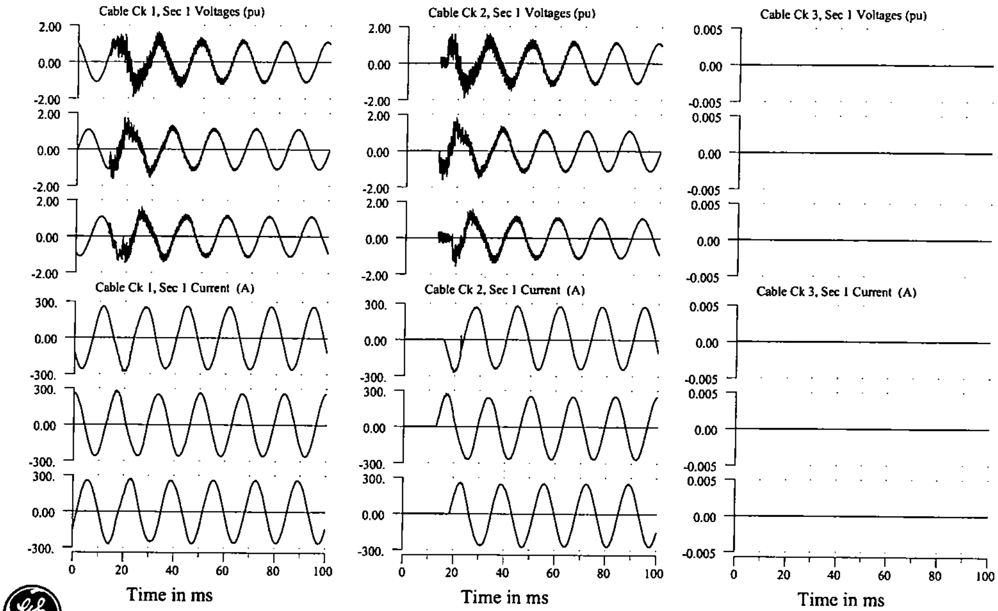
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_06
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



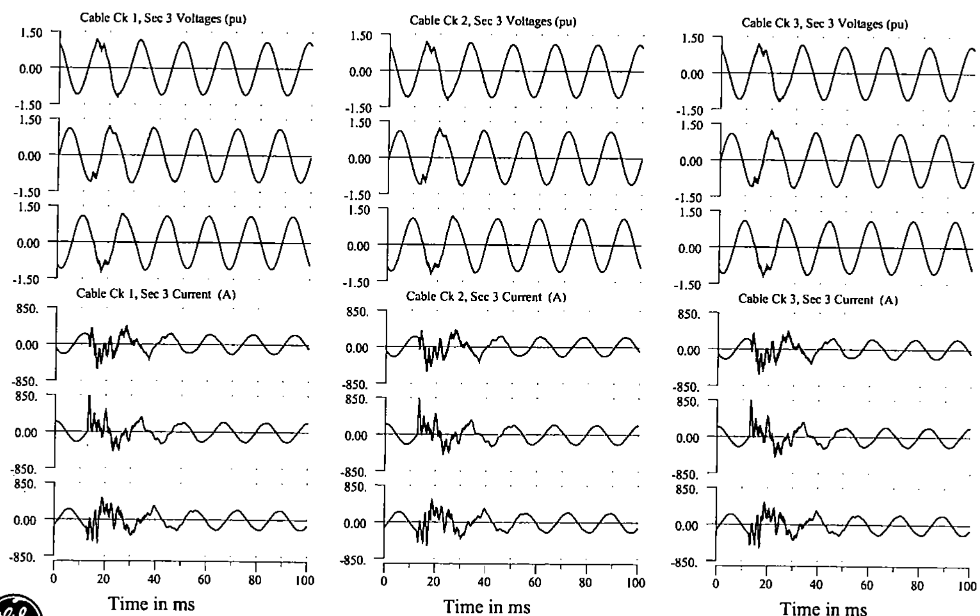
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_06
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_06
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_06
Devon-Beseck 345 kV Cables



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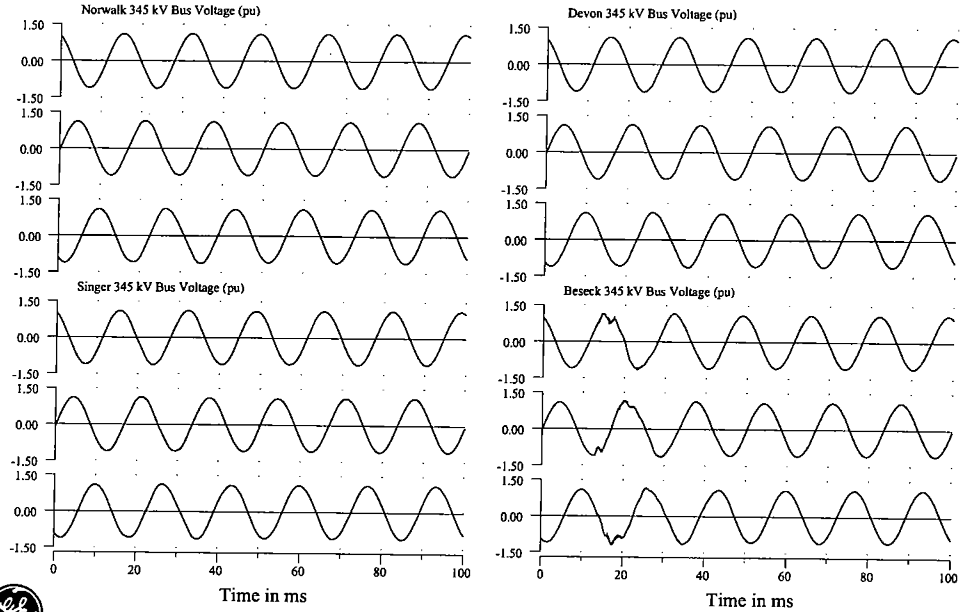
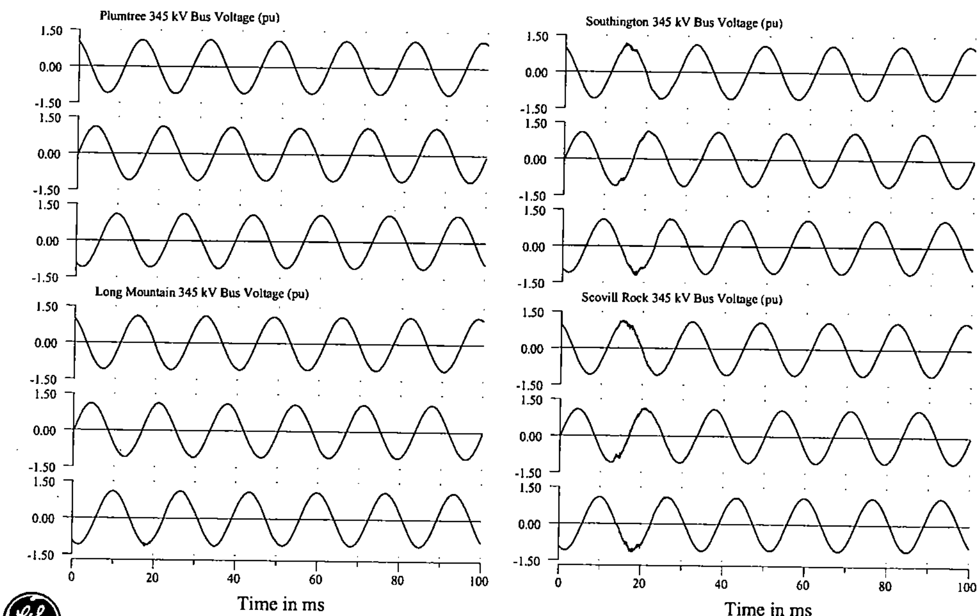
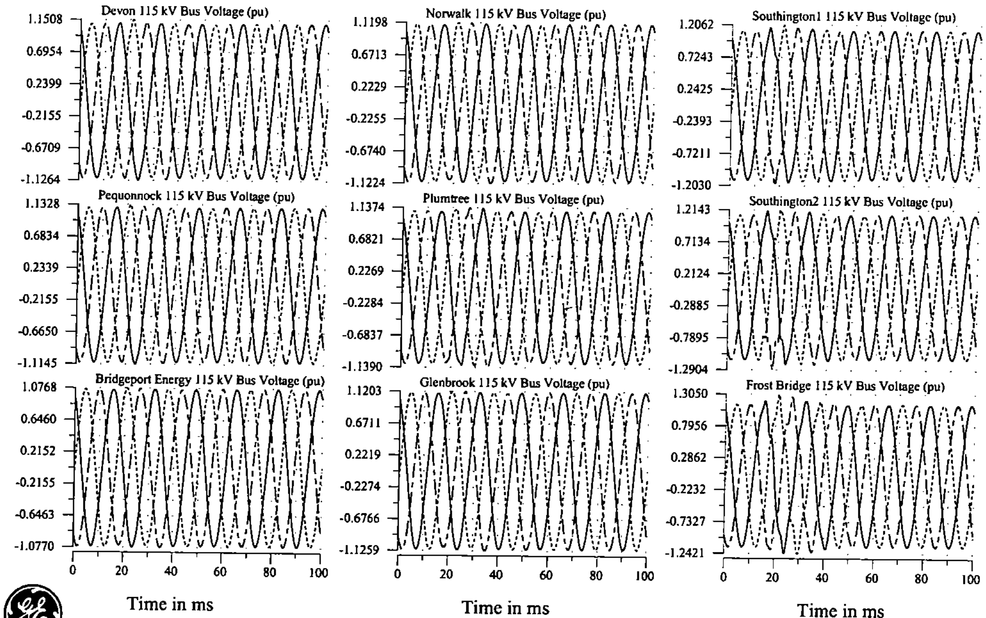
FEB_06
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_06
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_06
115 kV Bus Voltages and Capacitor Bank Locations



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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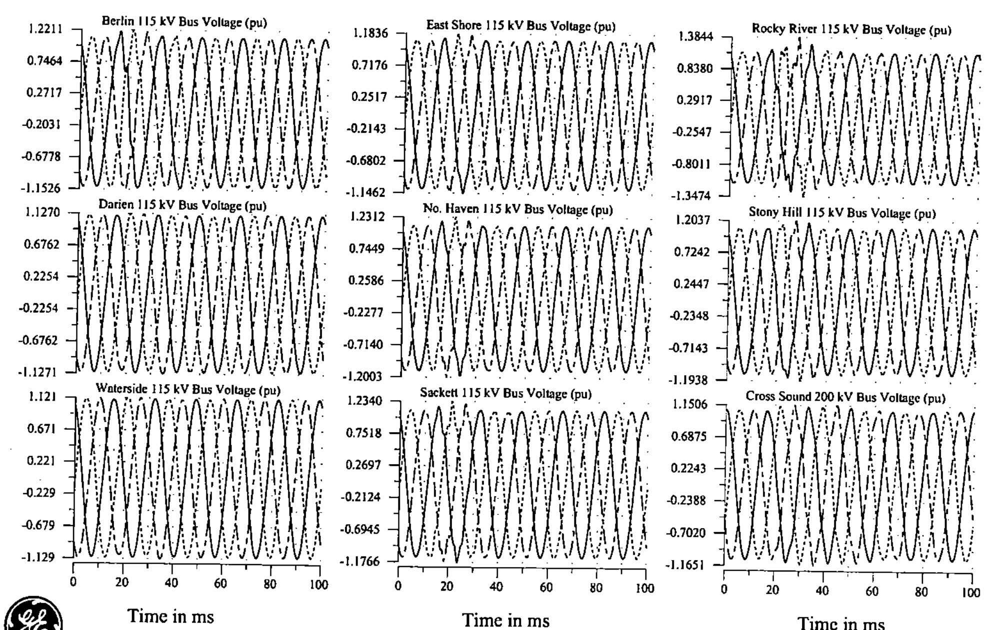
115 kV Bus Voltages and Capacitor Bank Locations



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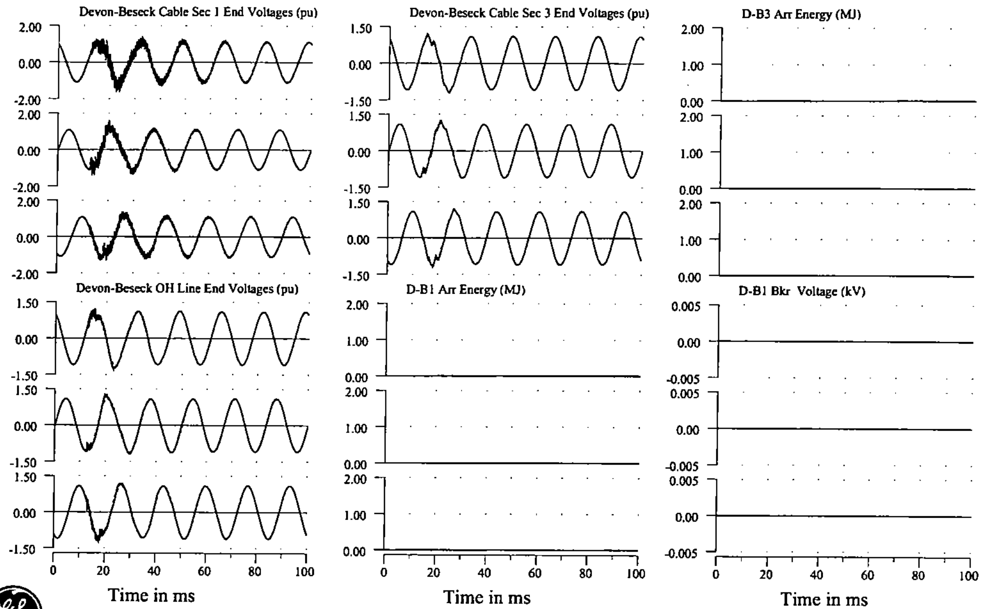
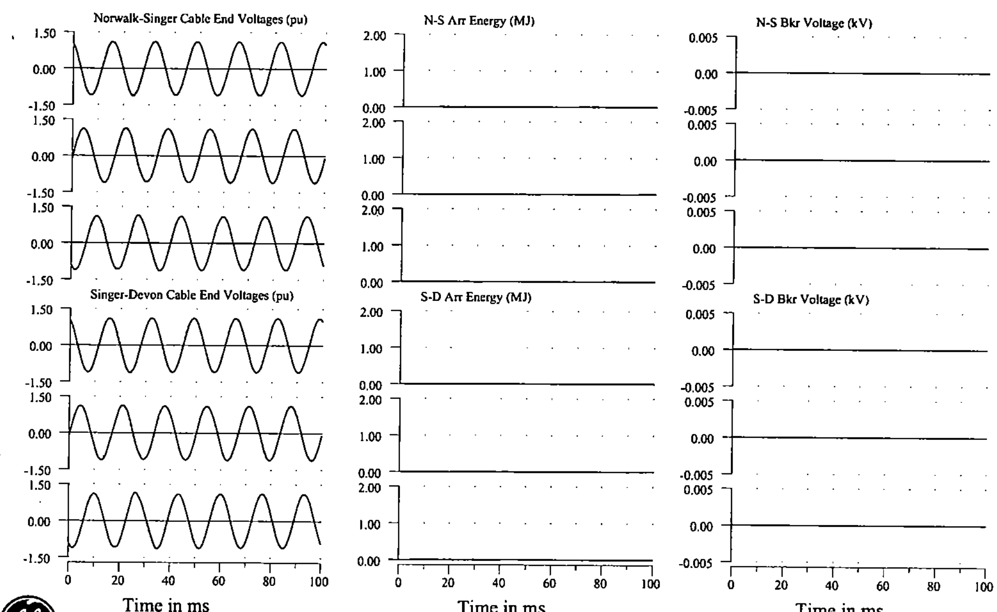
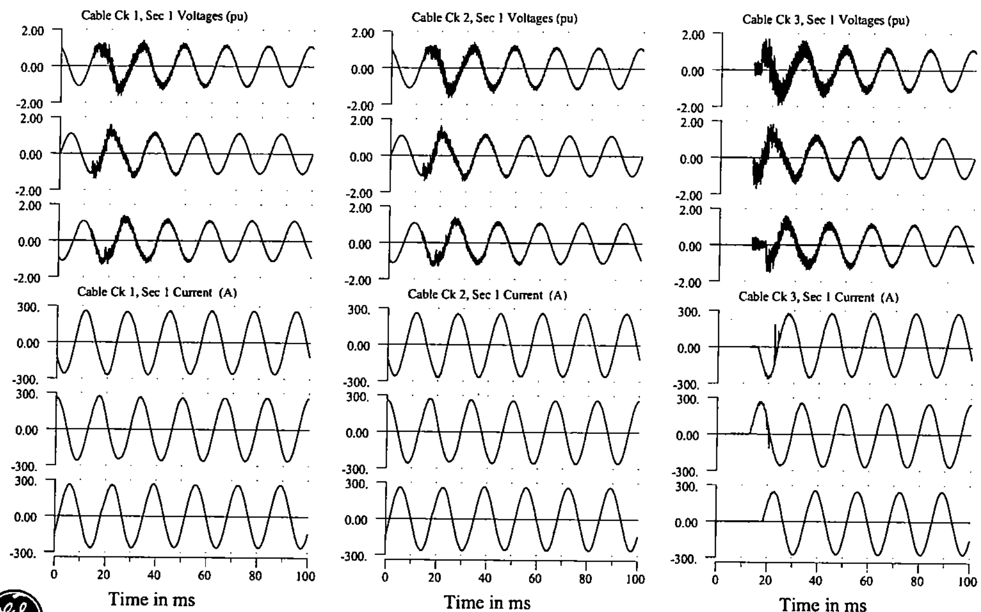
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_07
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



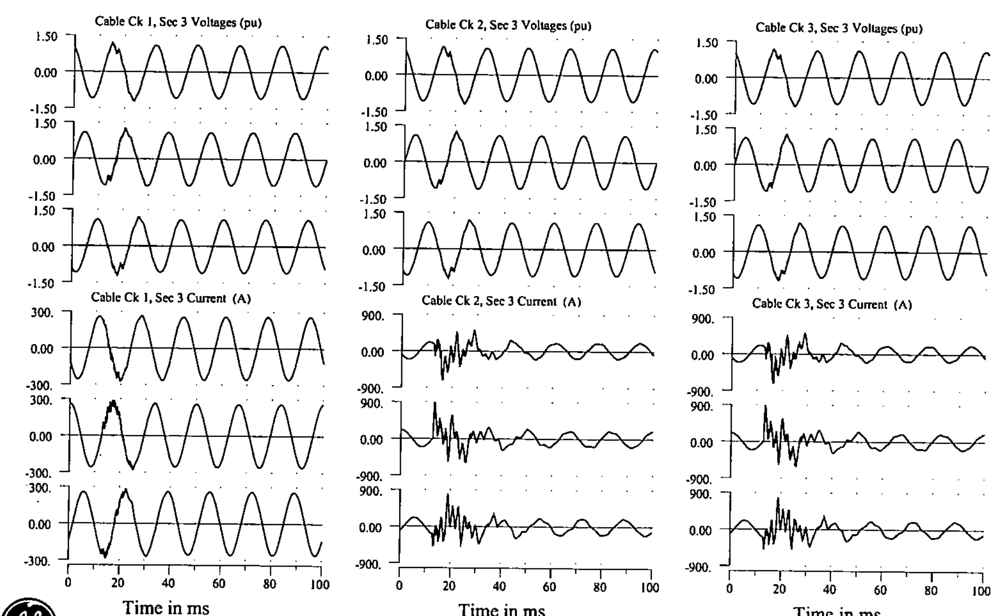
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_07
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



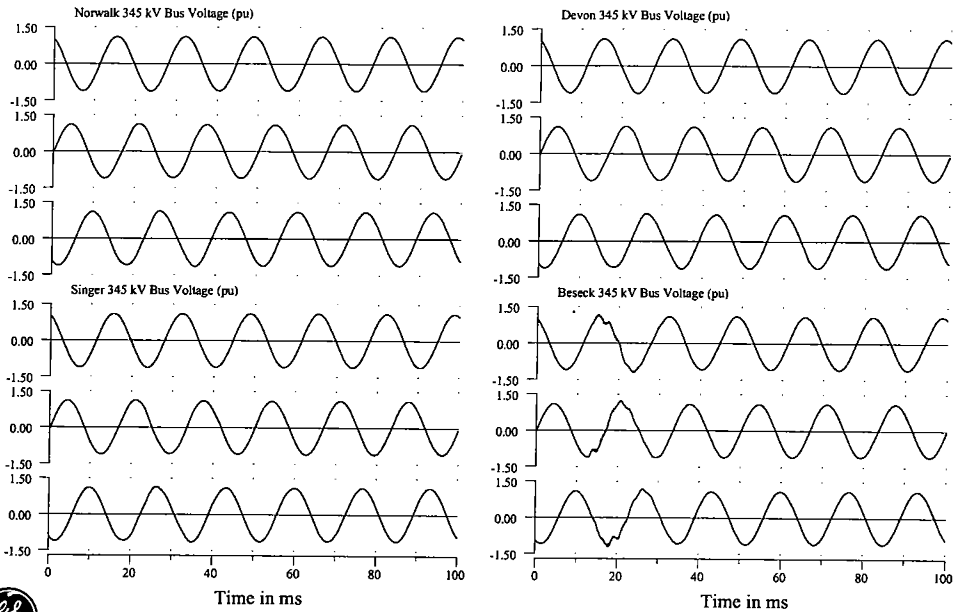
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_07
Devon-Beseck 345 kV Cables



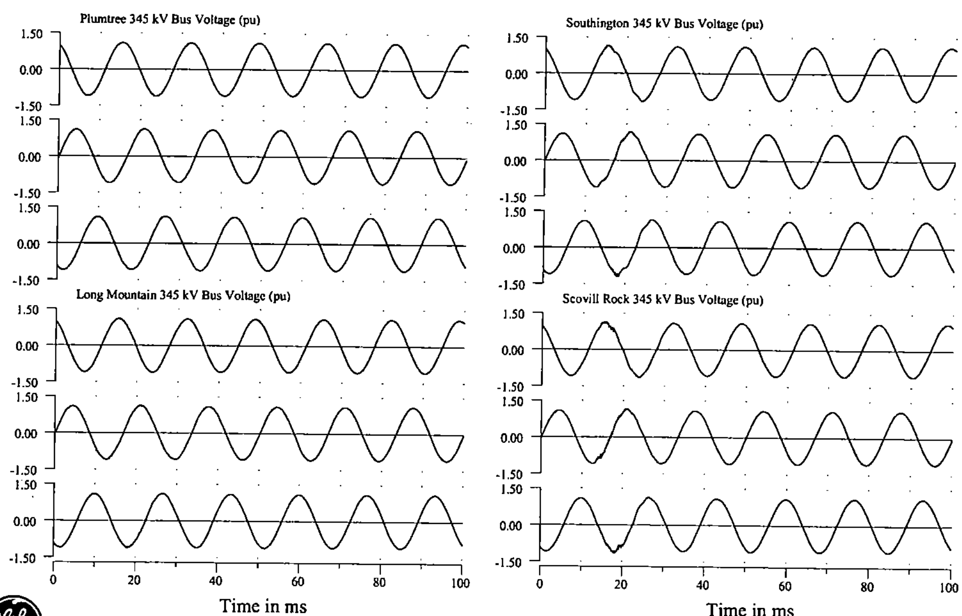
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_07
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_07
345 kV Bus Voltages



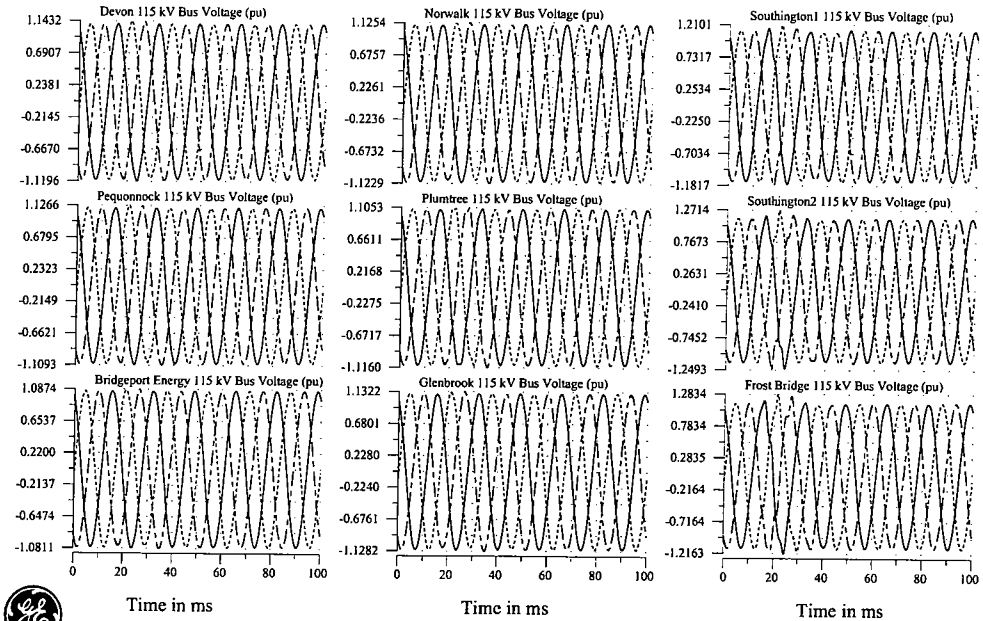
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_07
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FEB_07

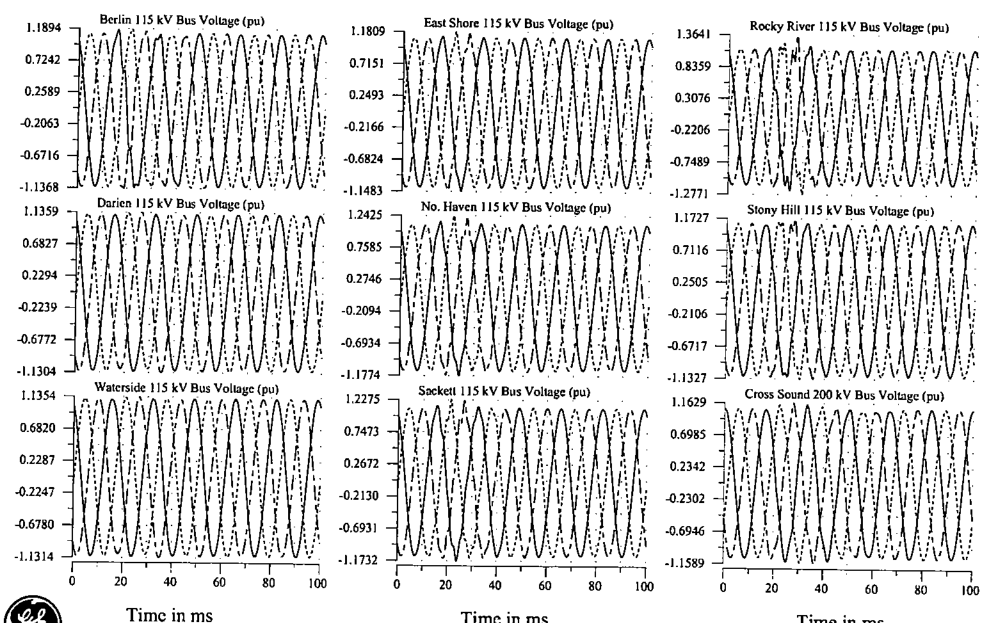
115 kV Bus Voltages and Capacitor Bank Locations



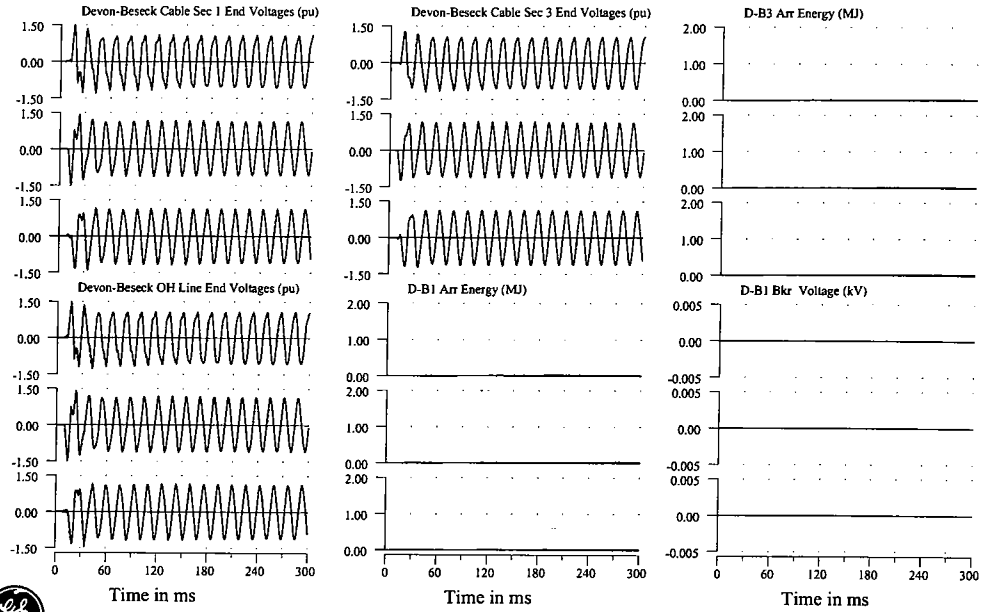
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FEB_07

115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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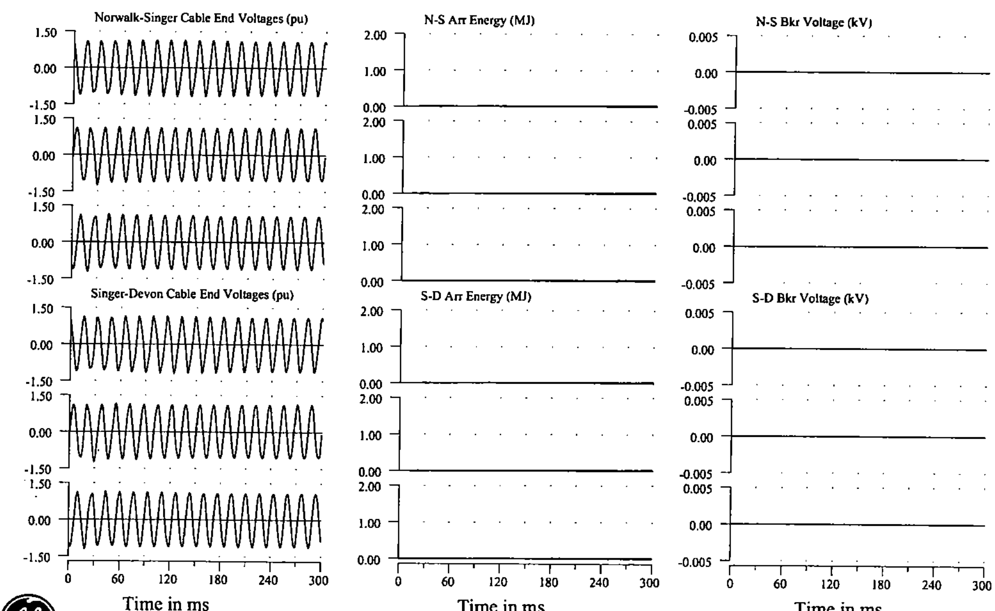
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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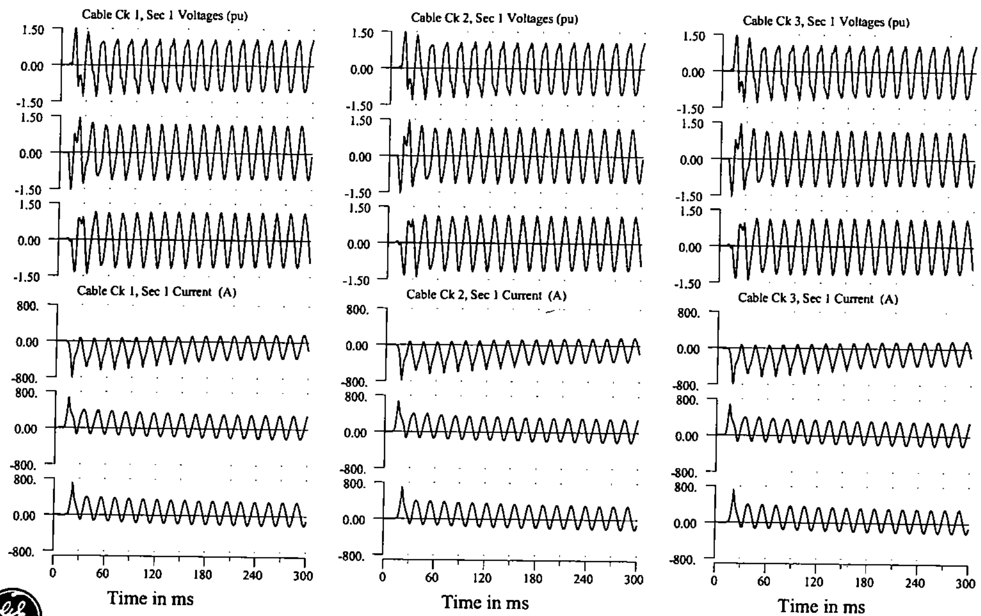
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FEB_08

Devon-Beseck 345 kV Cables



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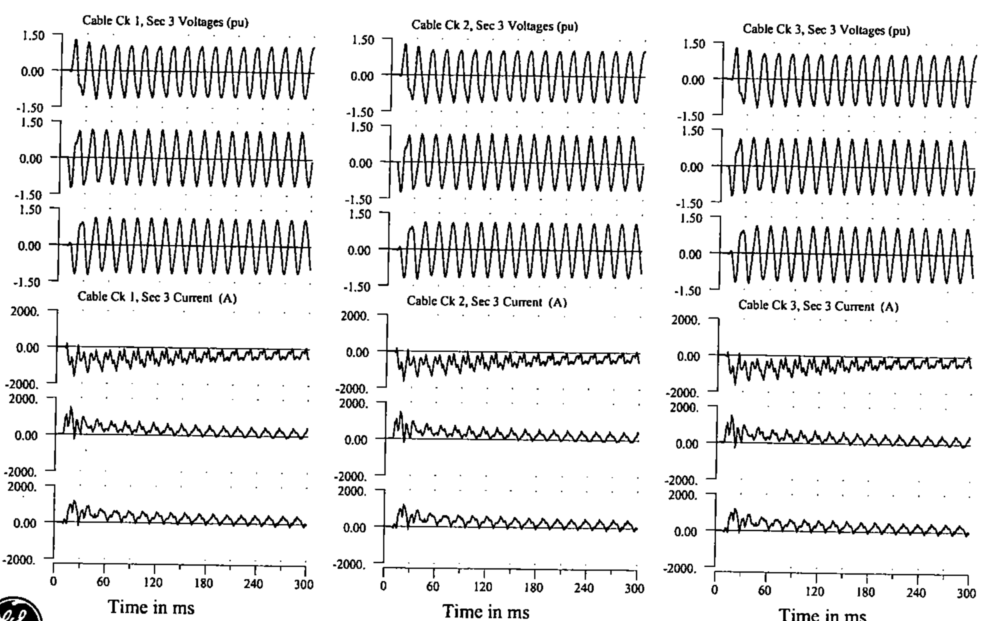
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

FEB_08

Devon-Beseck 345 kV Cables



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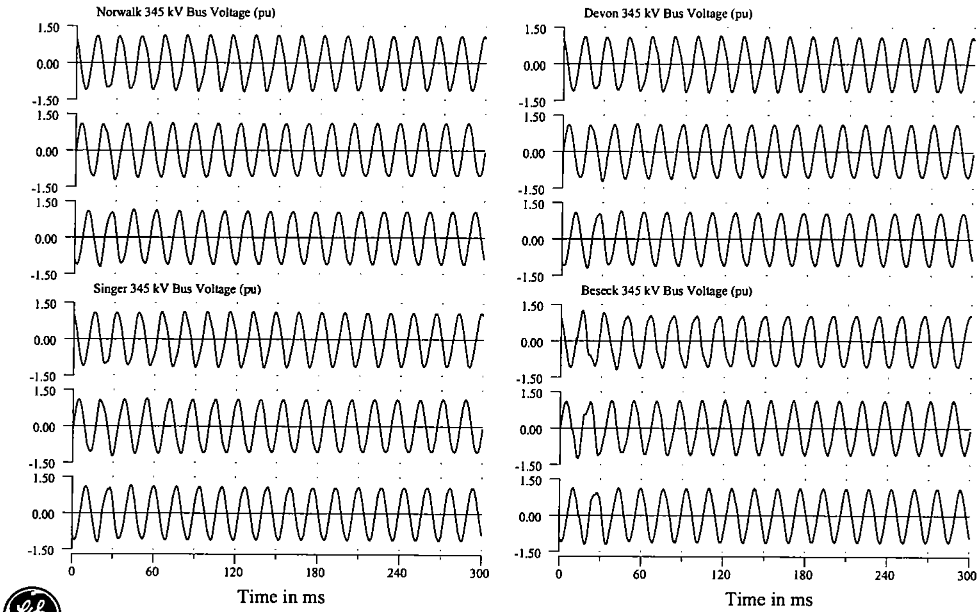
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08
345 kV Bus Voltages



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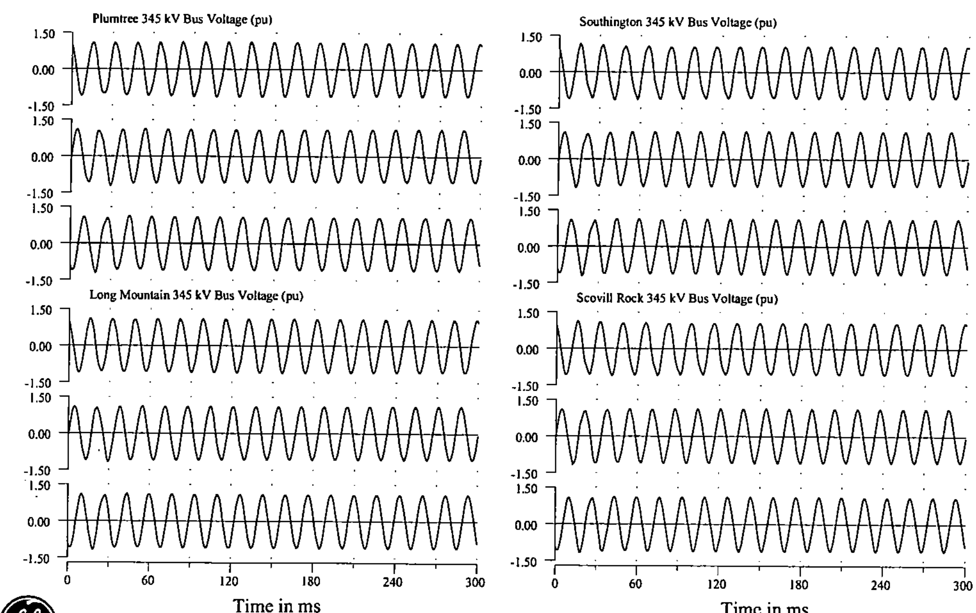
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08
345 kV Bus Voltages



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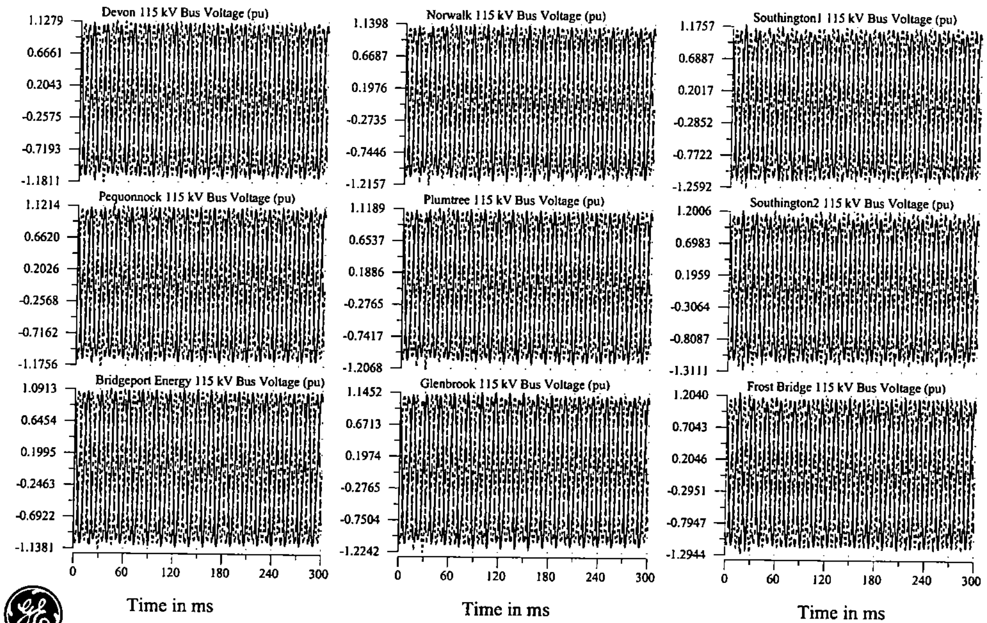
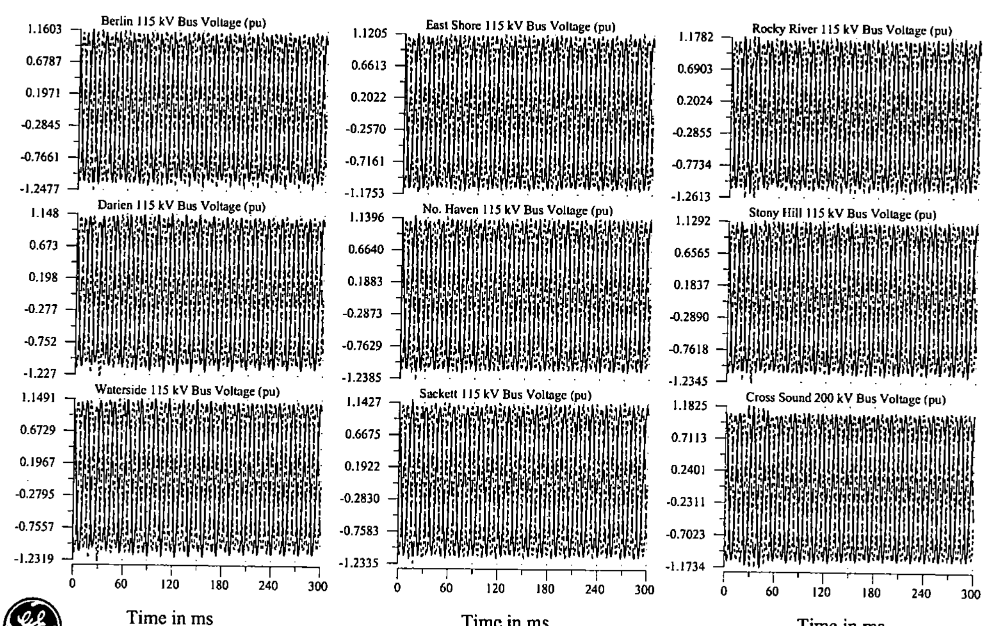
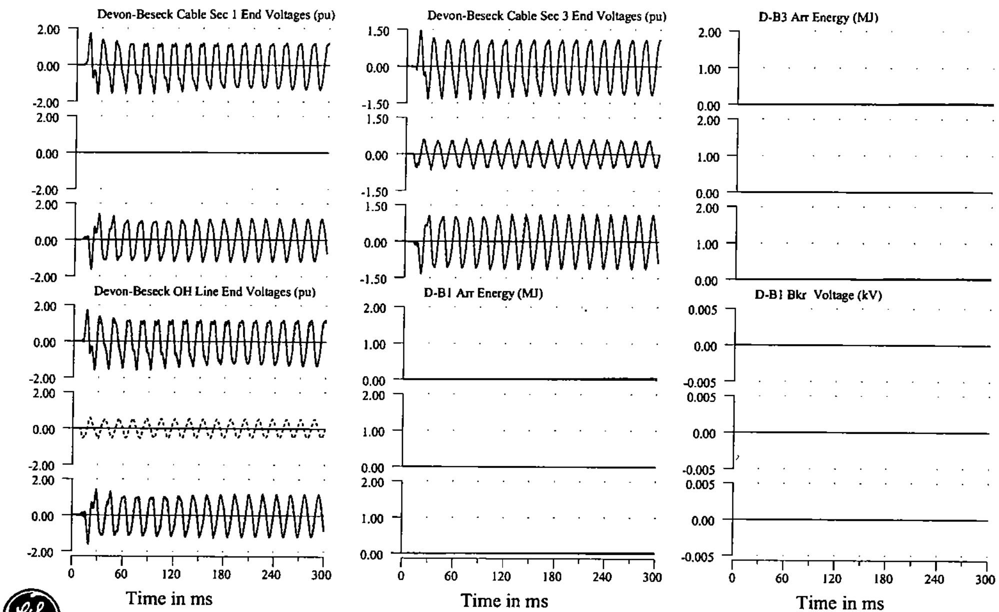
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08A
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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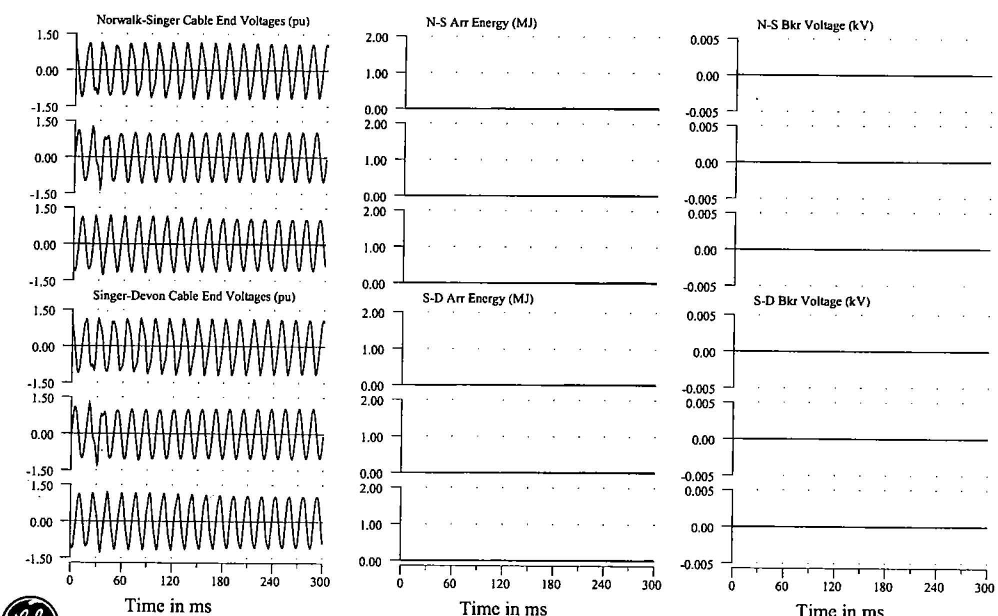
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08A
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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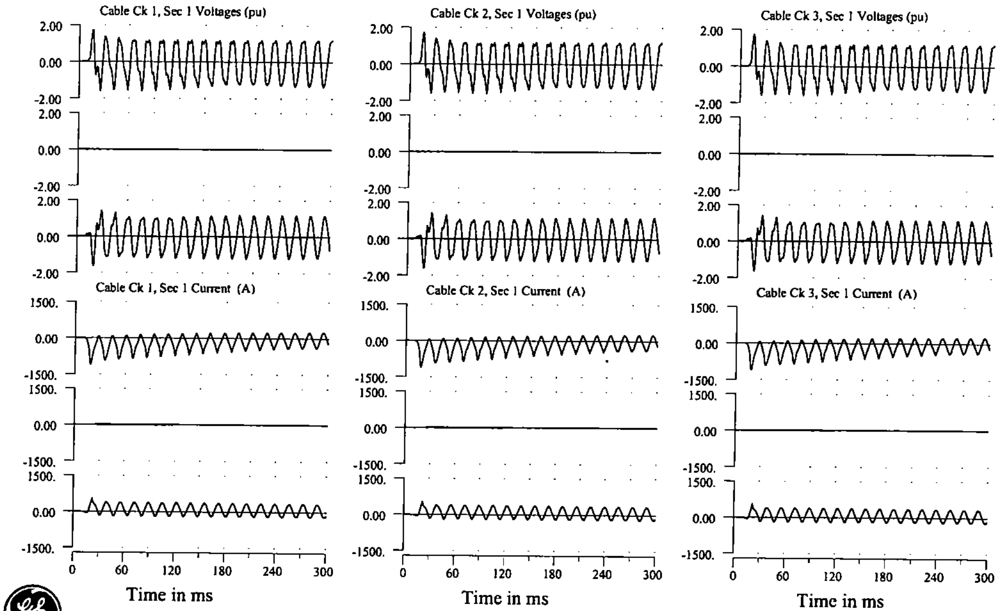
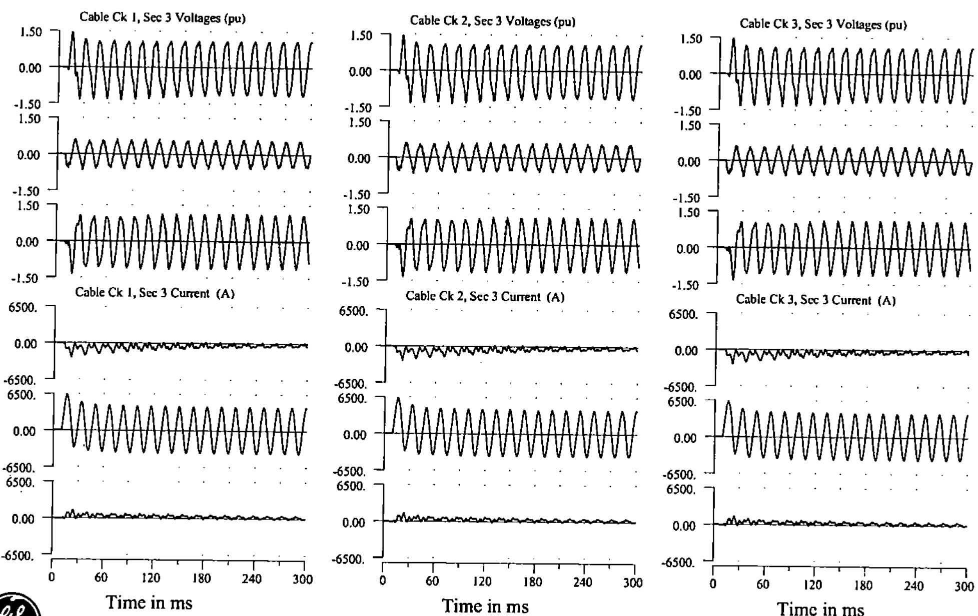
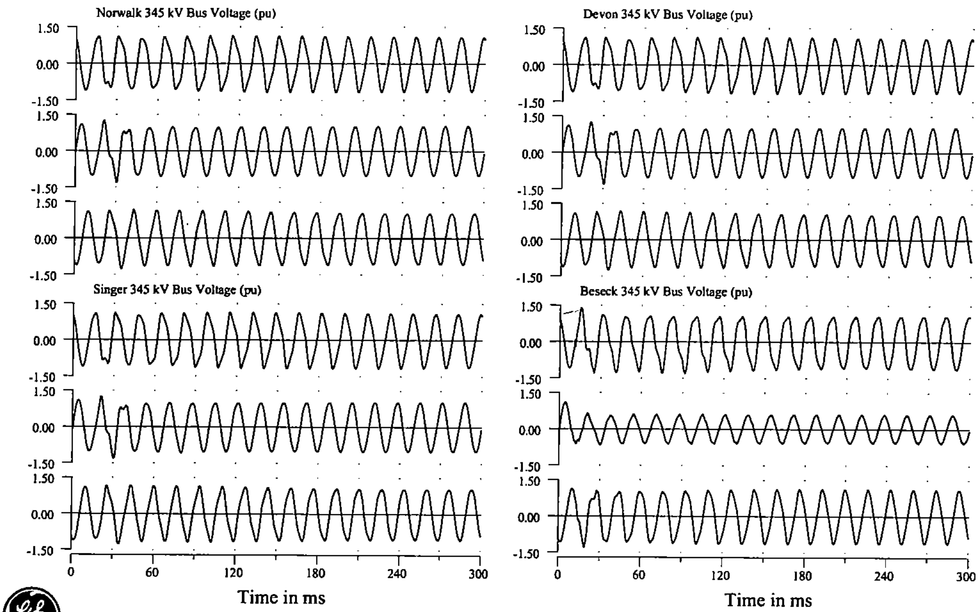
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08A
Devon-Beseck 345 kV Cables



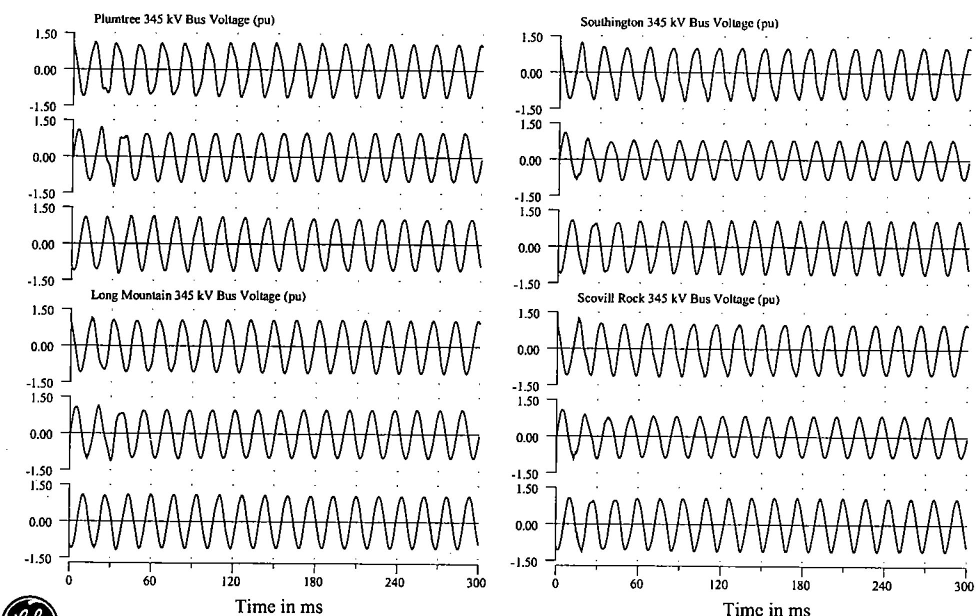
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08A
Devon-Beseck 345 kV Cables



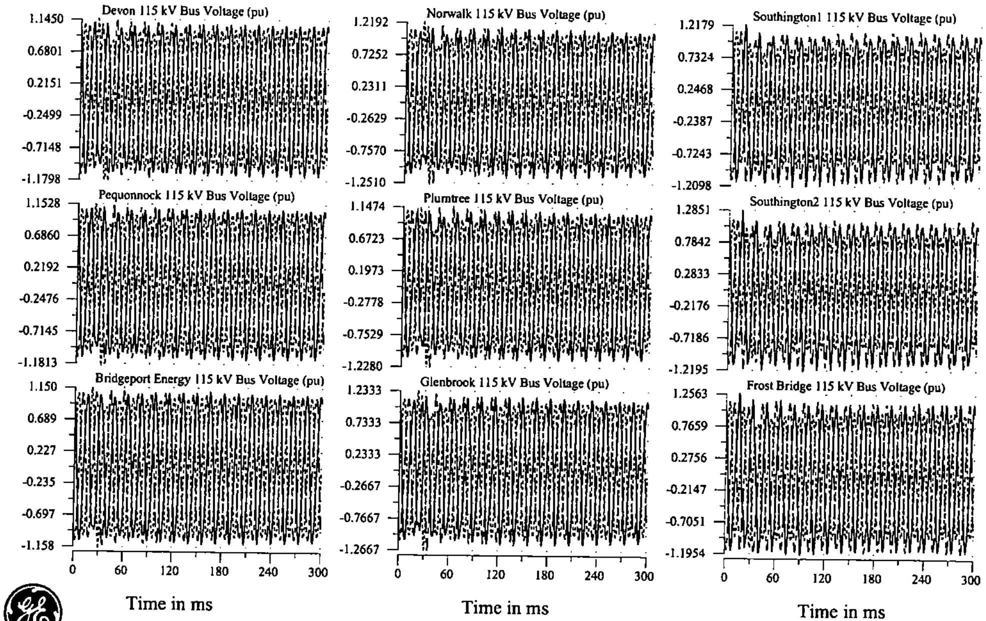
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08A
345 kV Bus Voltages



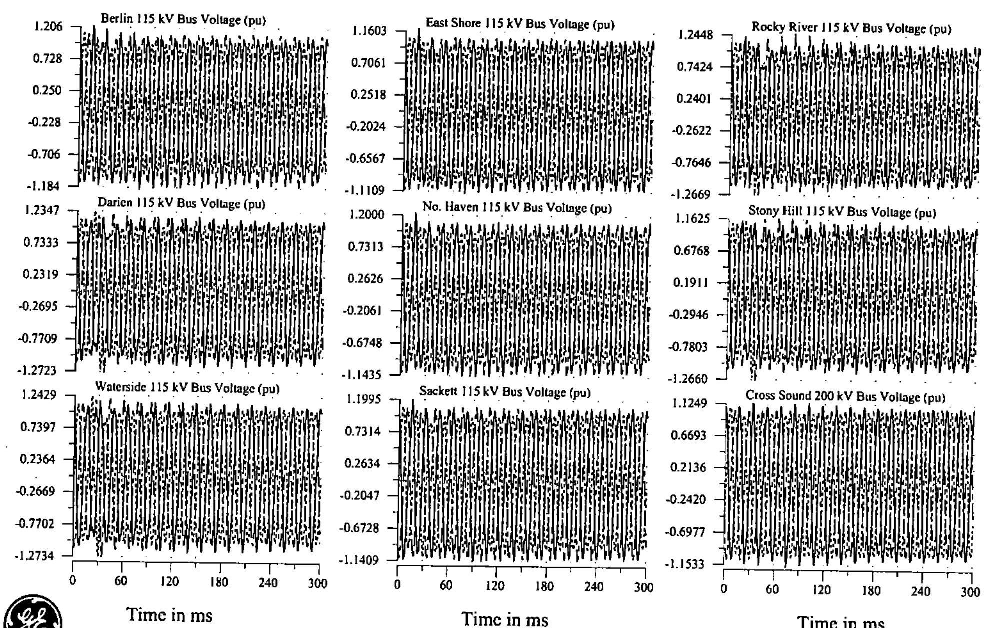
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08A
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08A
11A5 kV Bus Voltages and Capacitor Bank Locations



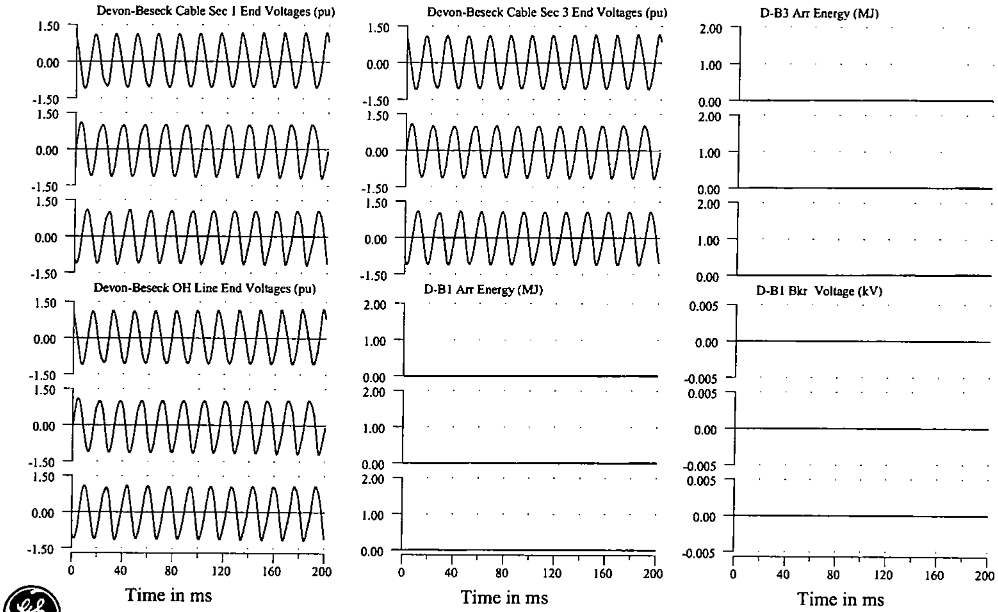
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
FEB_08A
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_01

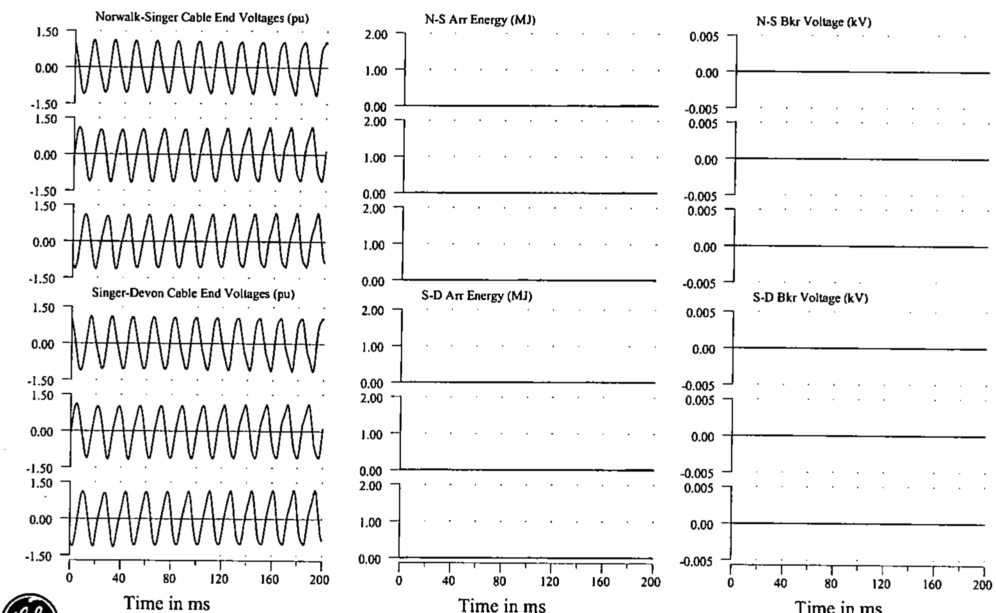
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_01

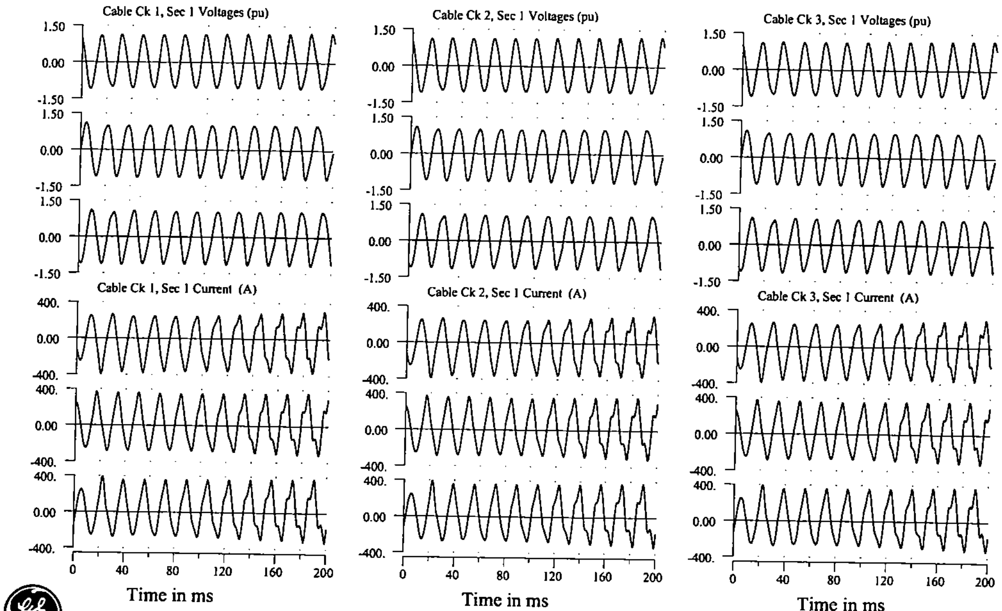
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_01

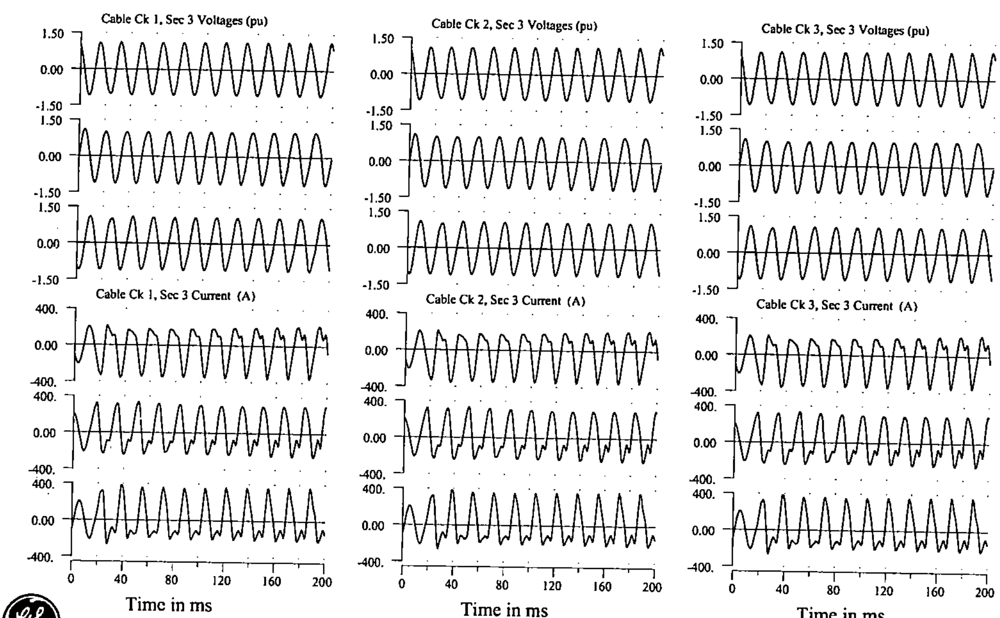
Devon-Beseck 345 kV Cables



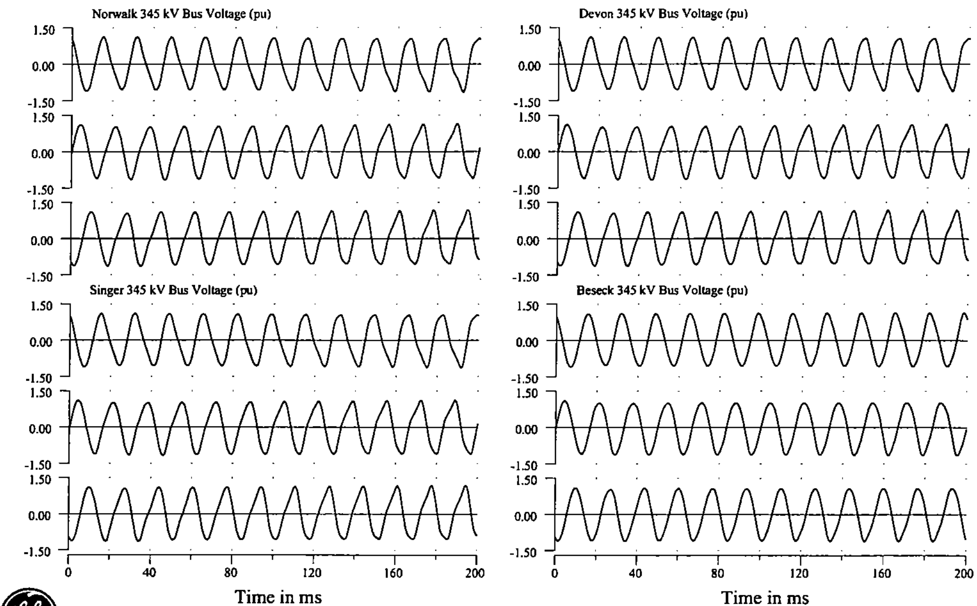
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_01

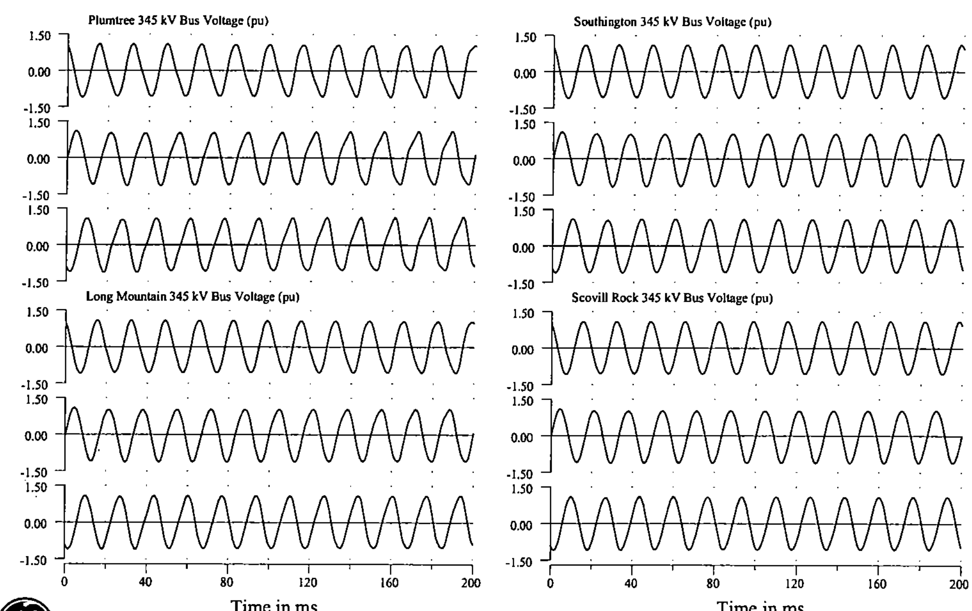
Devon-Beseck 345 kV Cables



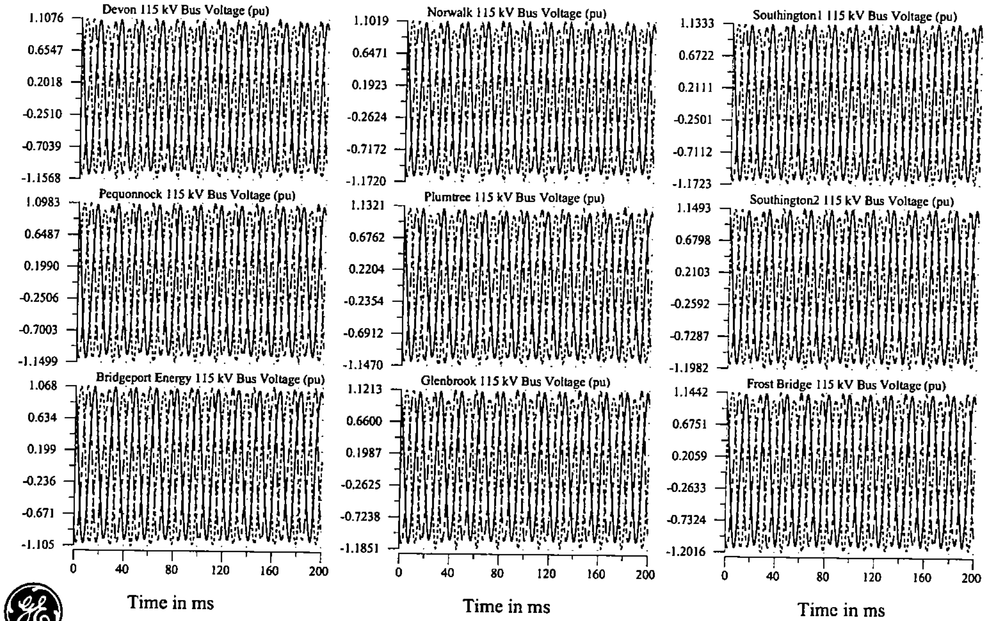
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01
115 kV Bus Voltages and Capacitor Bank Locations



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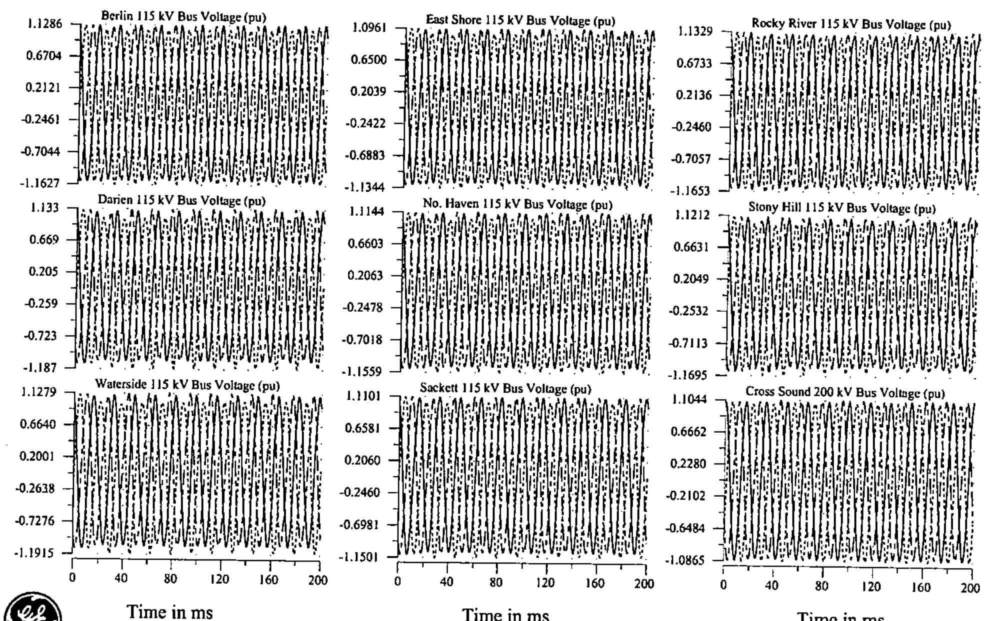
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01
115 kV Bus Voltages and Capacitor Bank Locations



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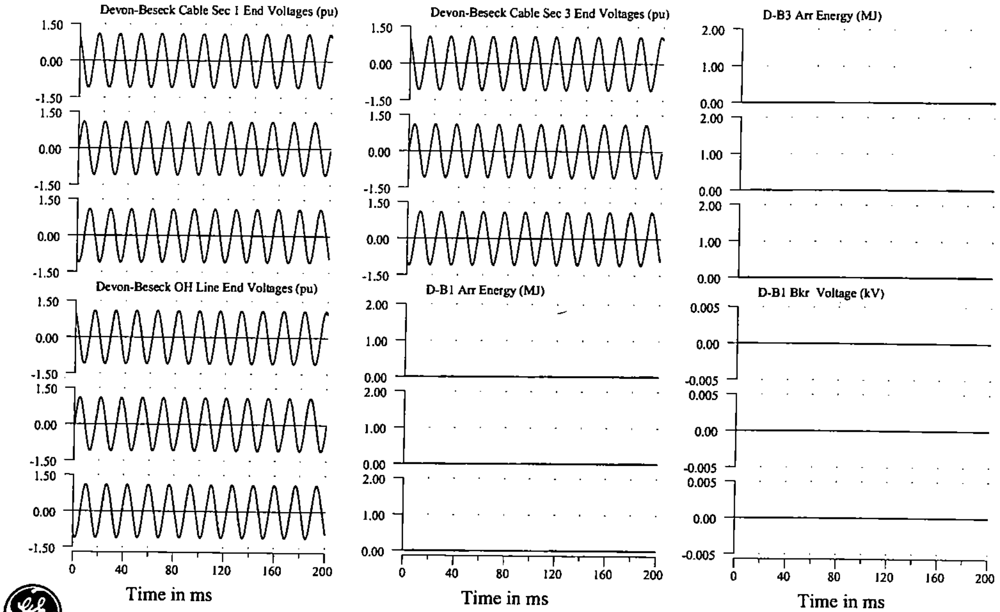
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01R
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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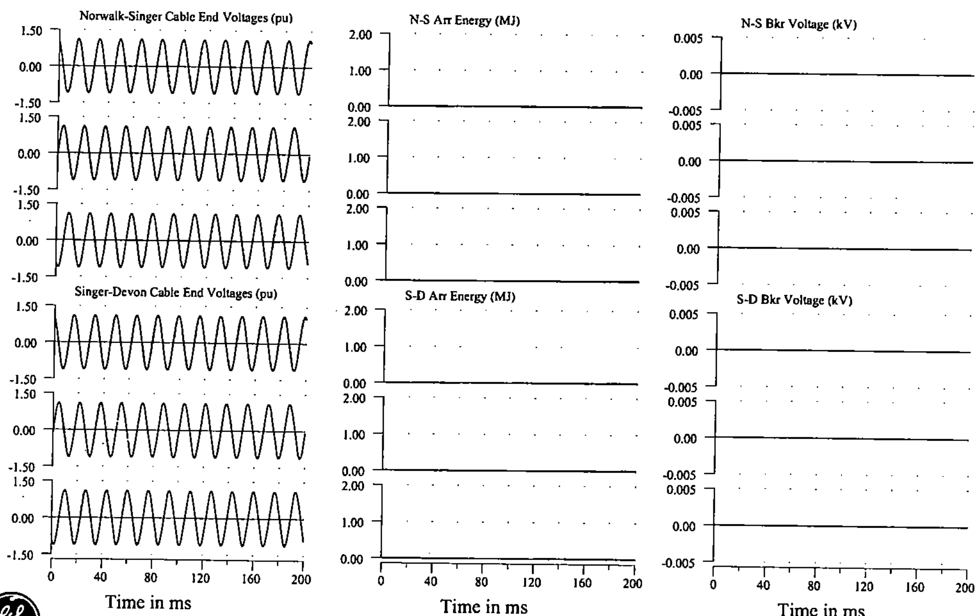
Page 1

Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01R
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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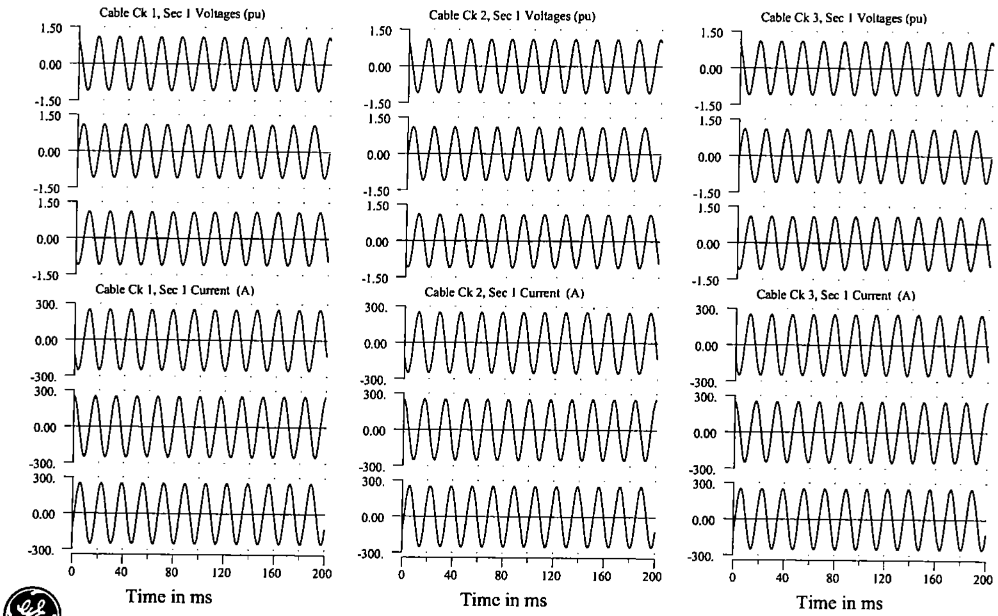
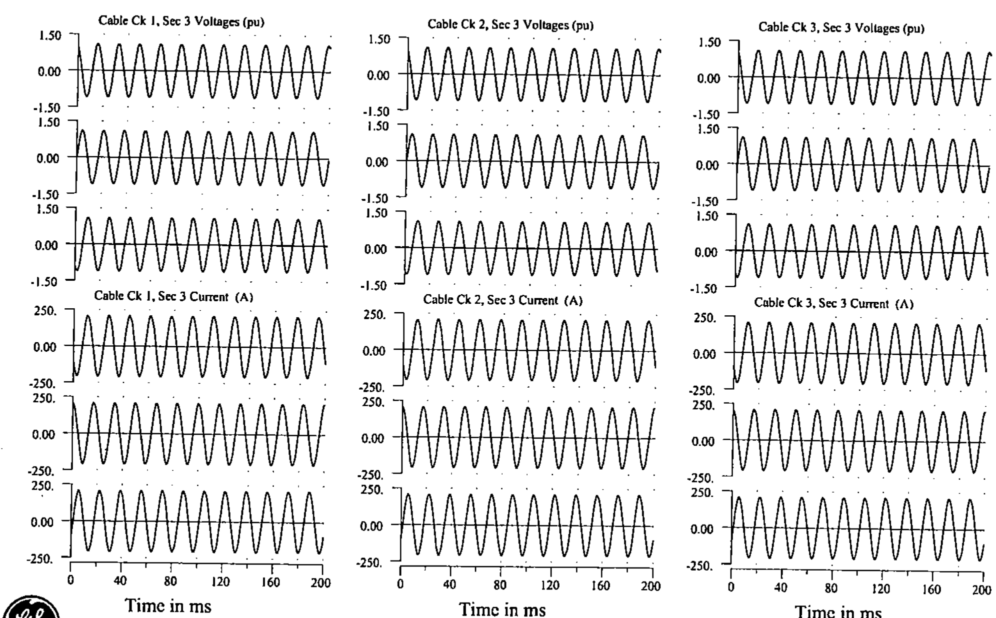
Page 2

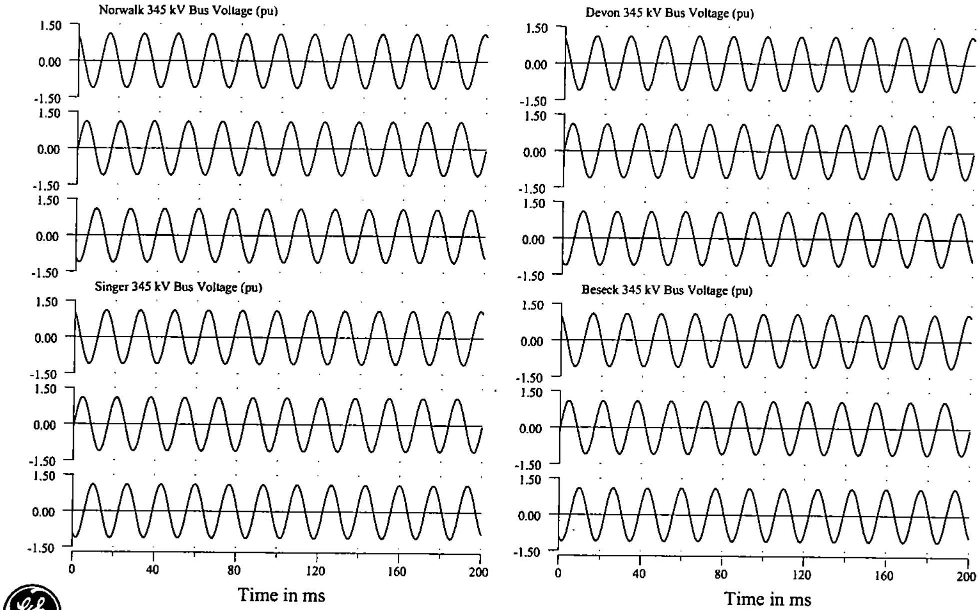
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01R
Devon-Beseck 345 kV Cables



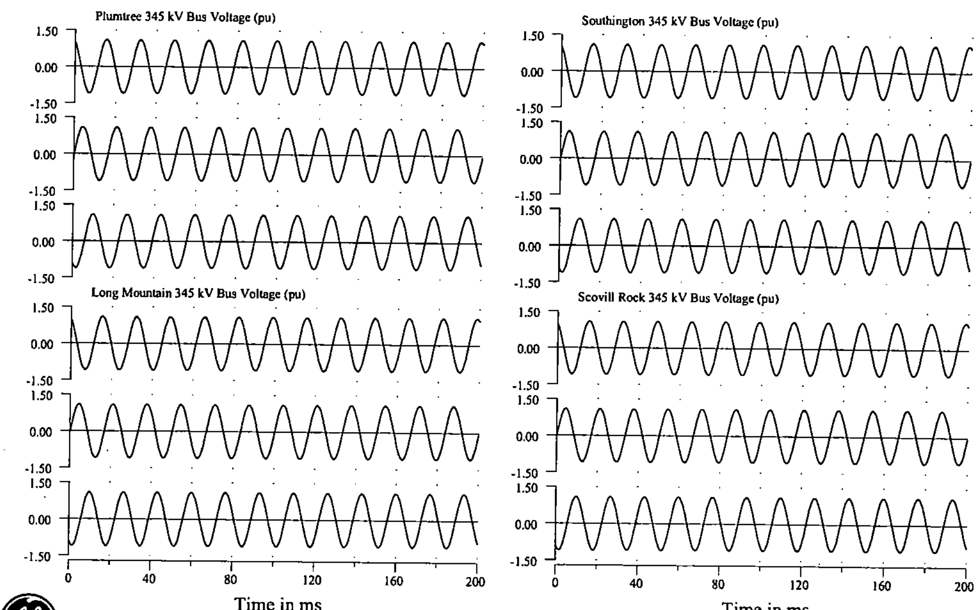
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01R
Devon-Beseck 345 kV Cables



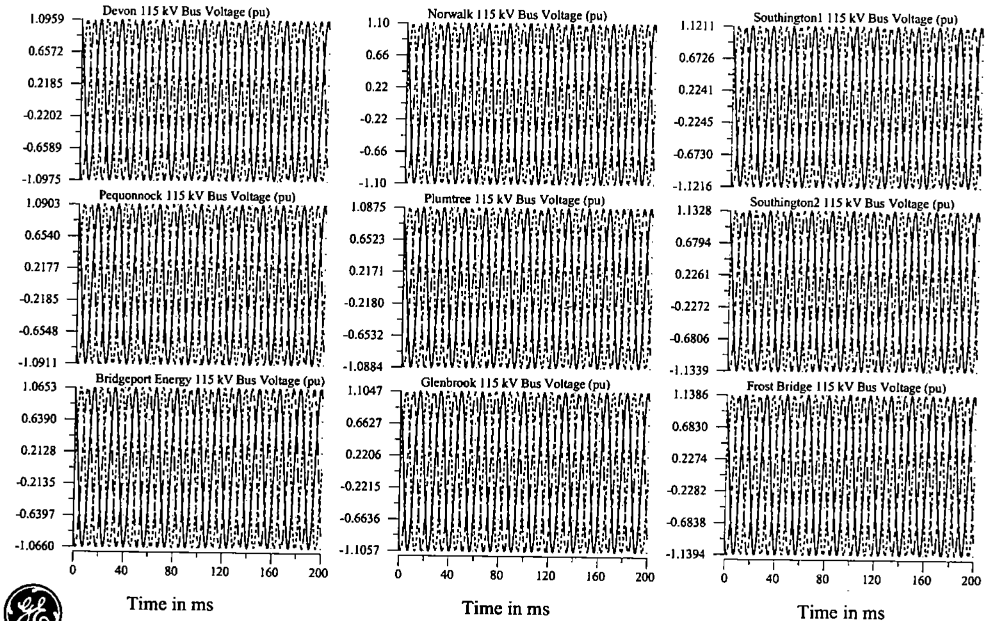
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01R
345 kV Bus Voltages



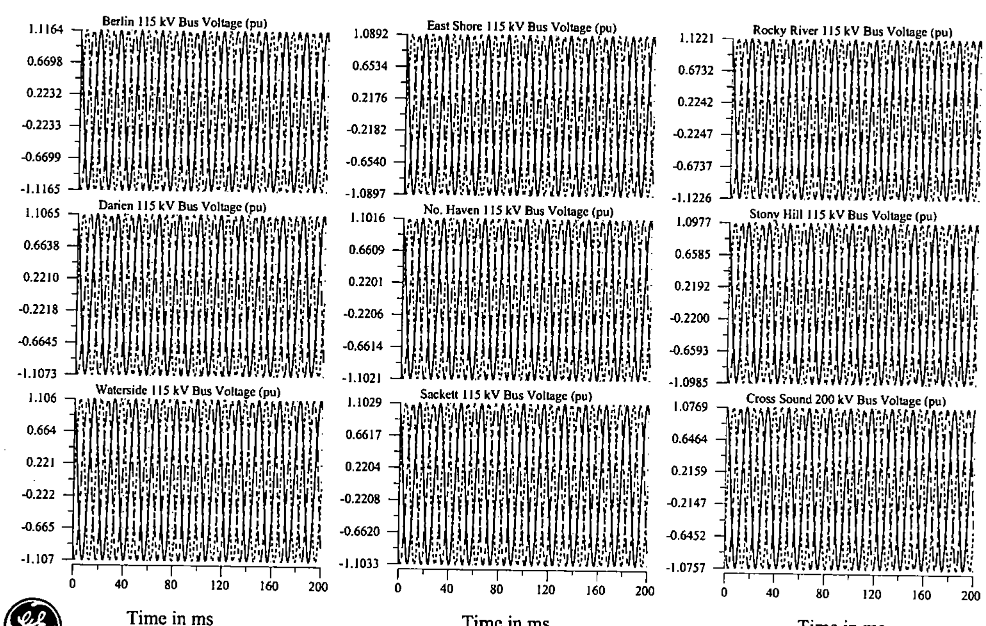
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01R
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01R
115 kV Bus Voltages and Capacitor Bank Locations



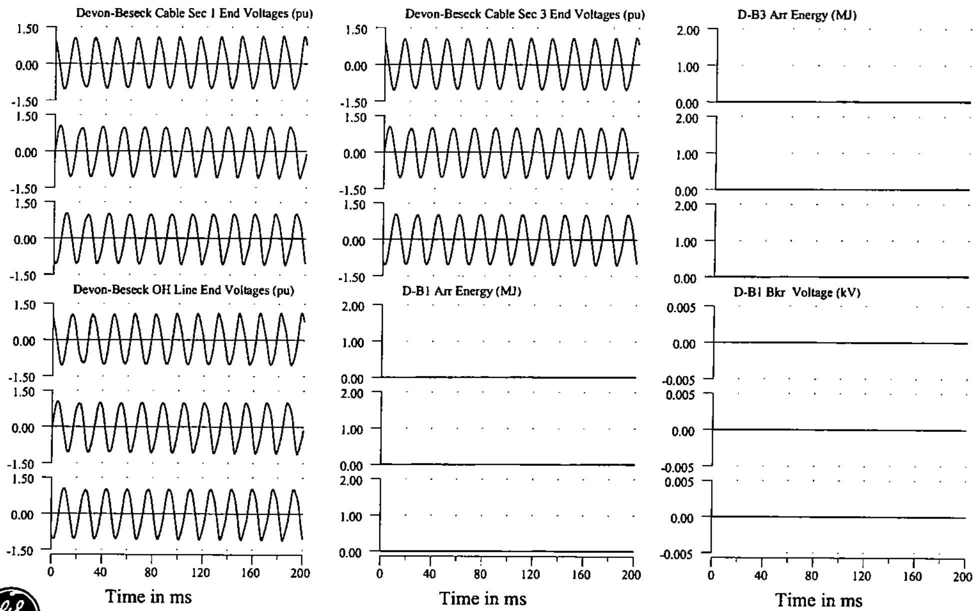
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_01R
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_02

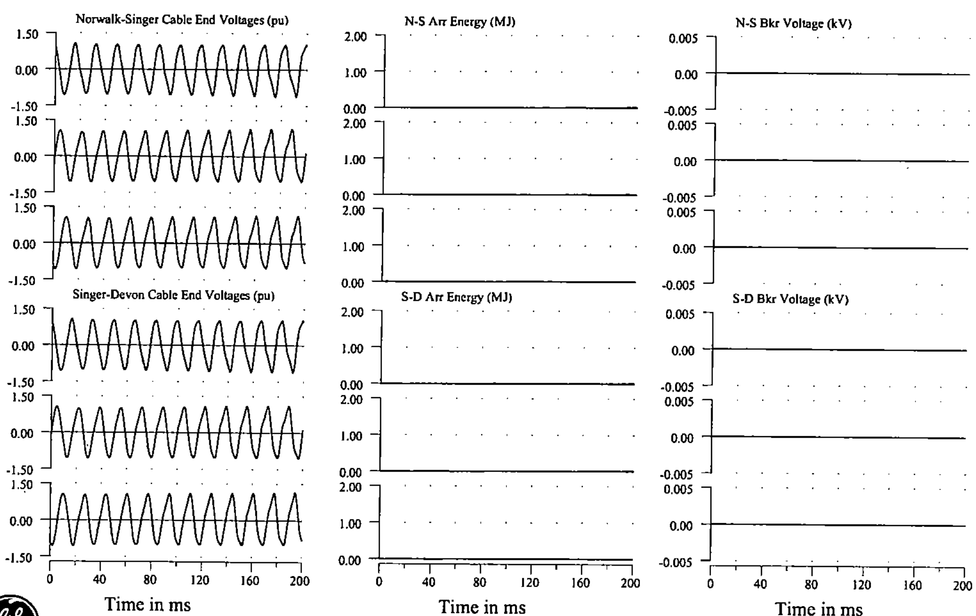
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



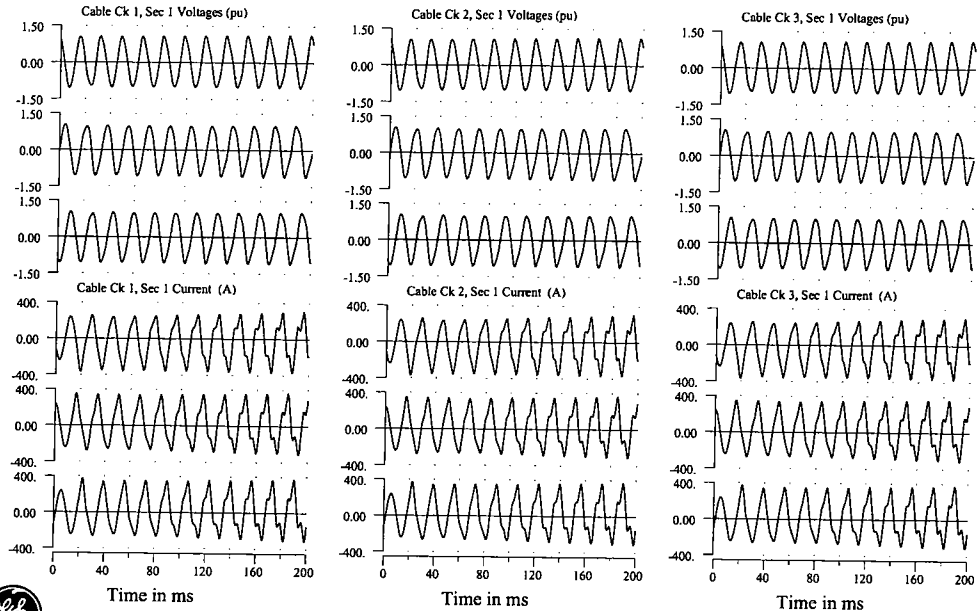
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_02

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_02
Devon-Beseck 345 kV Cables



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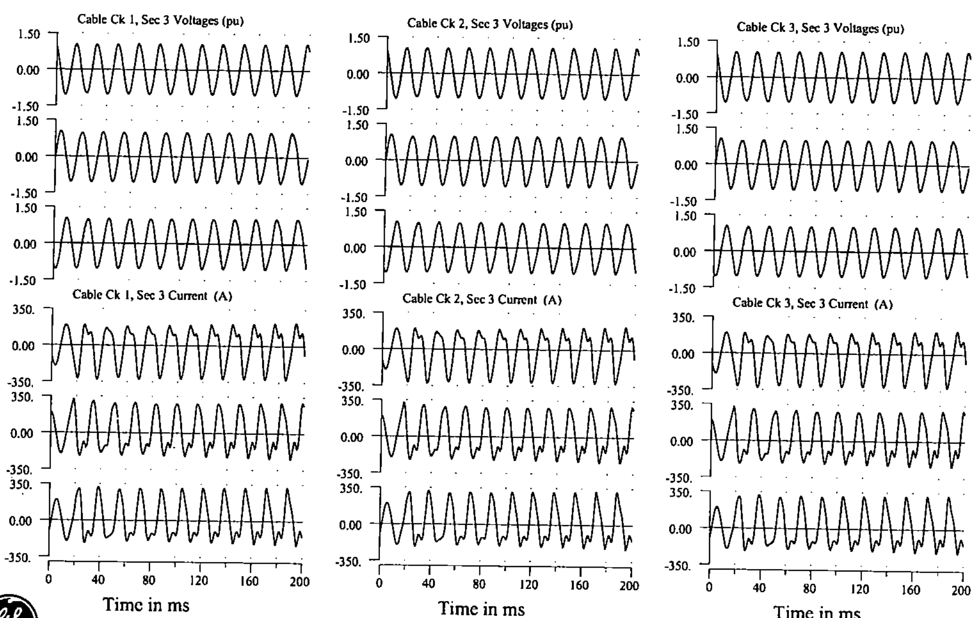
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_02
Devon-Beseck 345 kV Cables



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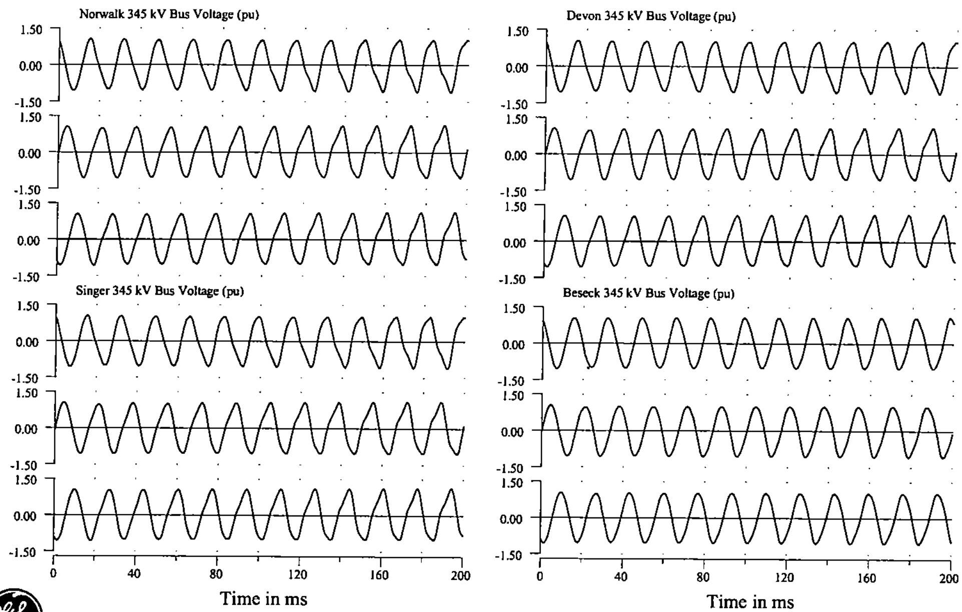
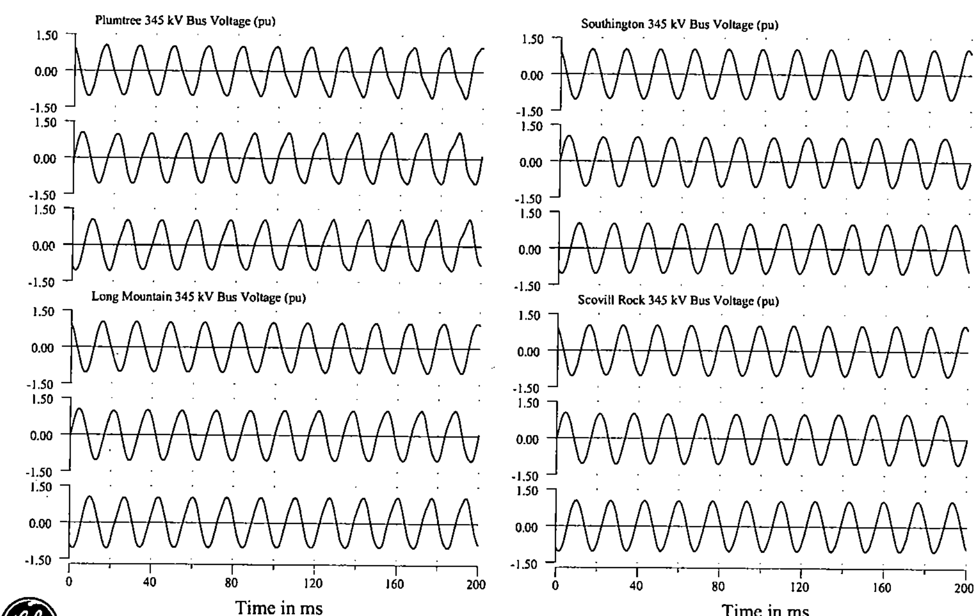
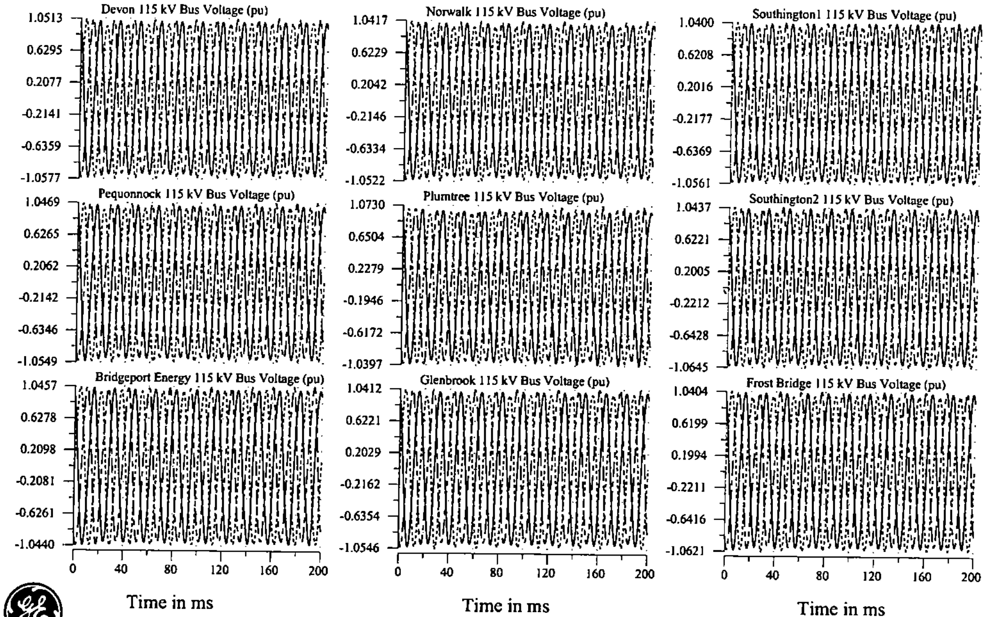
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_02
345 kV Bus Voltages



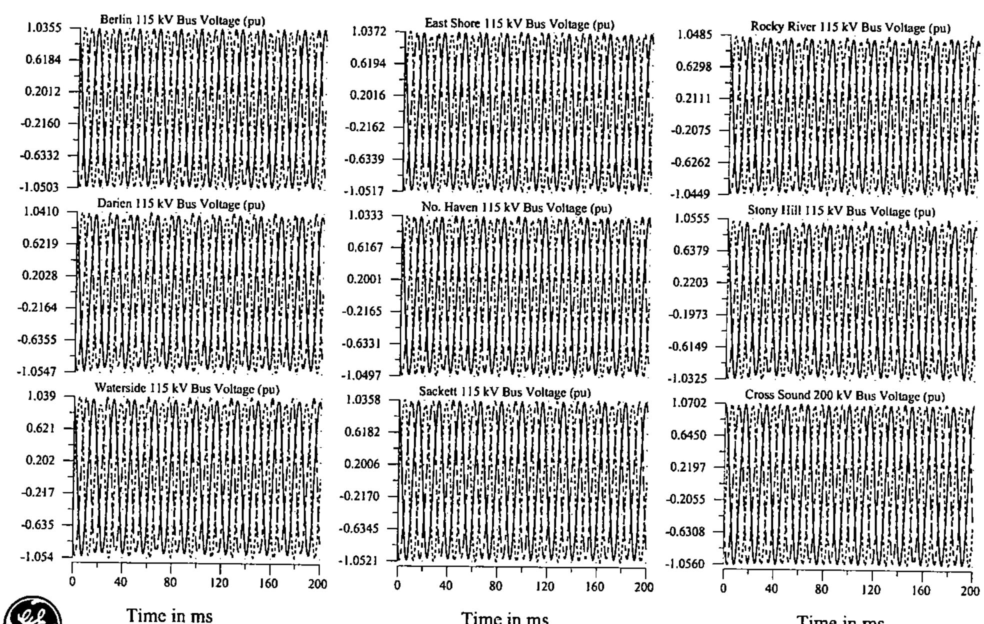
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_02
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_02
115 kV Bus Voltages and Capacitor Bank Locations



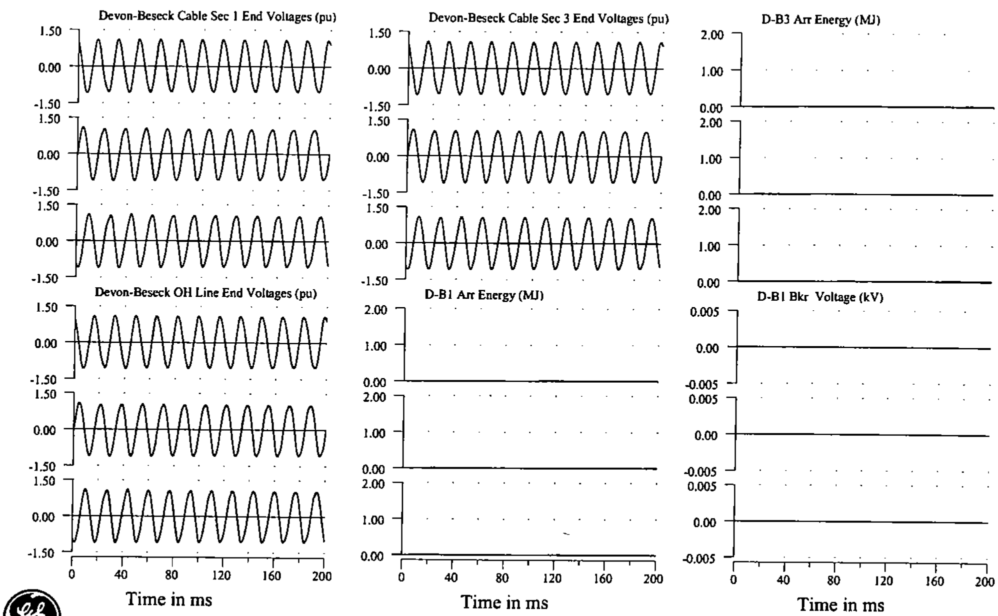
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_02
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_03

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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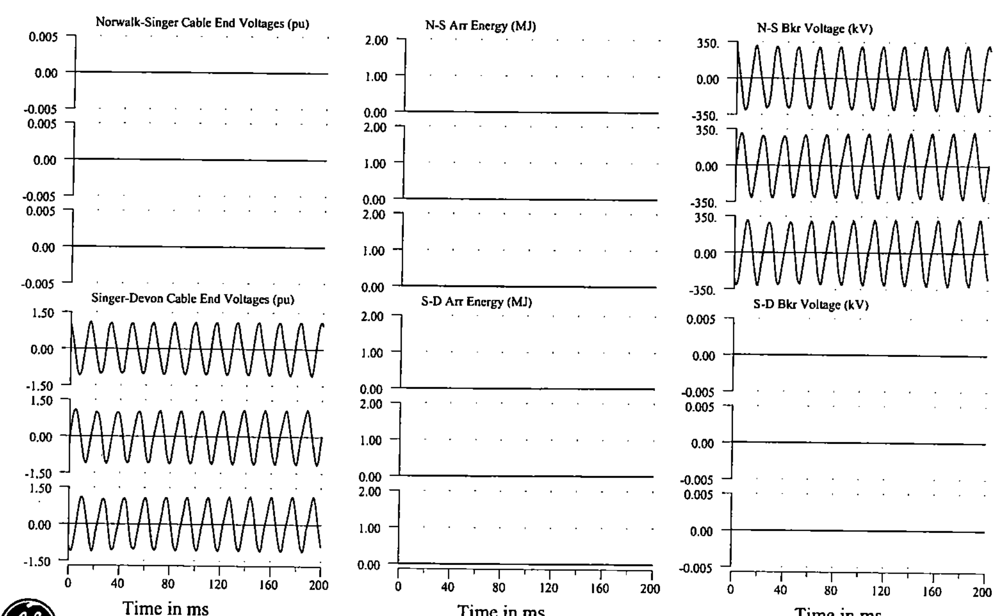
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_03

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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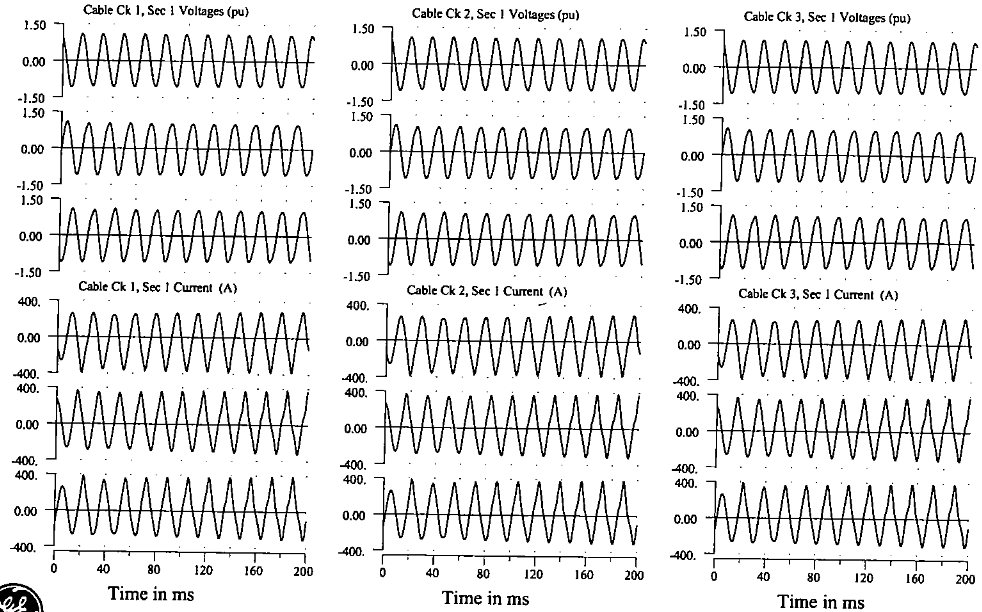
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_03

Devon-Beseck 345 kV Cables



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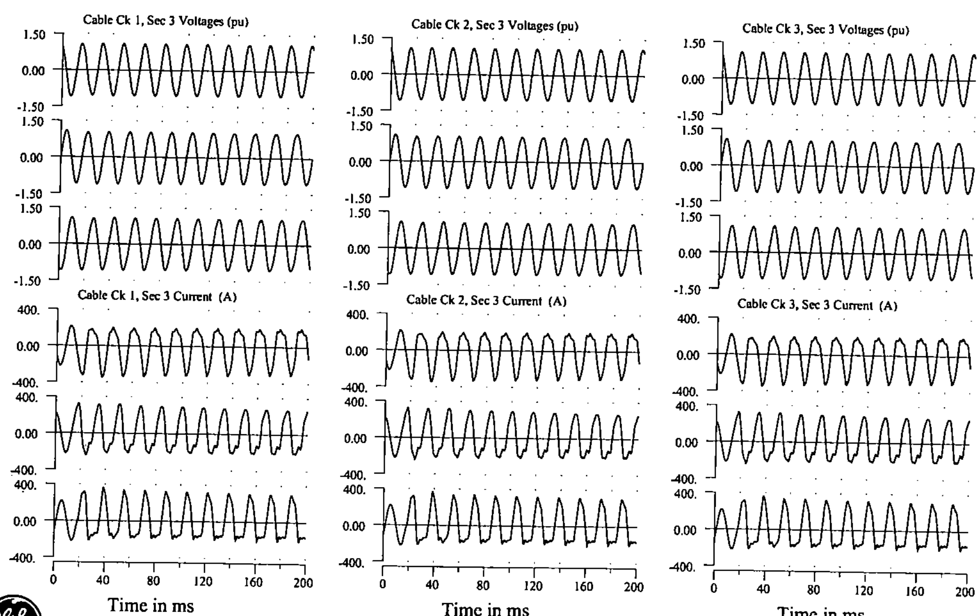
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_03

Devon-Beseck 345 kV Cables



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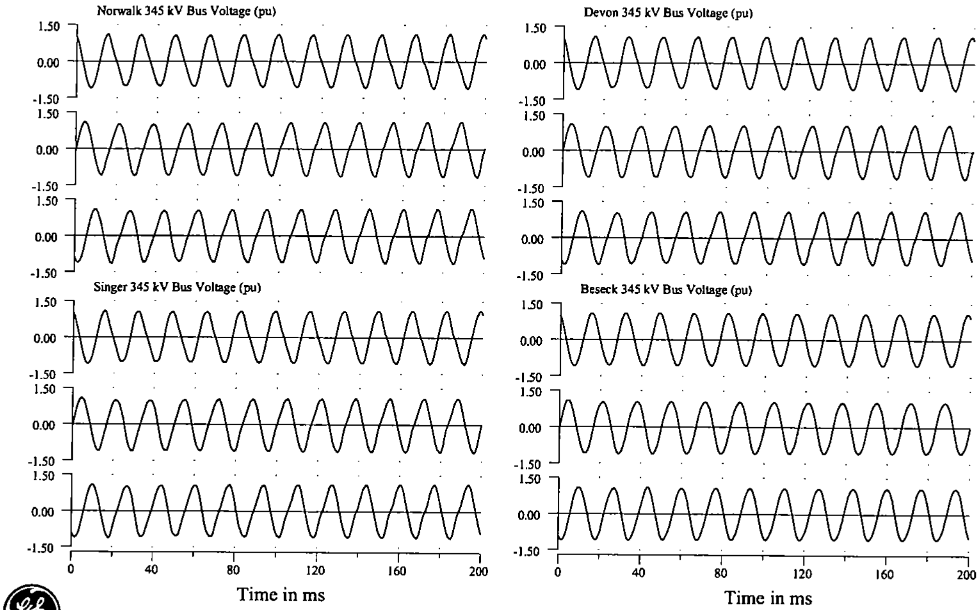
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_03
345 kV Bus Voltages



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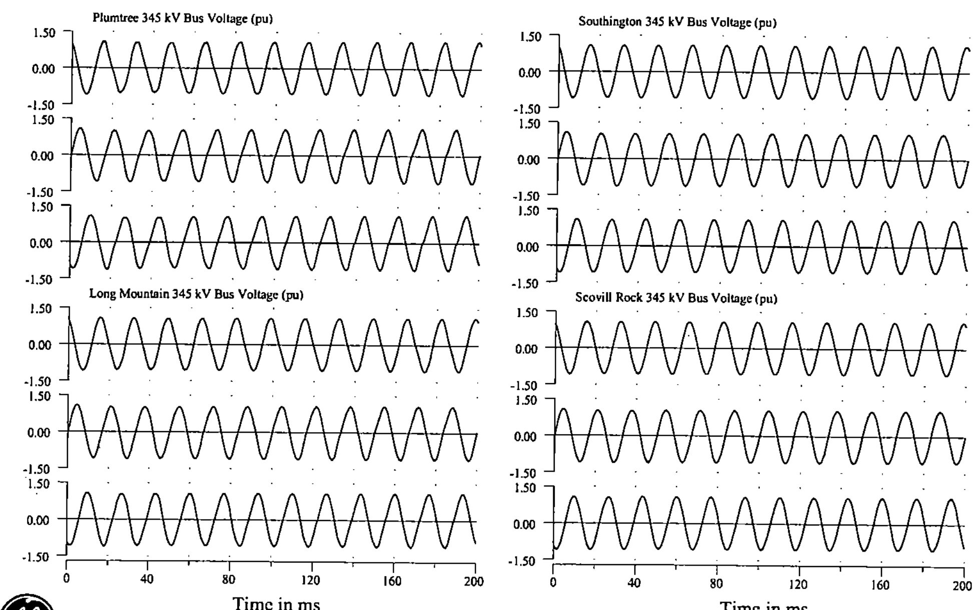
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_03
345 kV Bus Voltages



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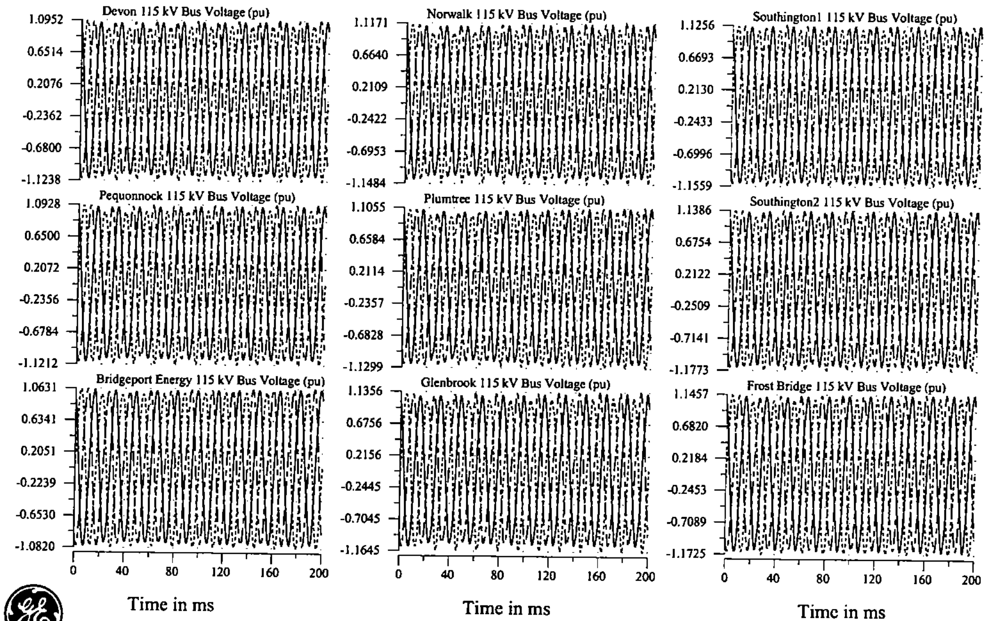
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_03
115 kV Bus Voltages and Capacitor Bank Locations



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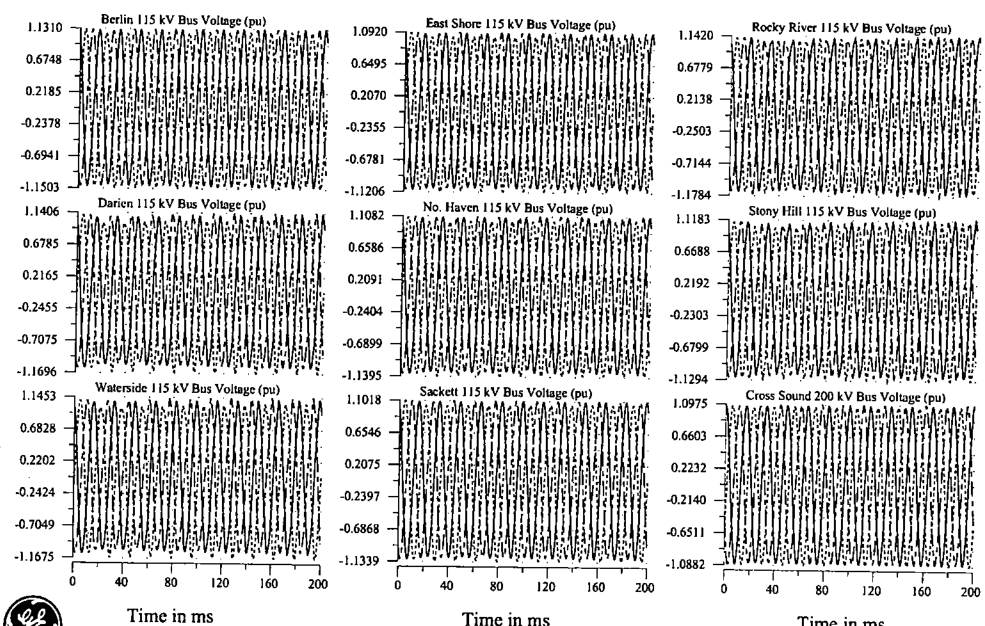
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_03
115 kV Bus Voltages and Capacitor Bank Locations



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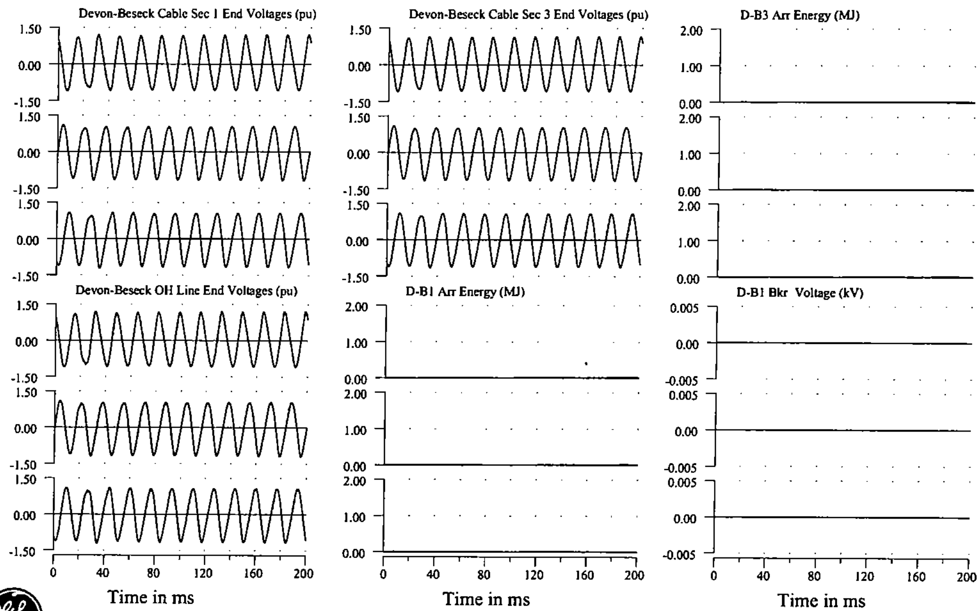
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_04

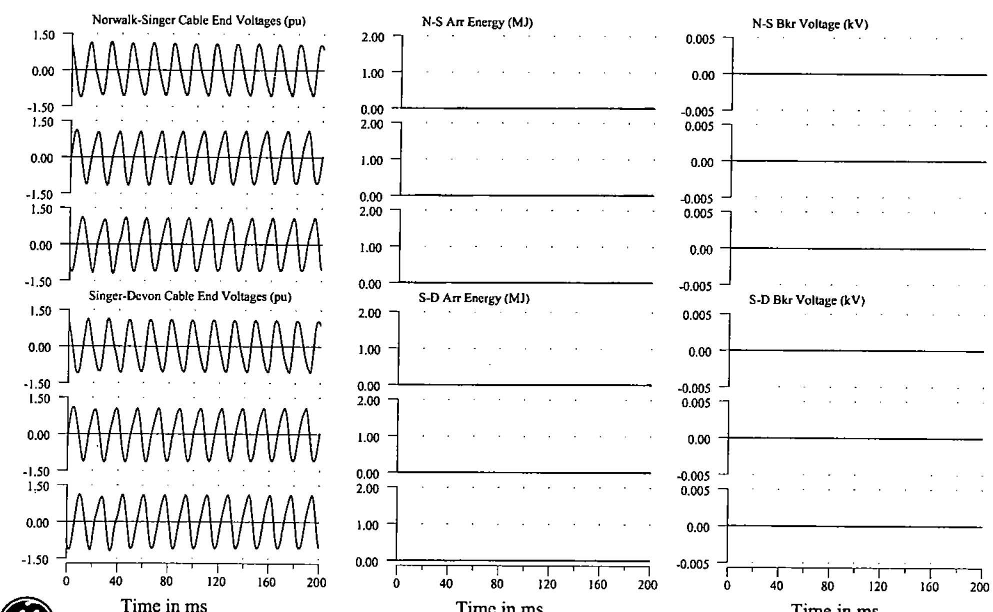
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



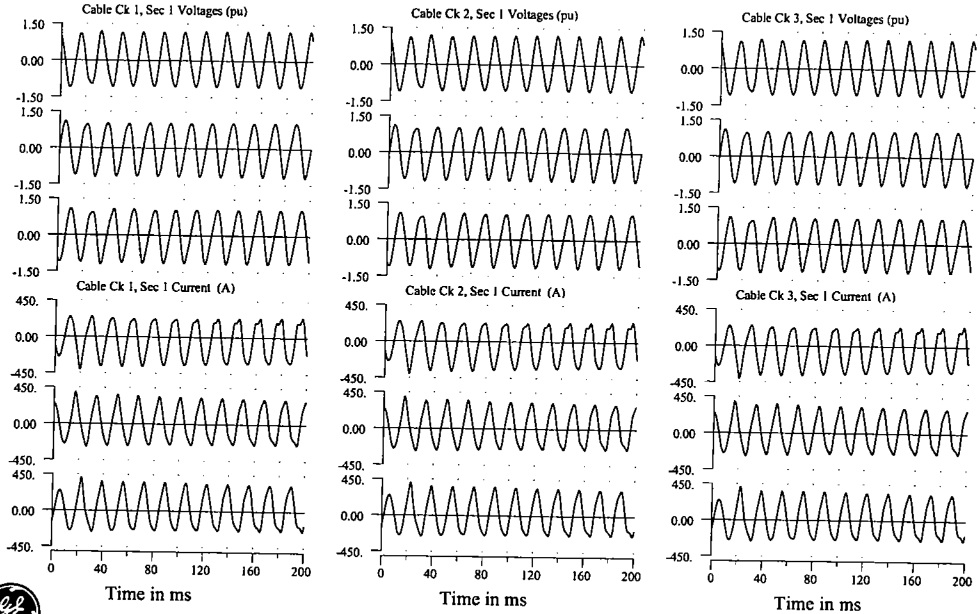
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

N_04

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_04
Devon-Beseck 345 kV Cables



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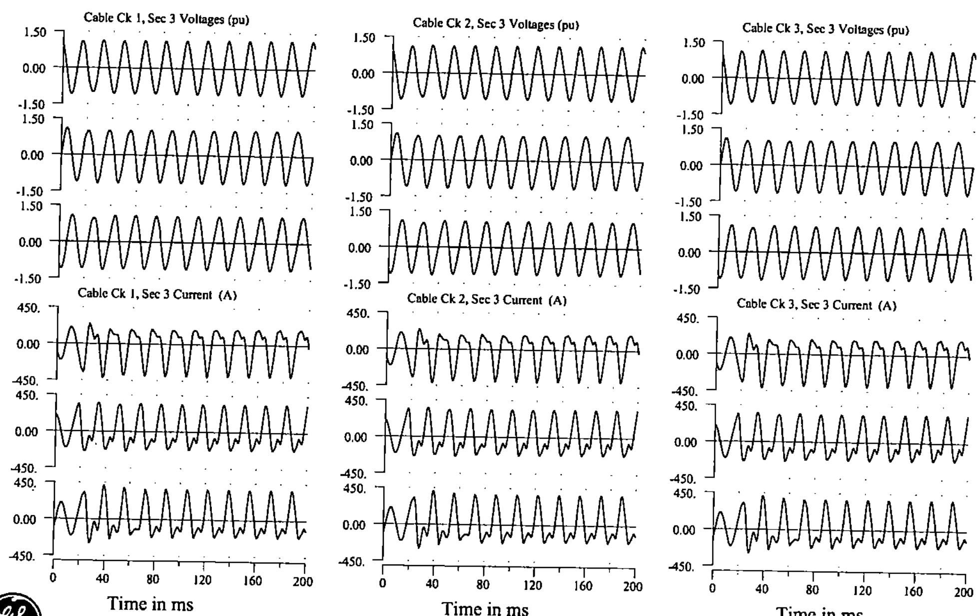
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_04
Devon-Beseck 345 kV Cables



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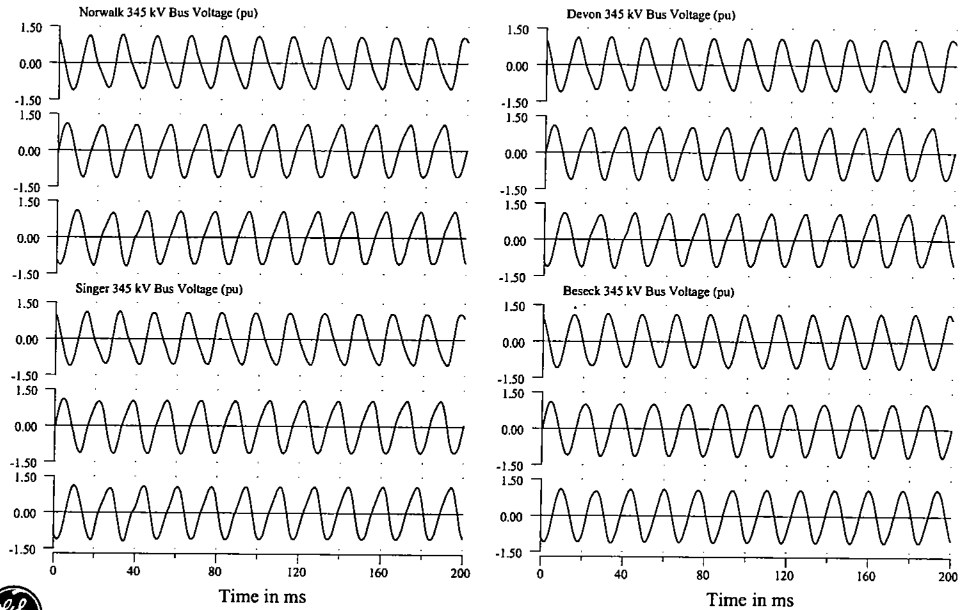
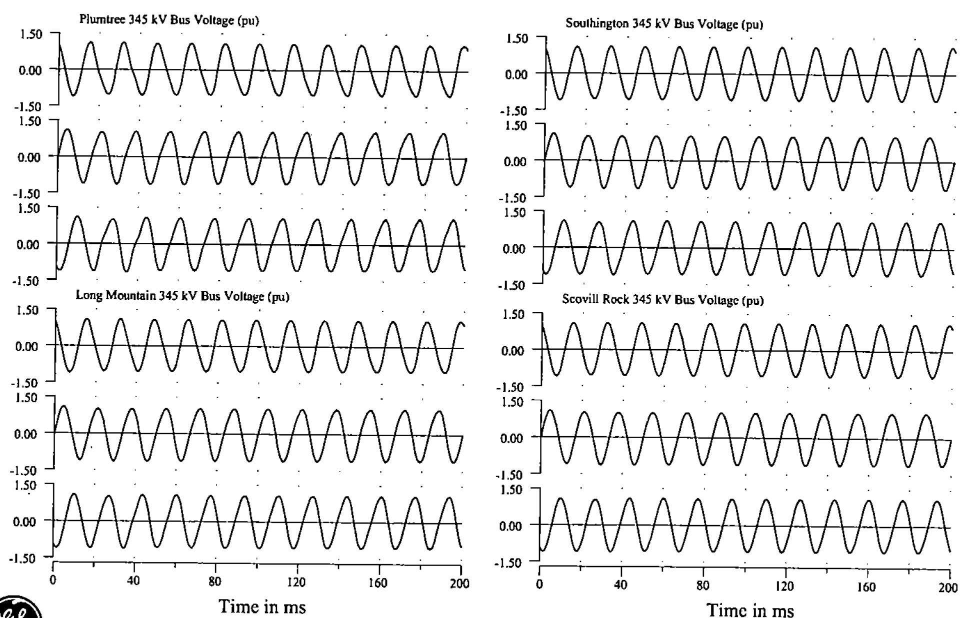
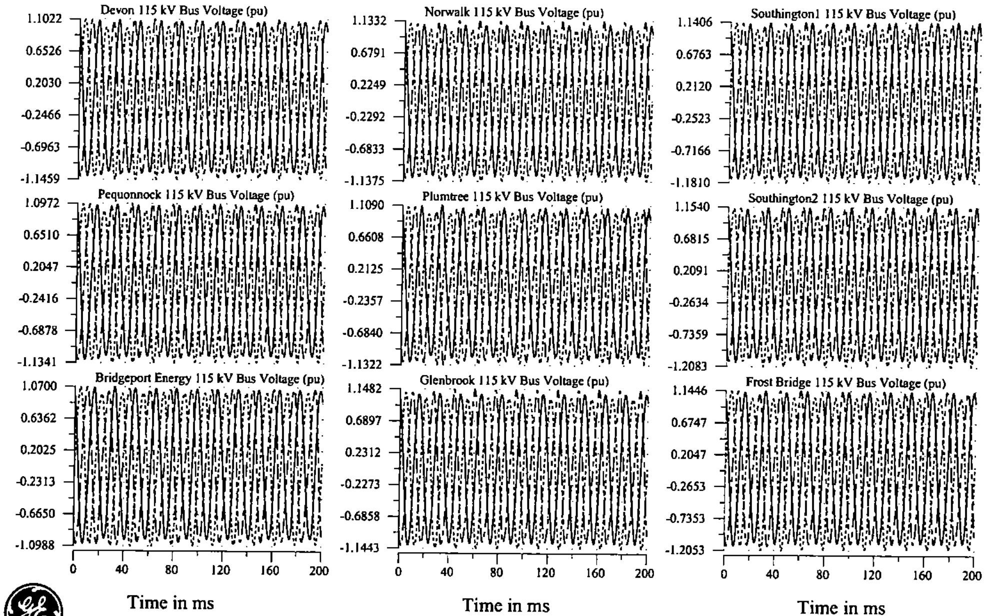
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_04
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_04
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_04
115 kV Bus Voltages and Capacitor Bank Locations



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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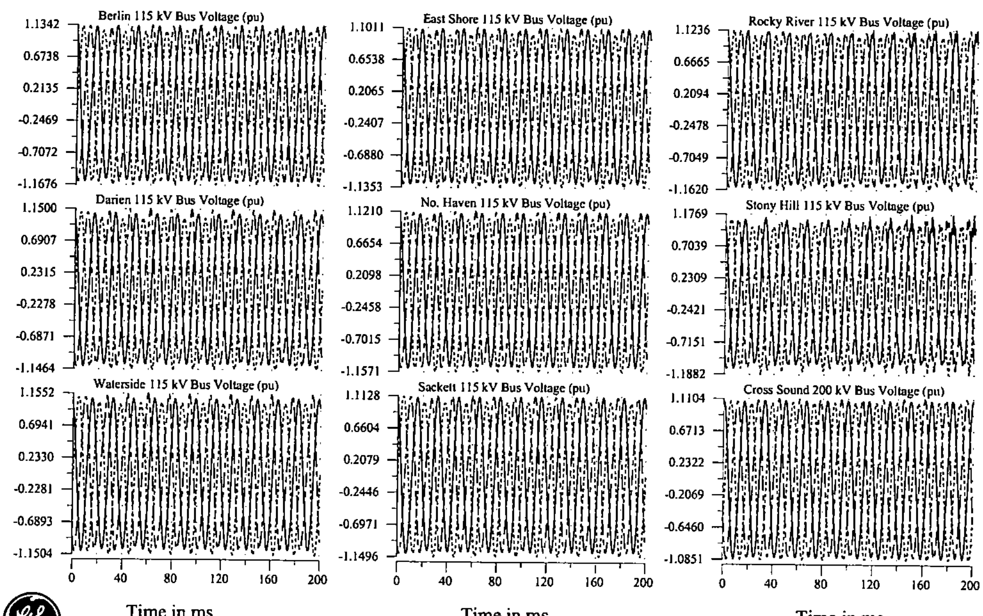
115 kV Bus Voltages and Capacitor Bank Locations



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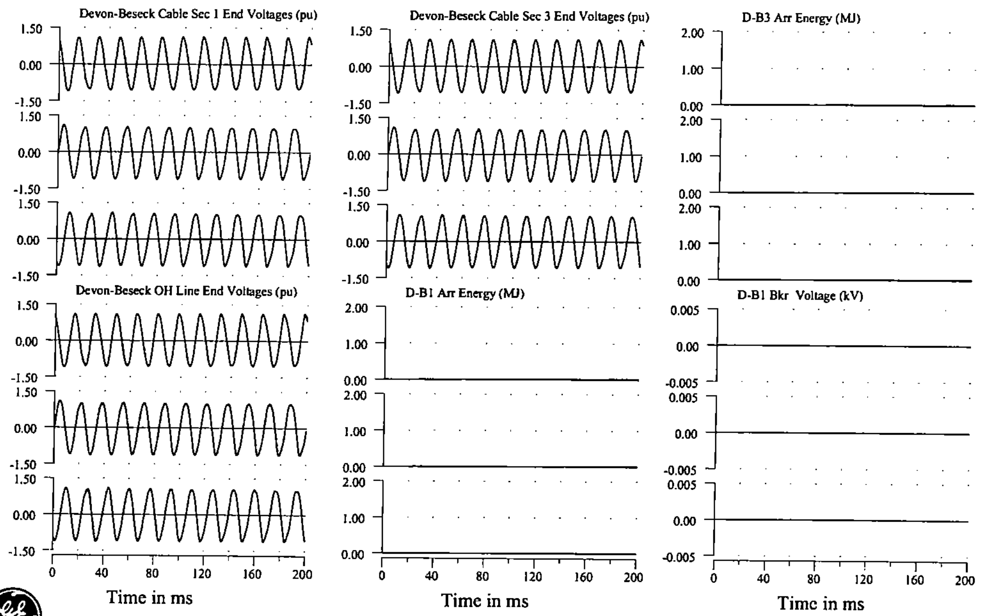
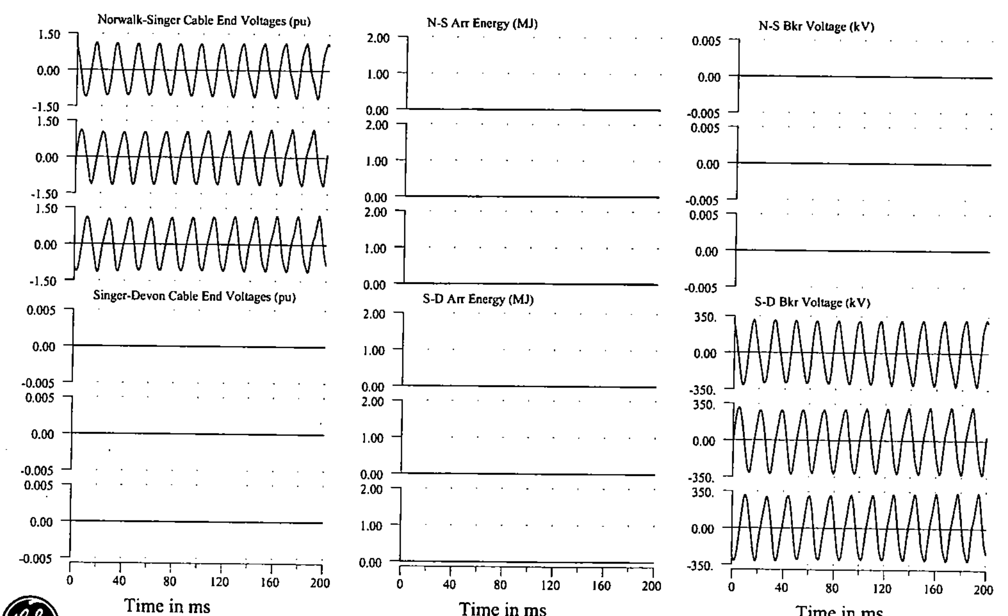
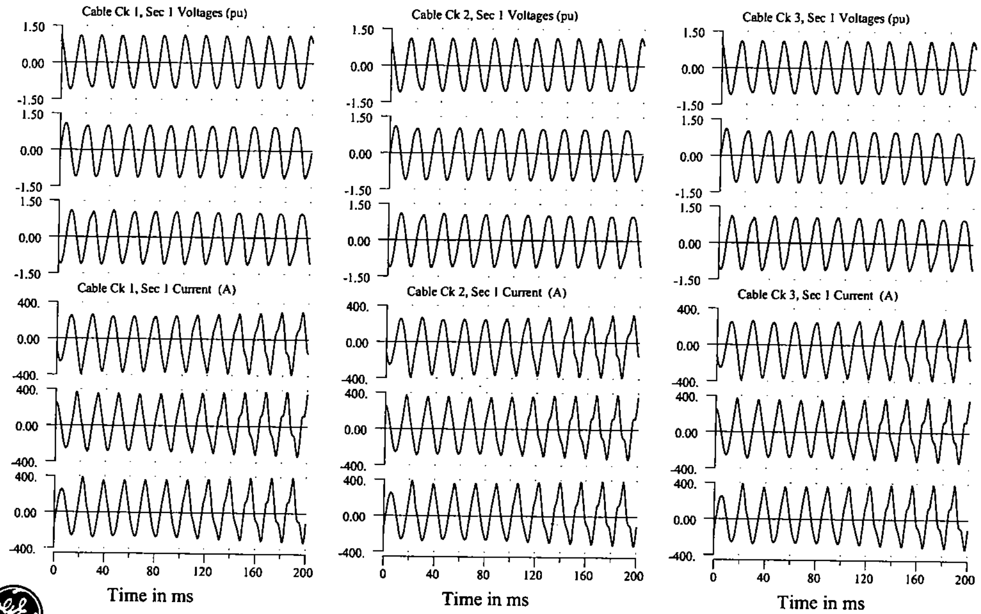
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_05
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_05
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_05
Devon-Beseck 345 kV Cables



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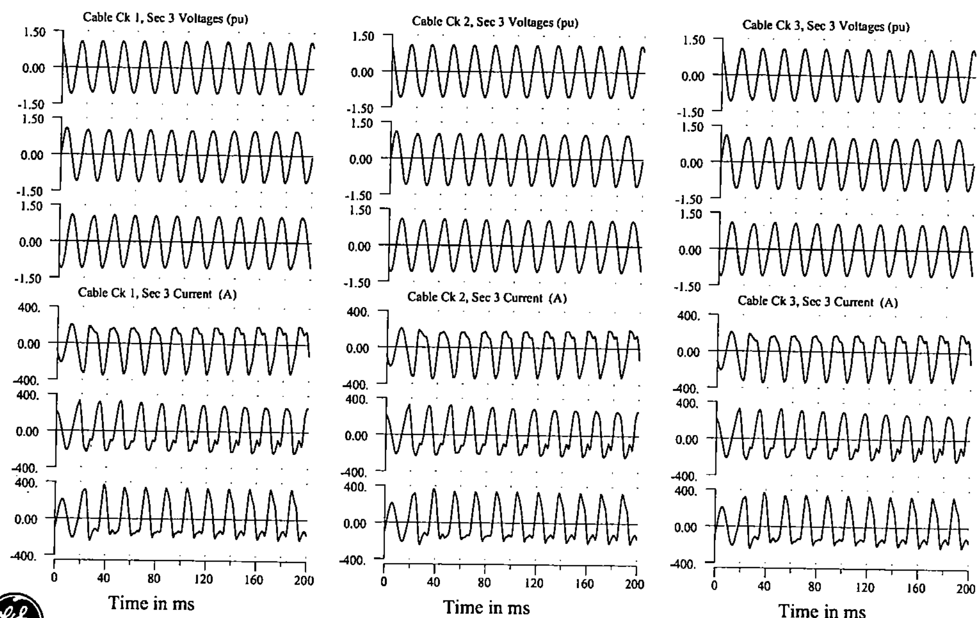
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_05
Devon-Beseck 345 kV Cables



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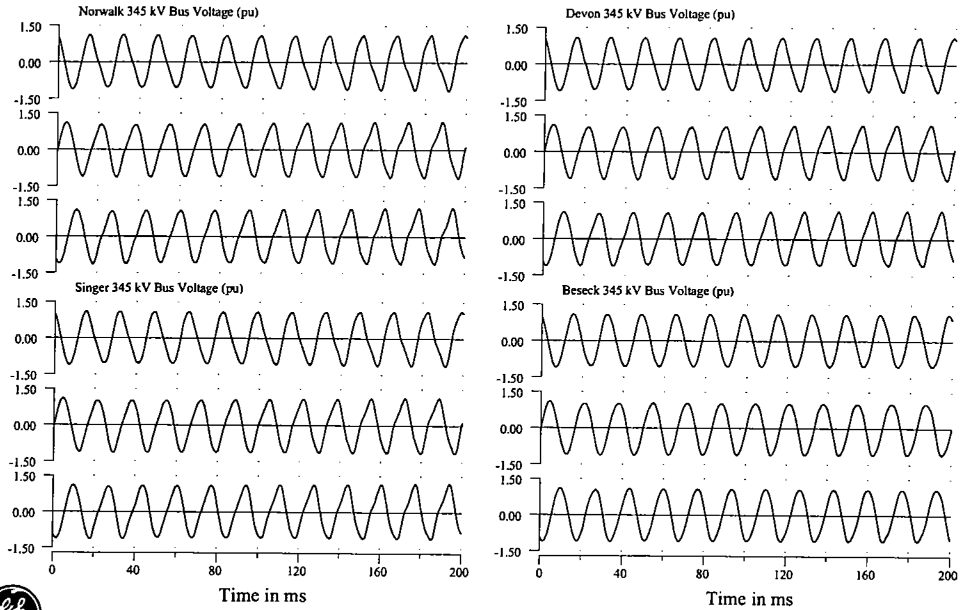
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_05
345 kV Bus Voltages



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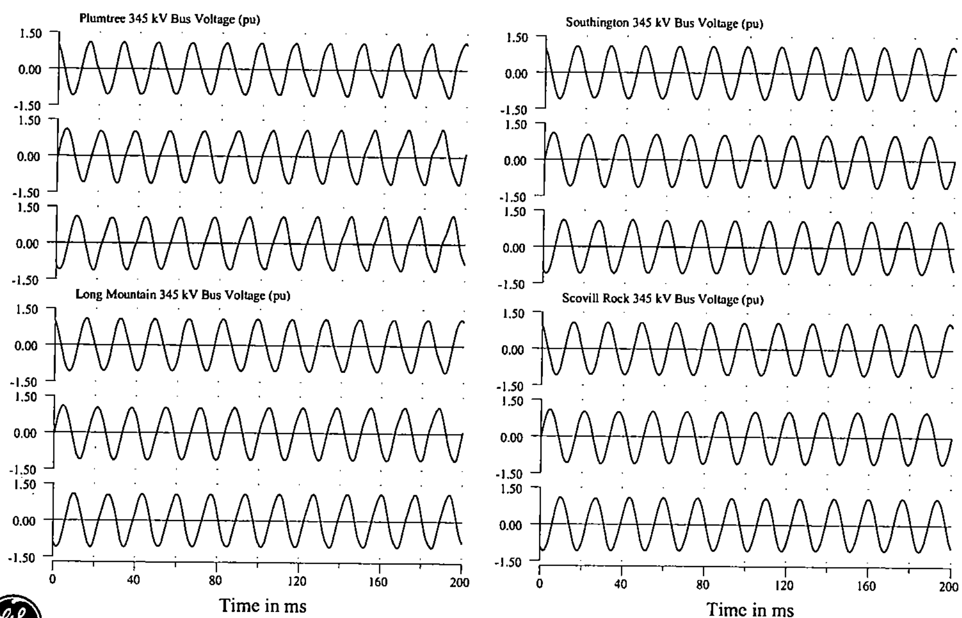
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_05
345 kV Bus Voltages



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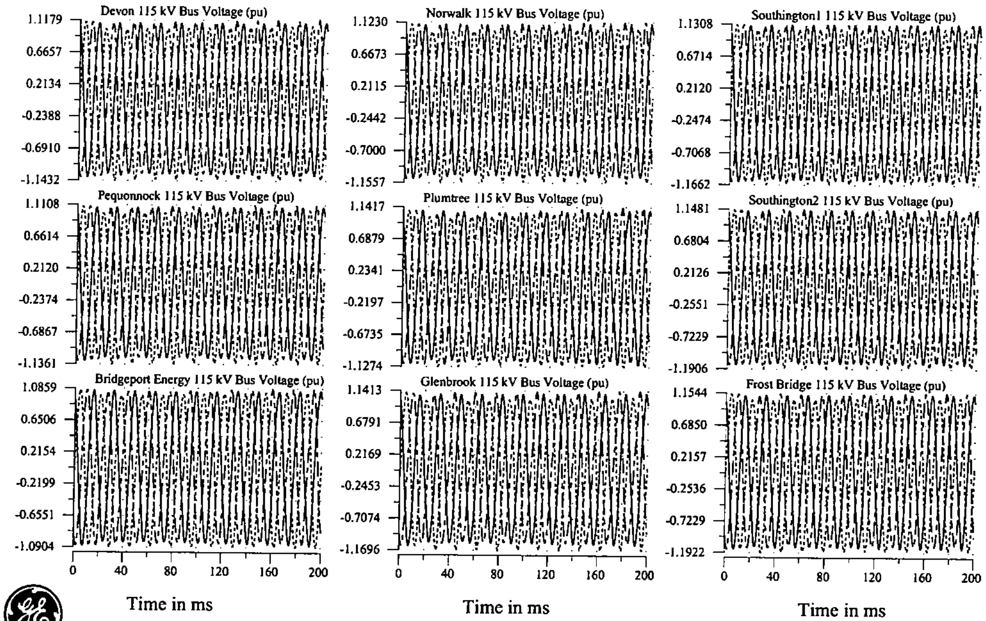
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_05
115 kV Bus Voltages and Capacitor Bank Locations



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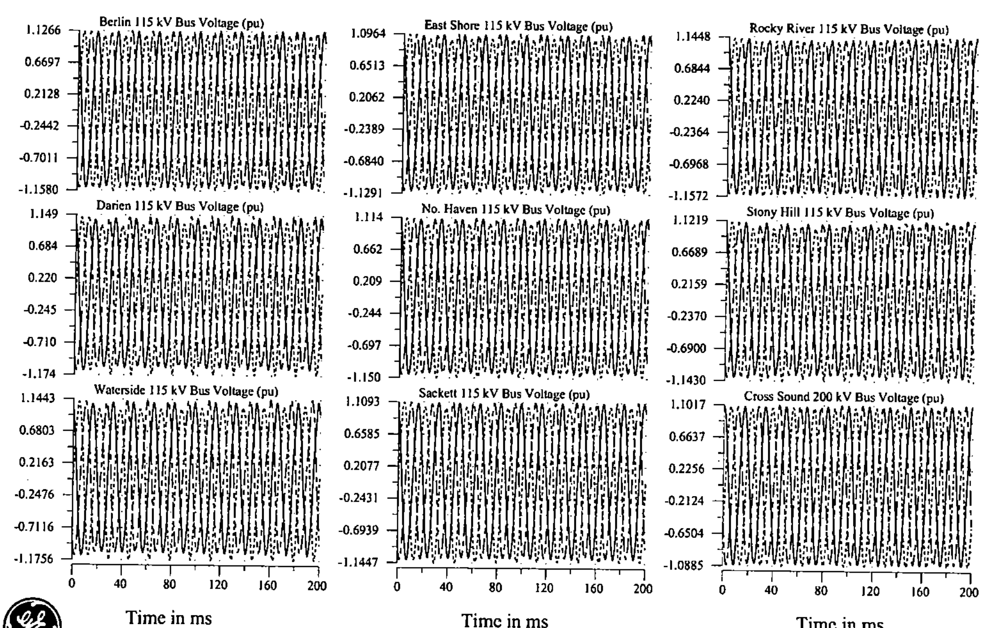
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
N_05
115 kV Bus Voltages and Capacitor Bank Locations



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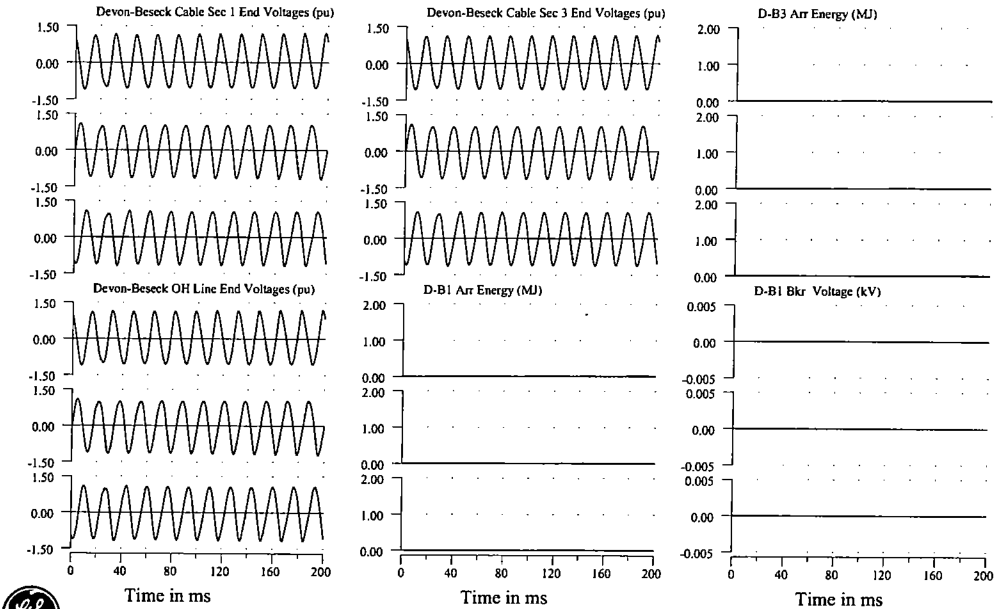
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_01

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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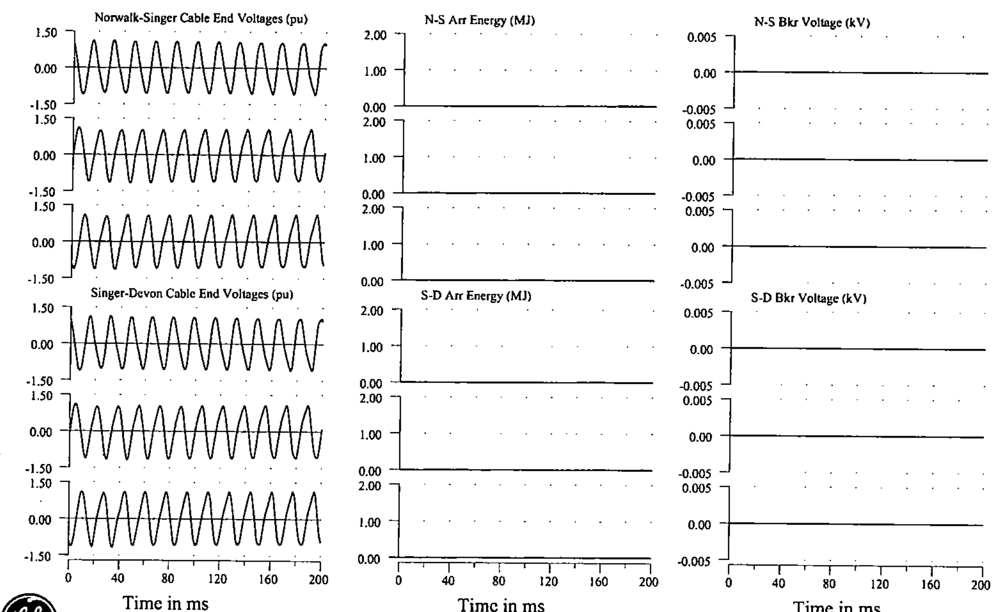
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_01

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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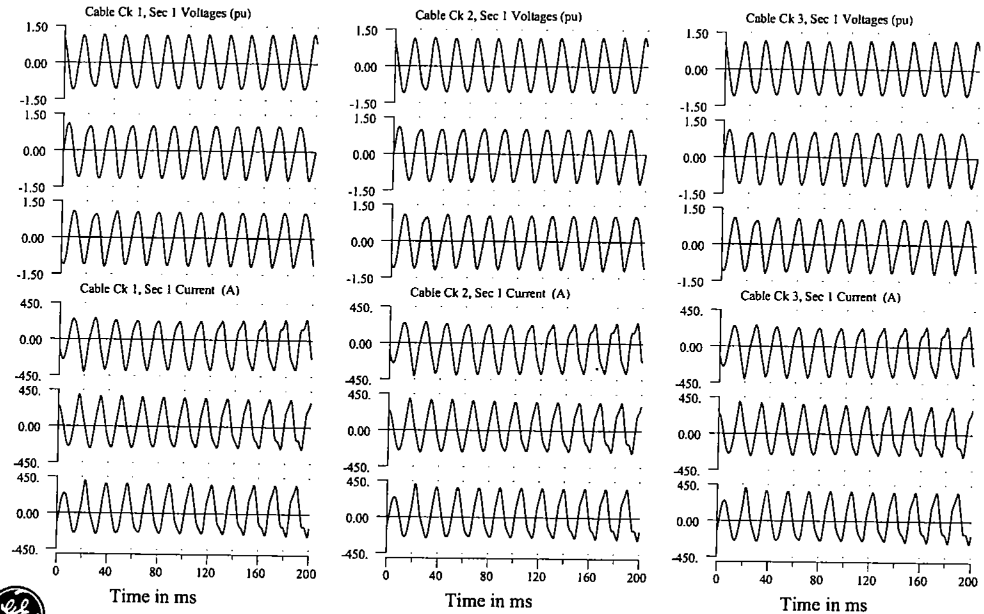
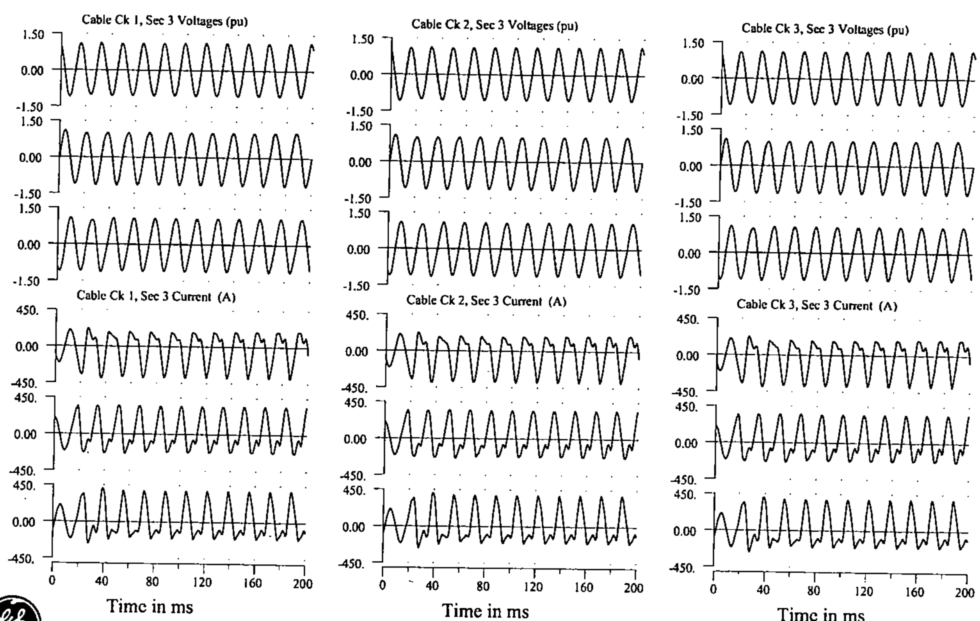
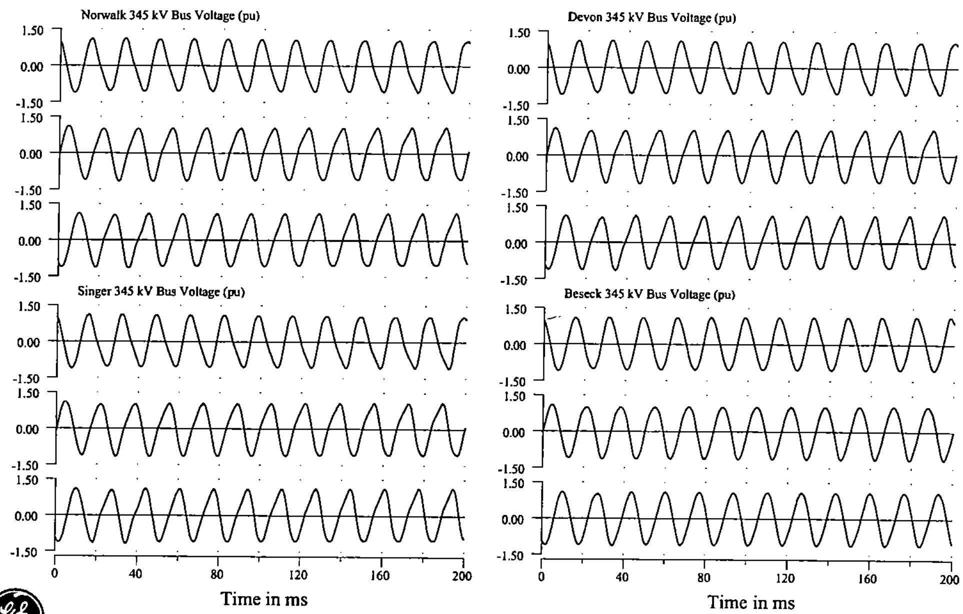
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_01
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_01
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_01
345 kV Bus Voltages



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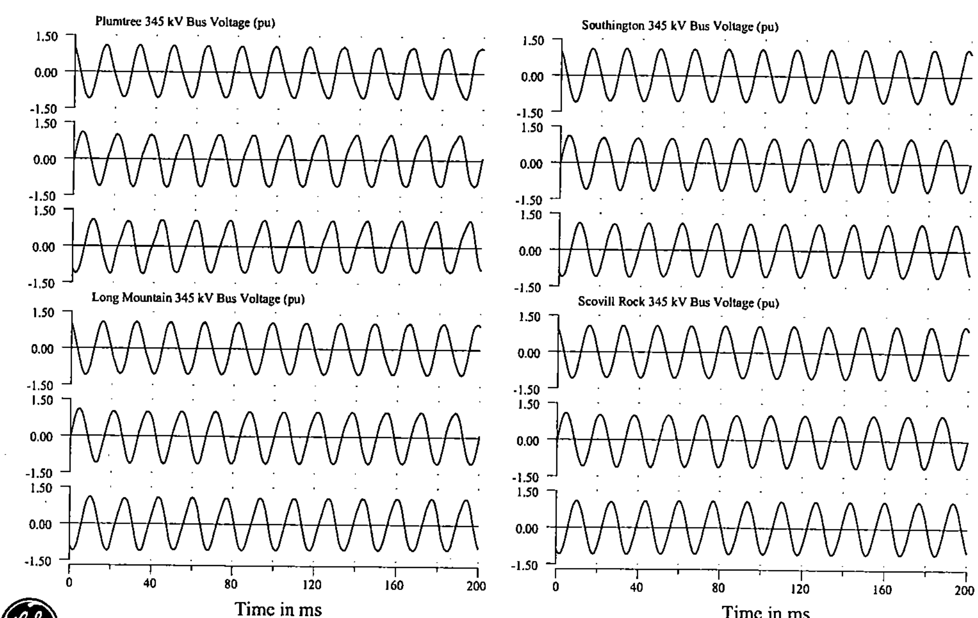
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_01
345 kV Bus Voltages



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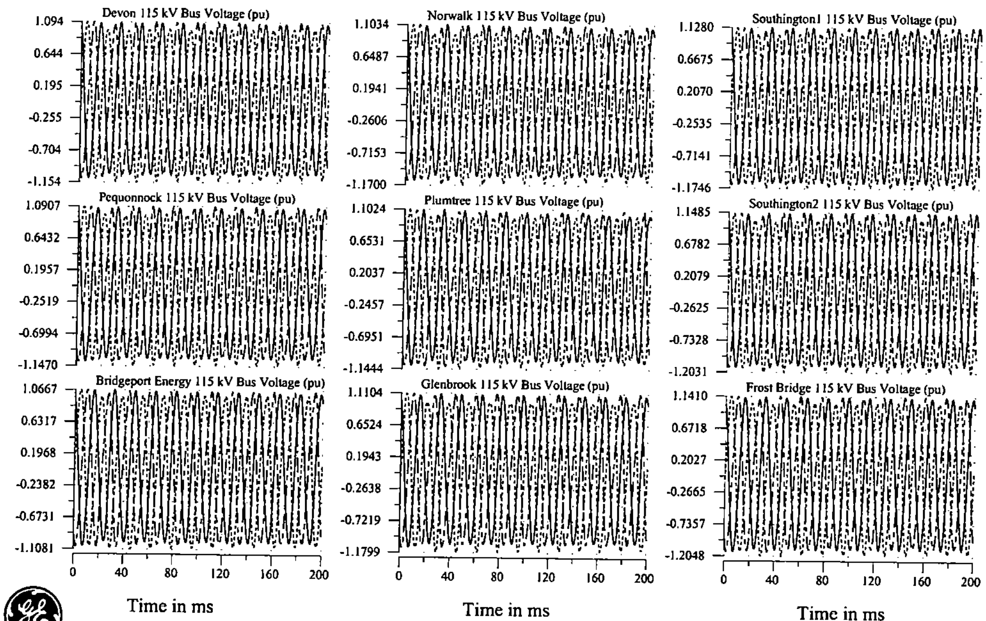
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_01

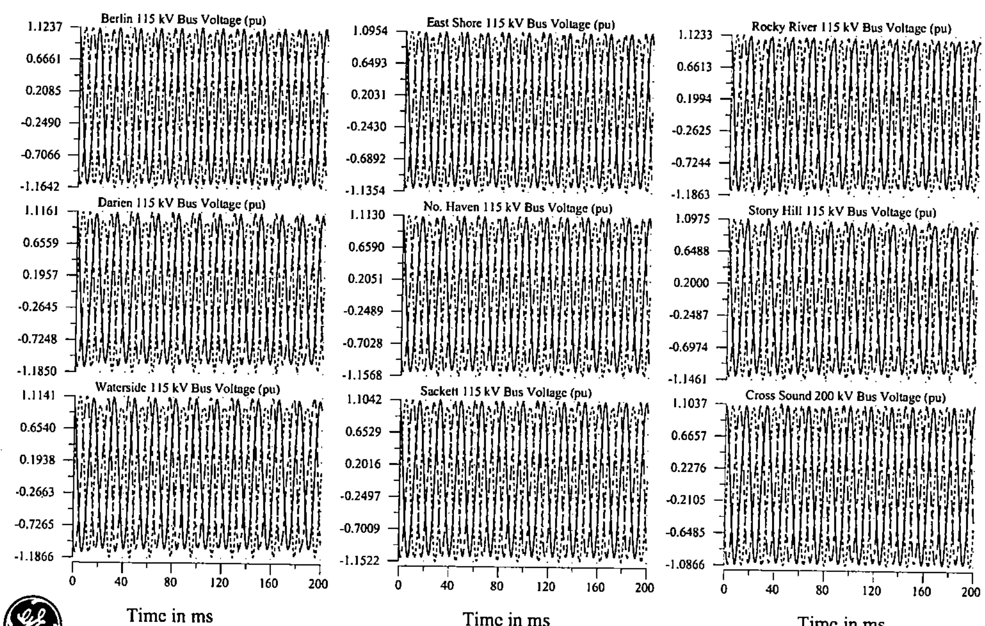
115 kV Bus Voltages and Capacitor Bank Locations



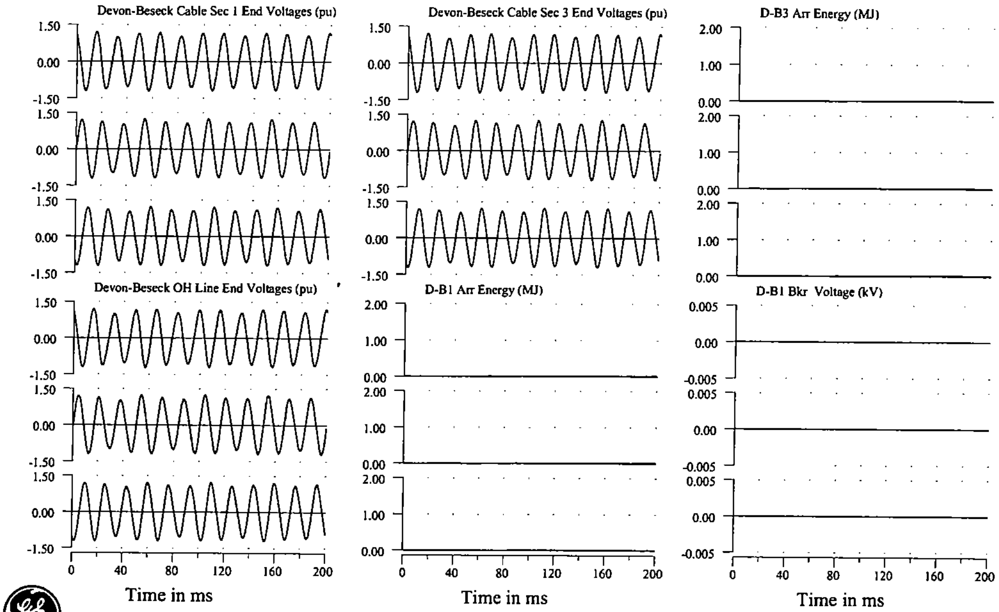
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_01

115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_01A
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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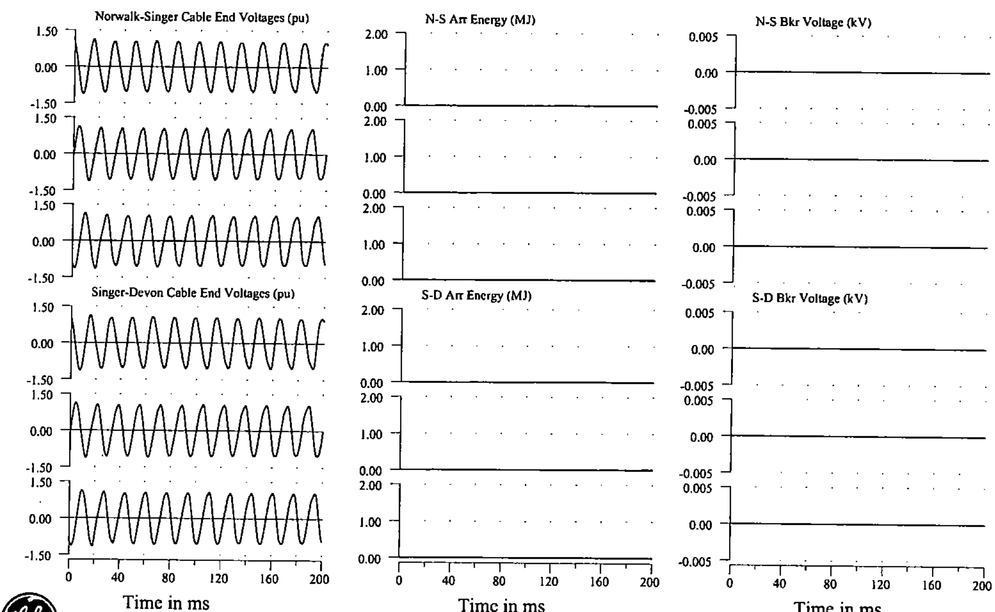
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_01A
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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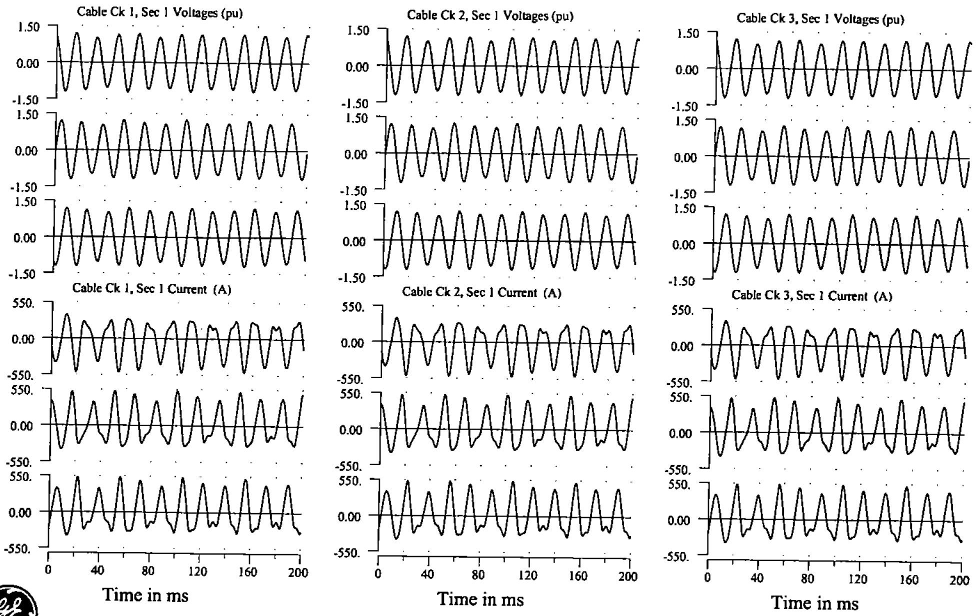
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_01A
Devon-Beseck 345 kV Cables



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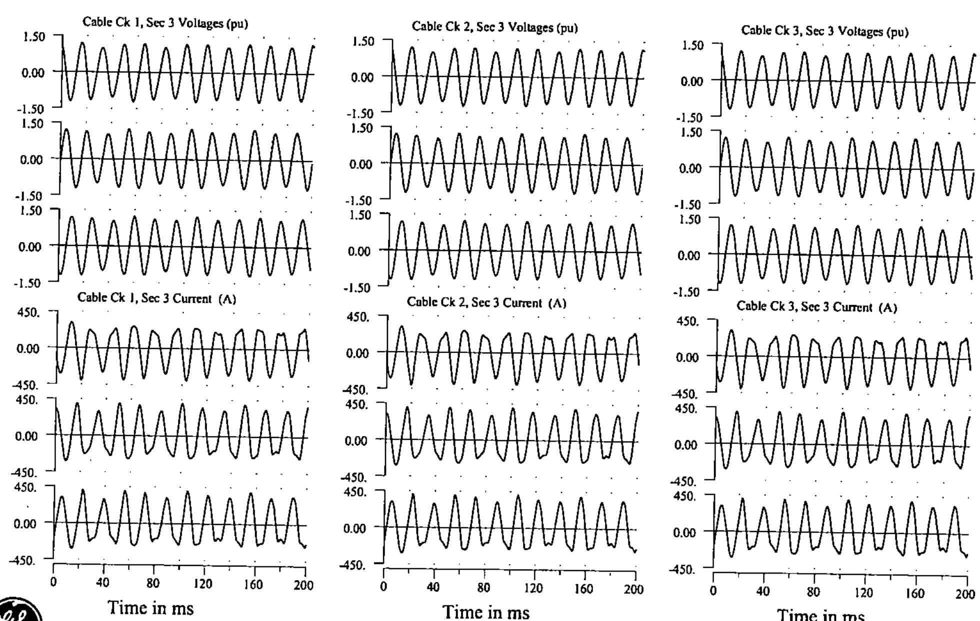
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_01A
Devon-Beseck 345 kV Cables



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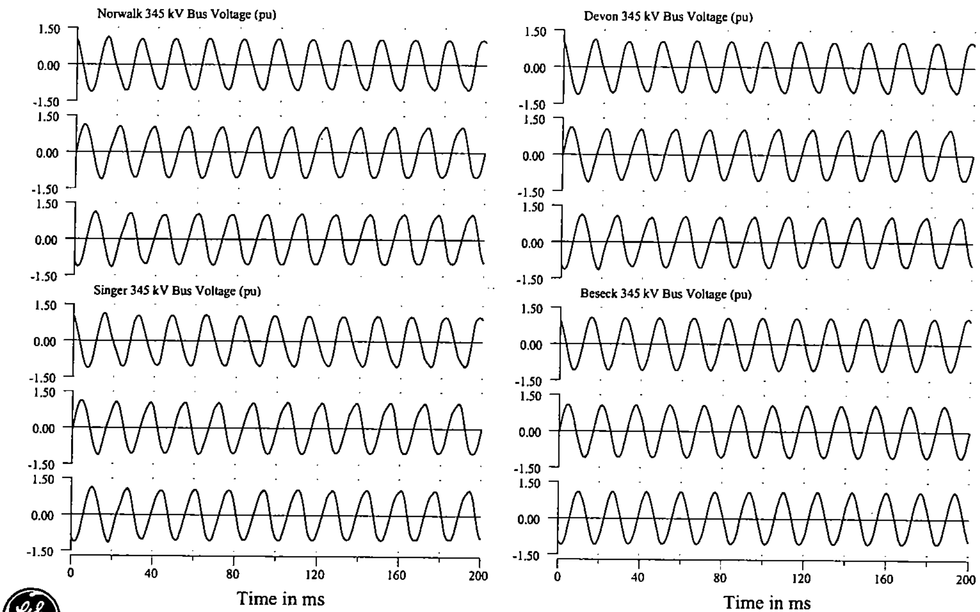
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_01A

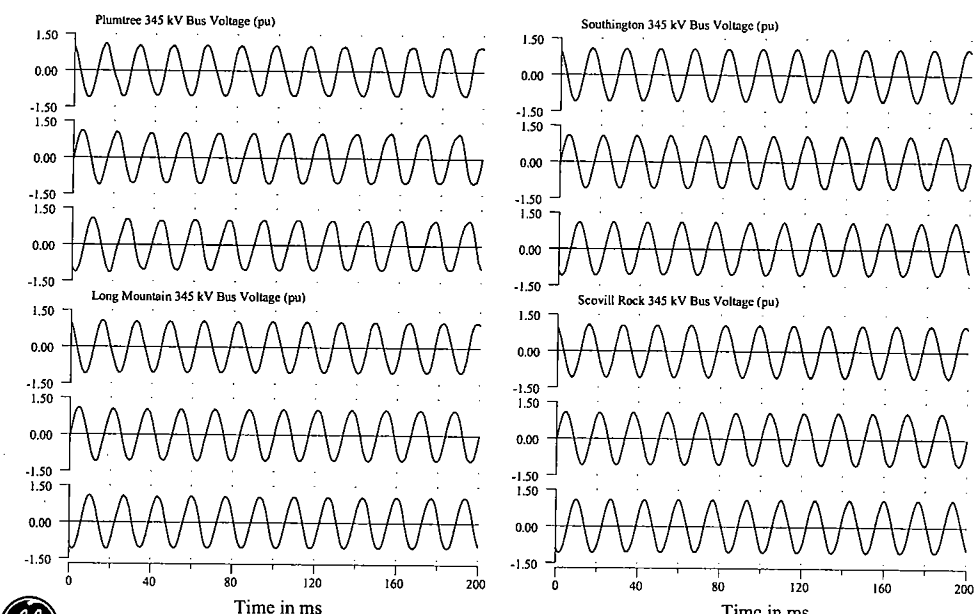
345 kV Bus Voltages



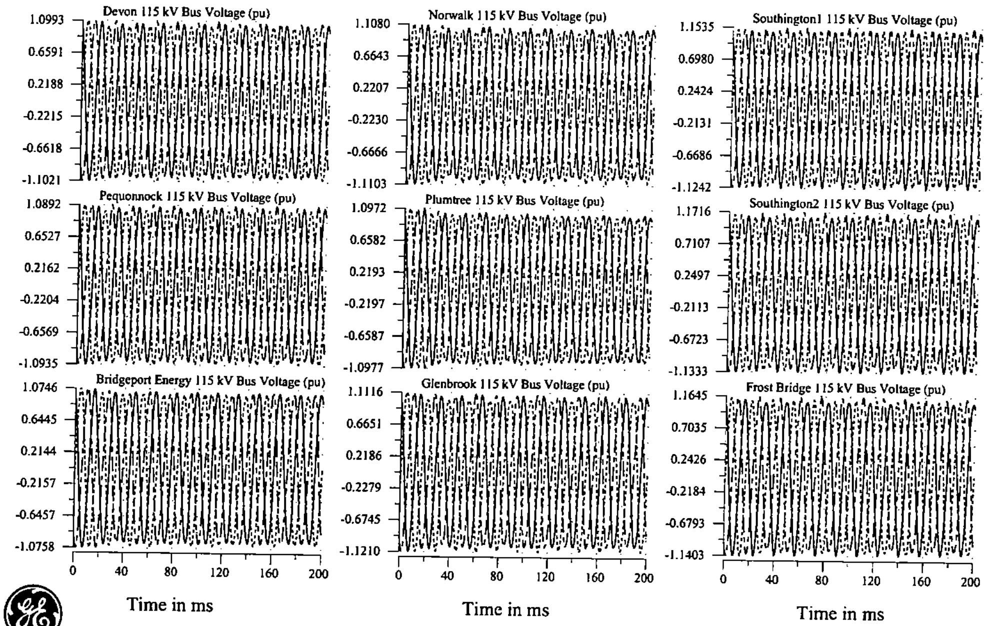
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_01A

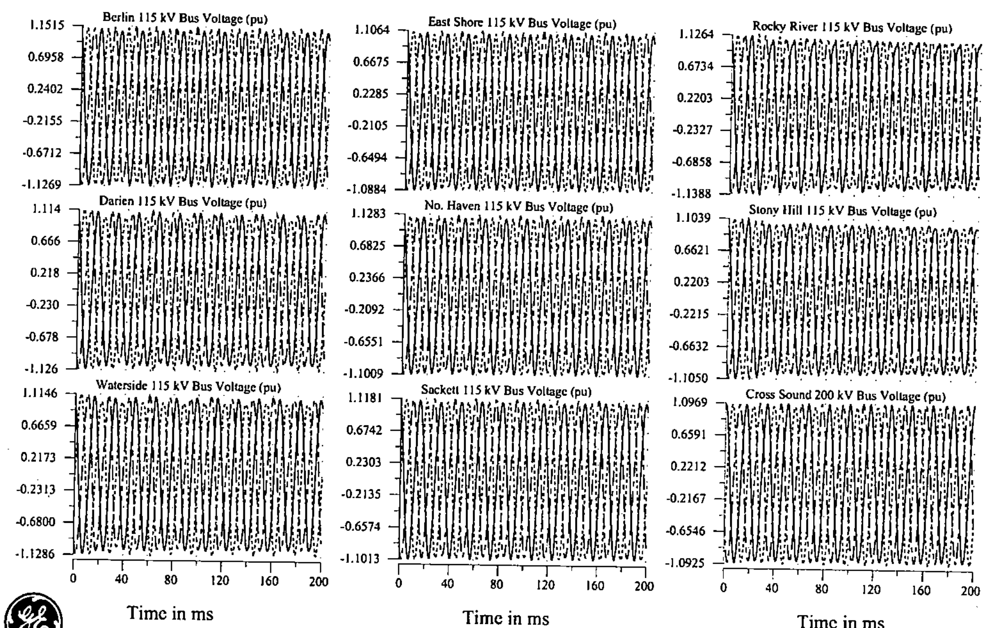
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_01A
11A5 kV Bus Voltages and Capacitor Bank Locations



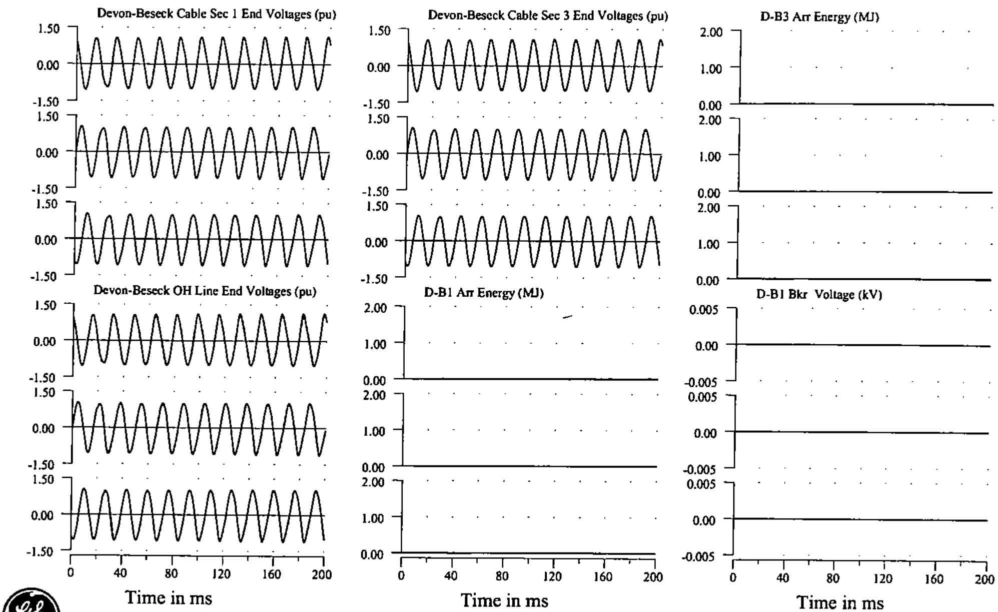
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_01A
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_02

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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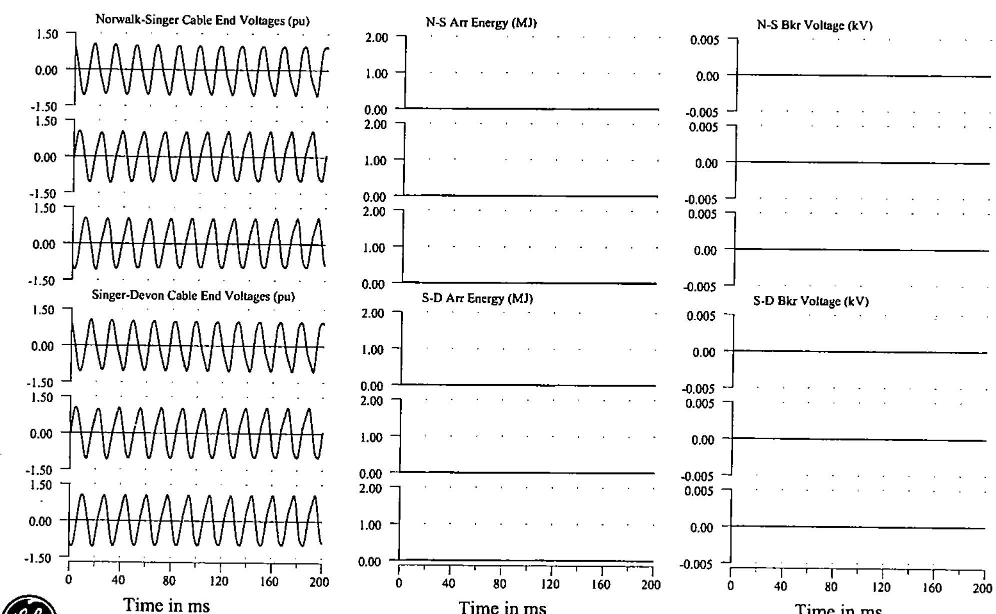
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_02

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

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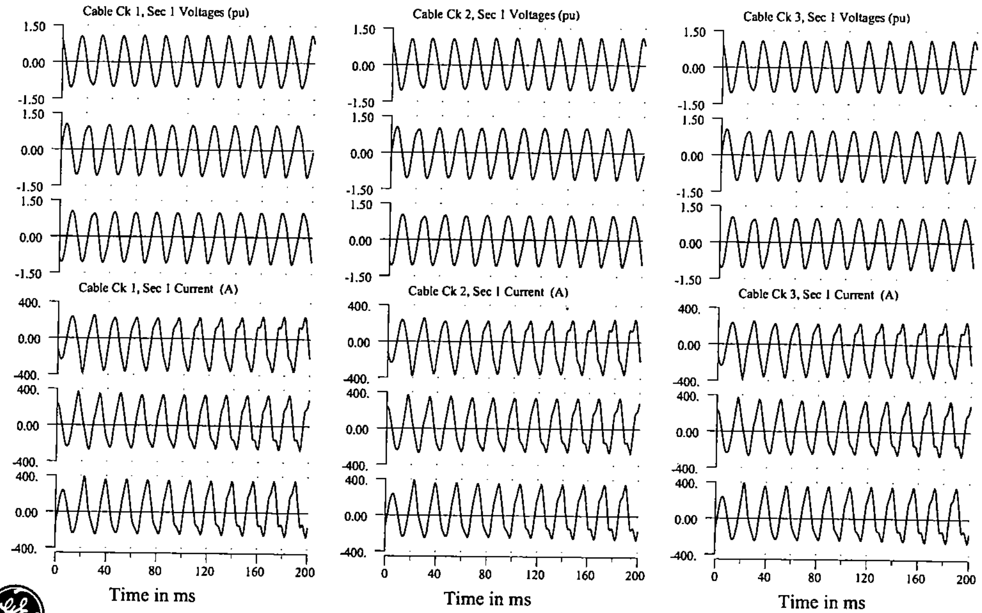
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

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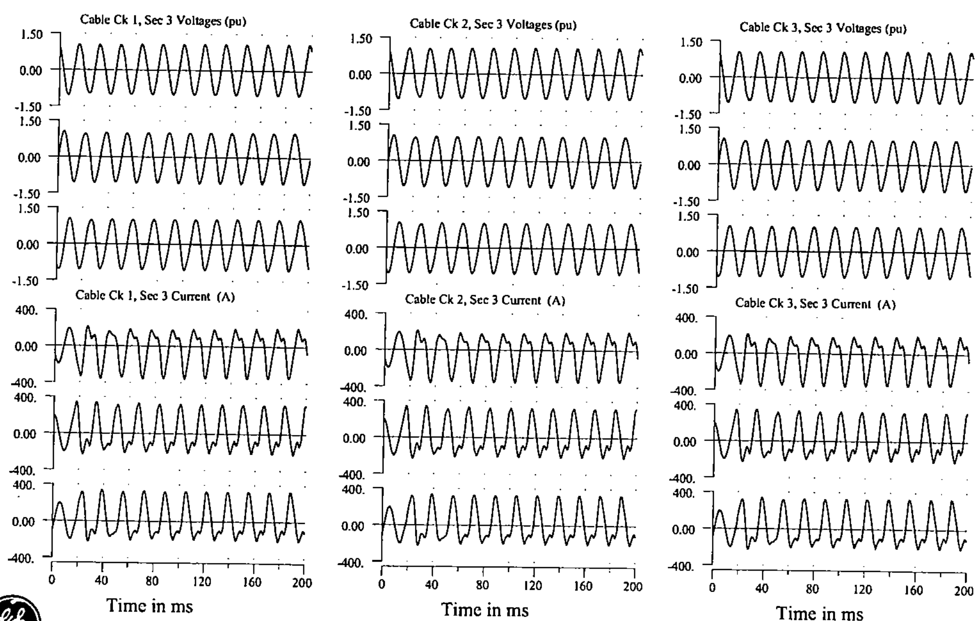
Devon-Beseck 345 kV Cables



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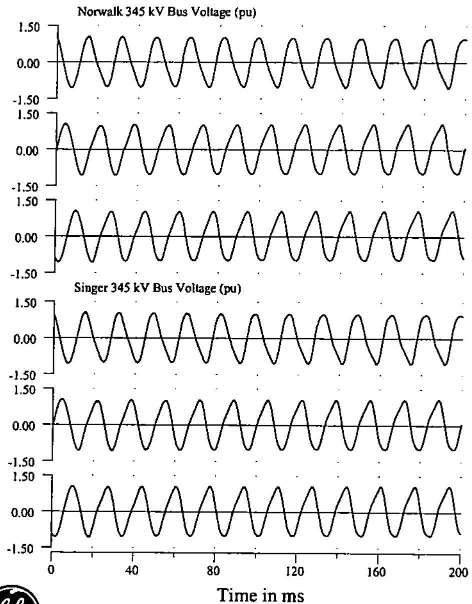
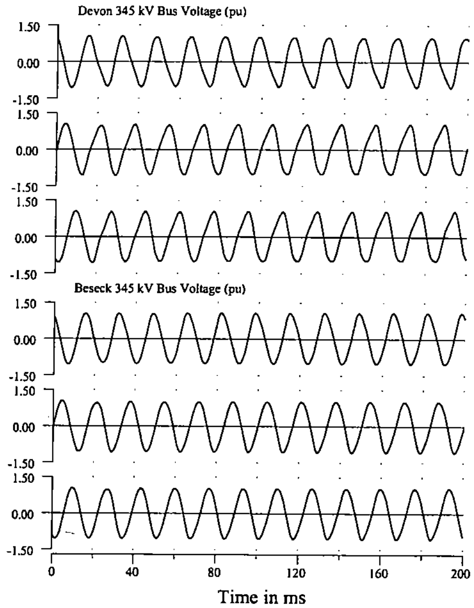
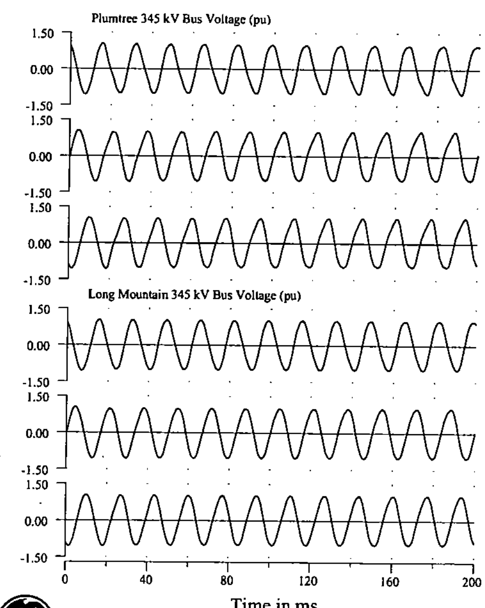
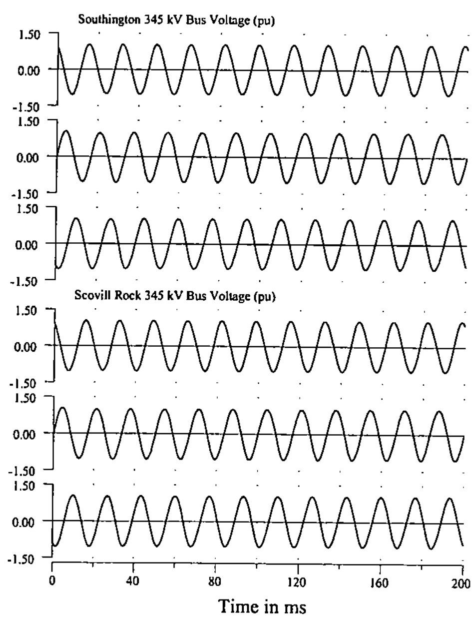
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_02
345 kV Bus Voltages



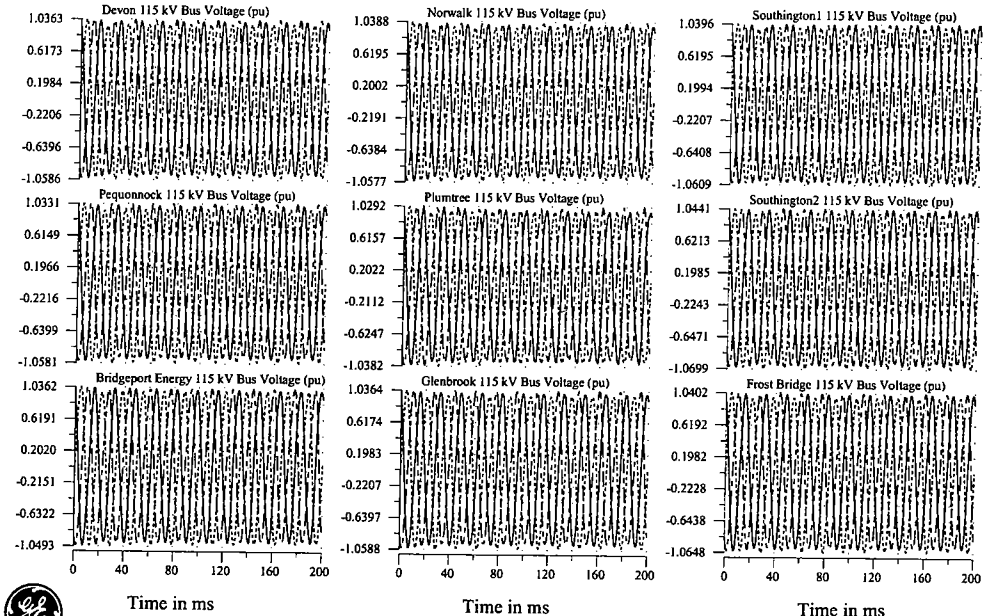


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_02
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_02
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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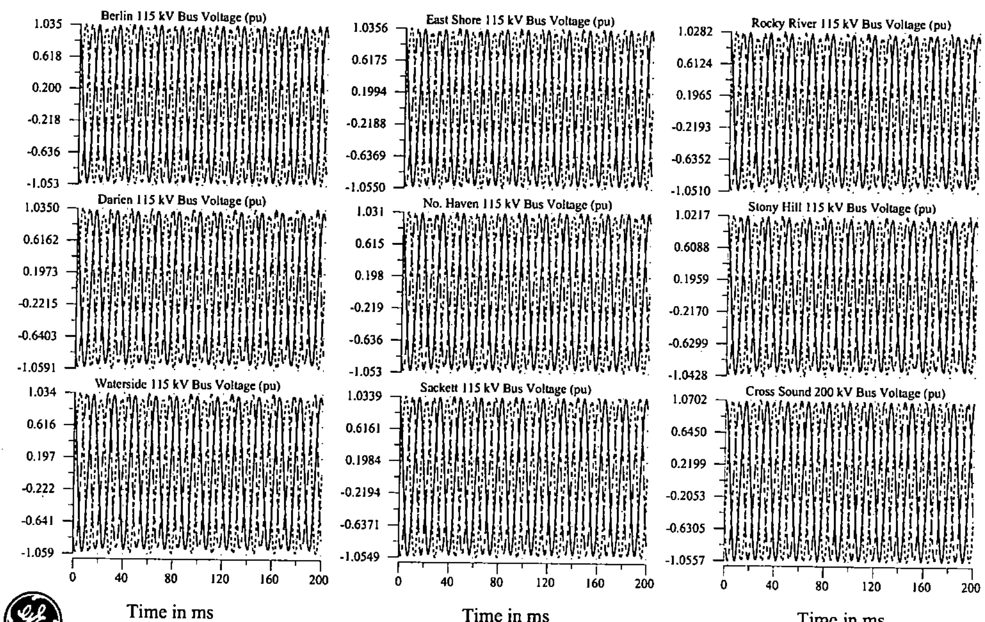
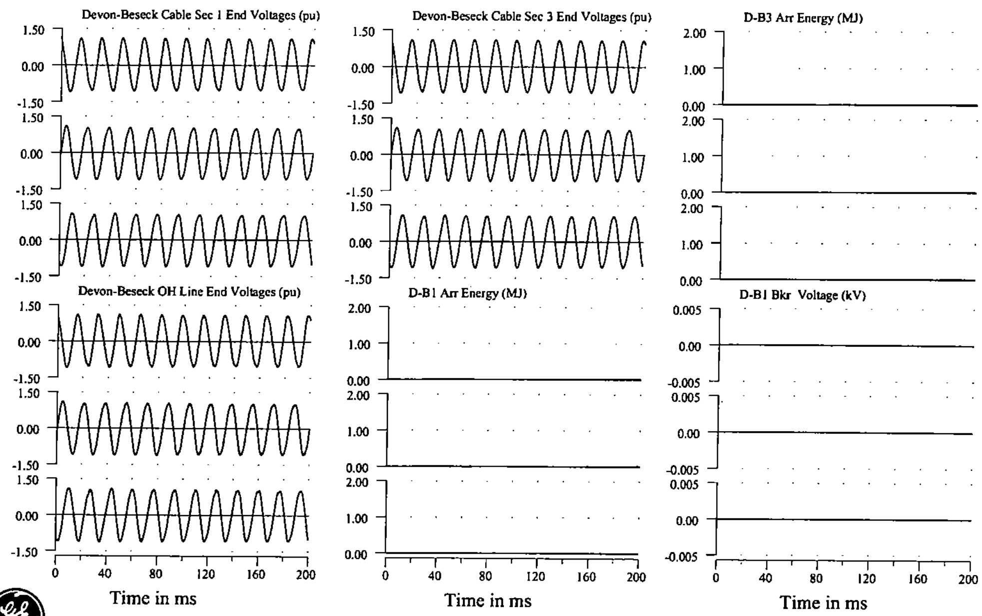
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_03

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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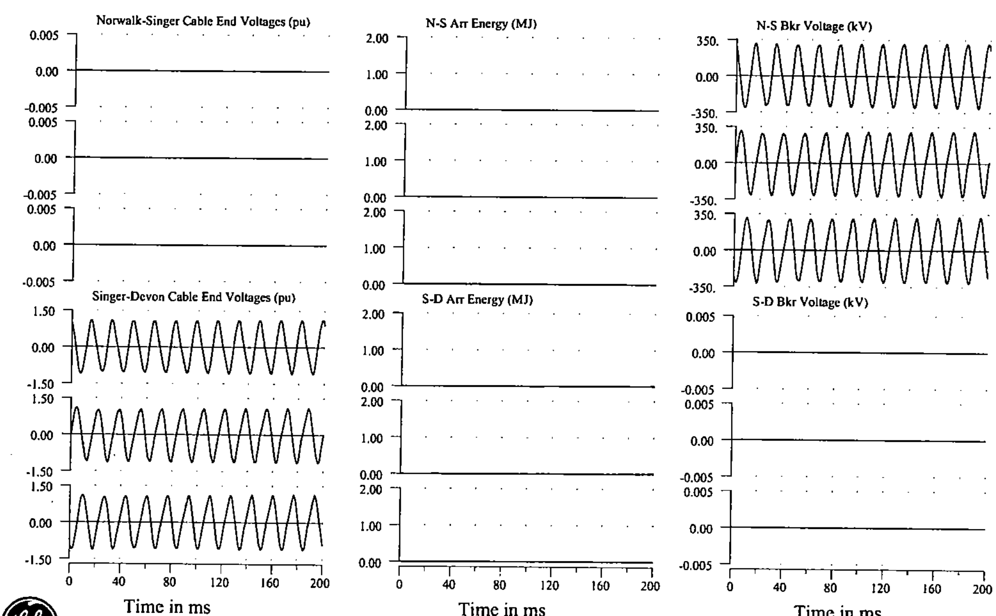
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_03

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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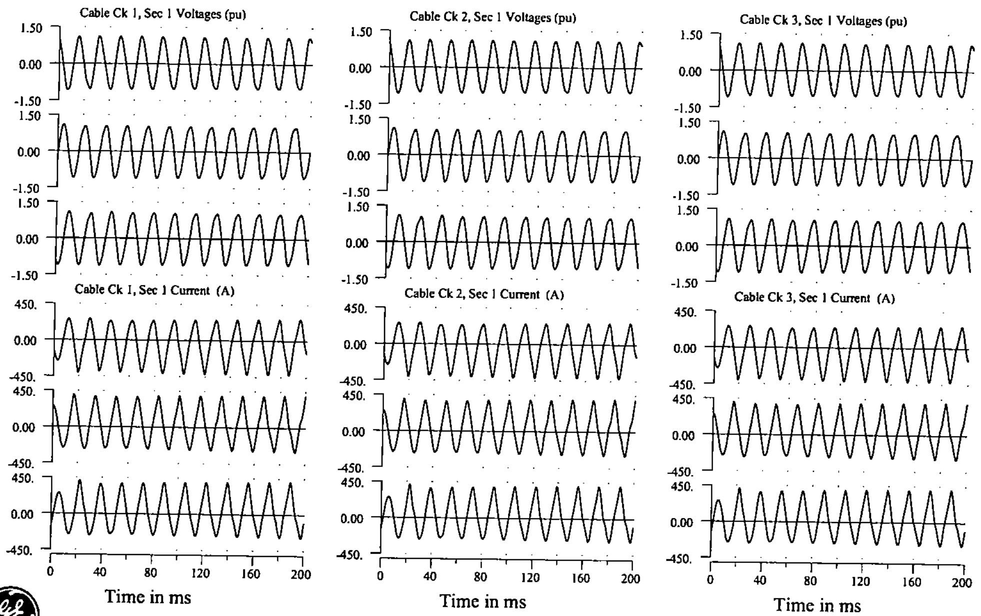
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_03
Devon-Beseck 345 kV Cables



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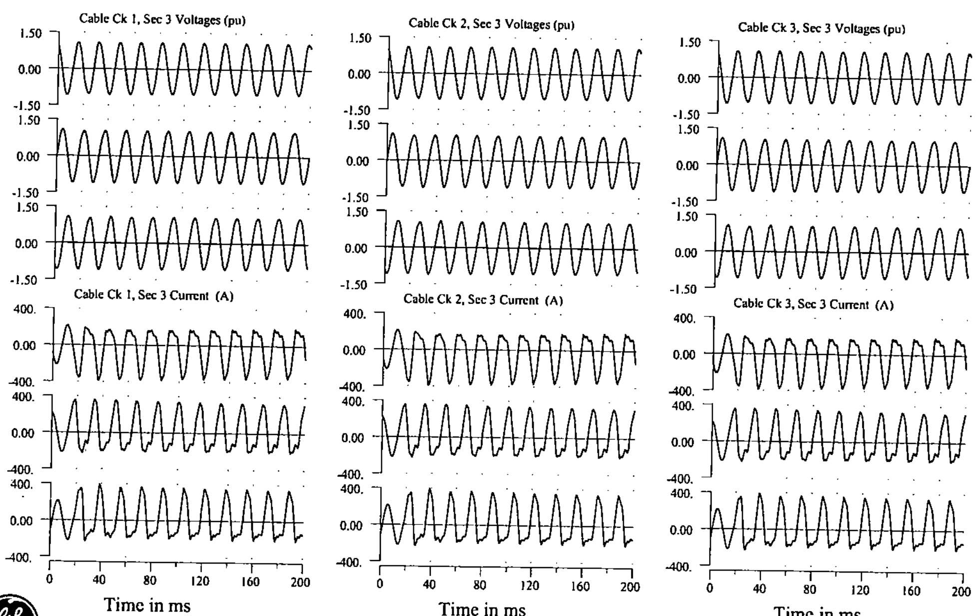
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_03
Devon-Beseck 345 kV Cables



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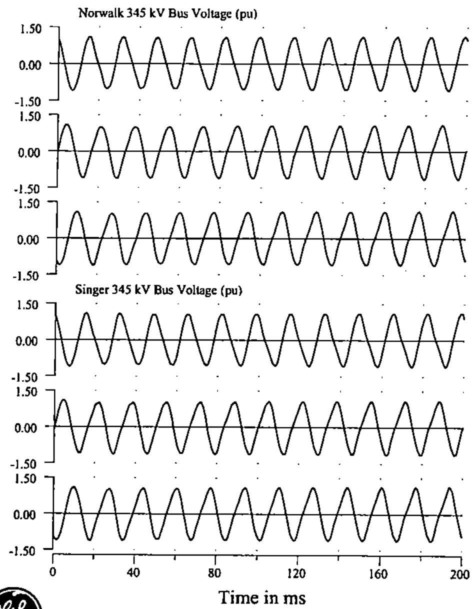
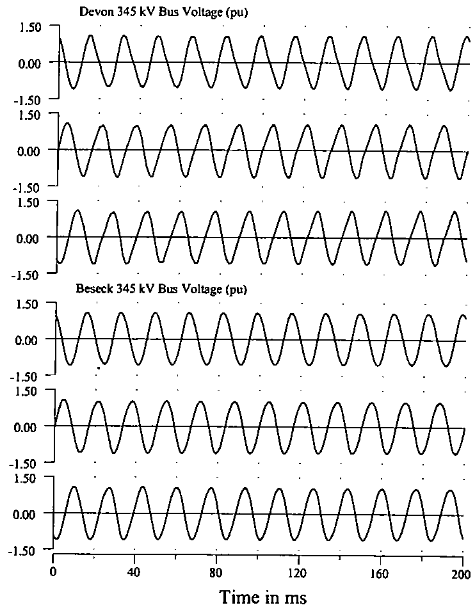
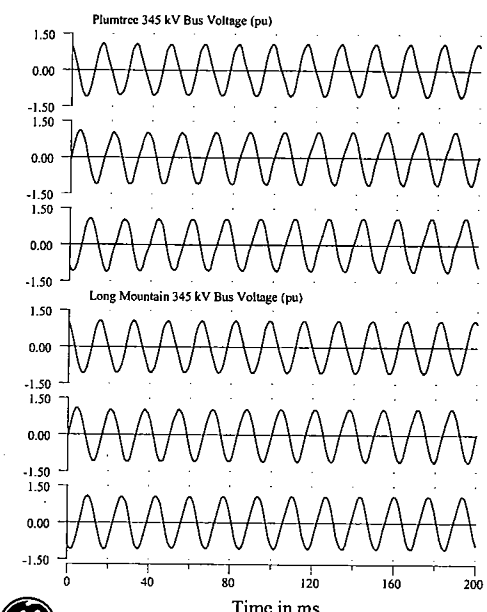
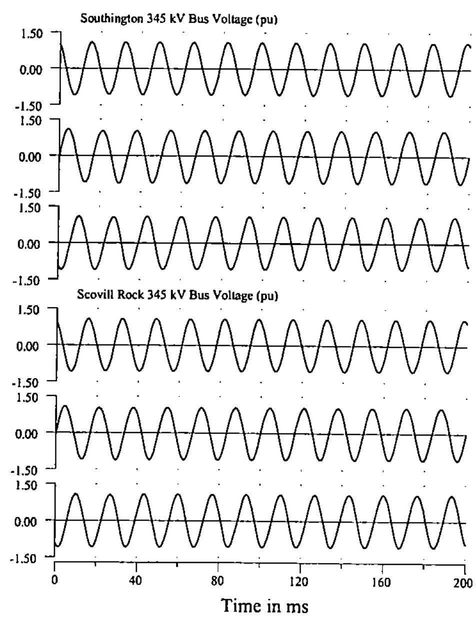
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_03
345 kV Bus Voltages



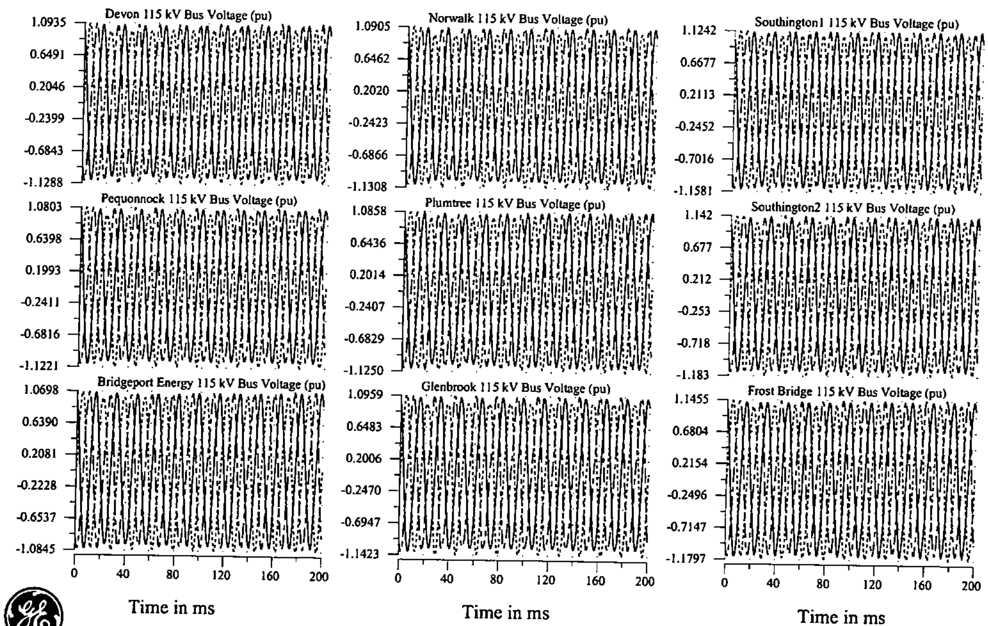


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_03
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_03
115 kV Bus Voltages and Capacitor Bank Locations



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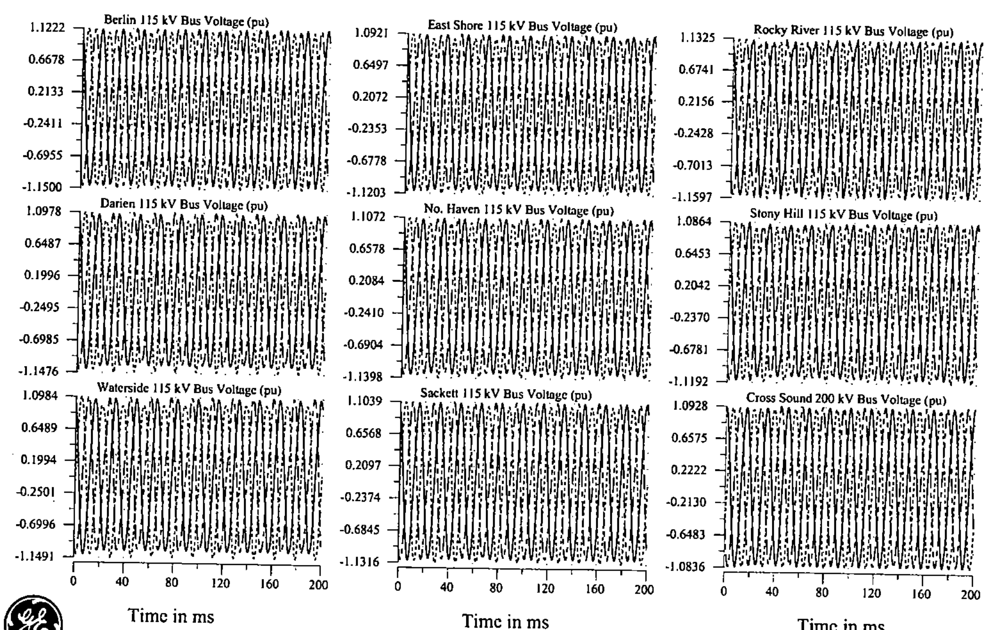
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_03
115 kV Bus Voltages and Capacitor Bank Locations



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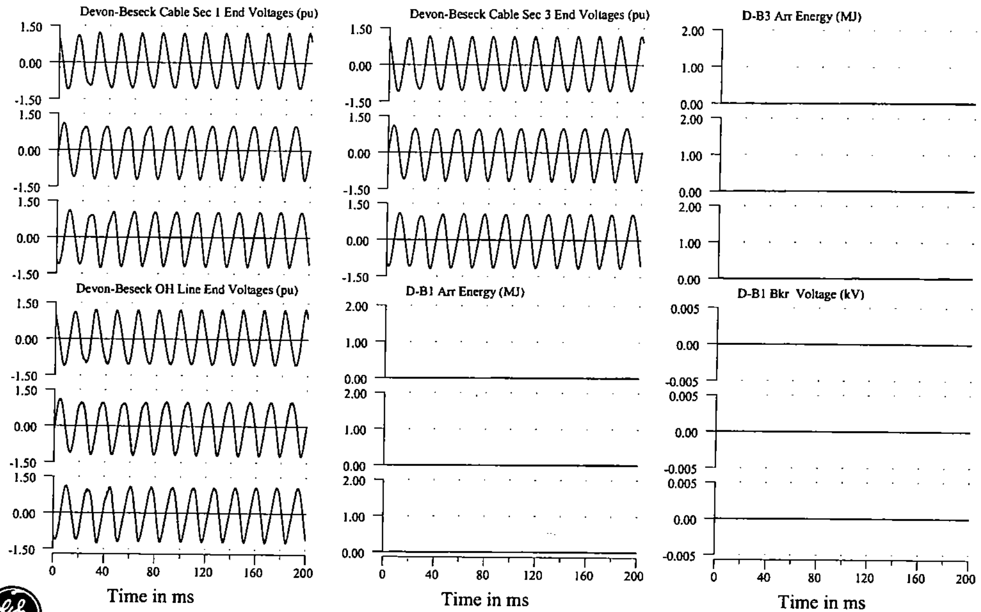
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_04

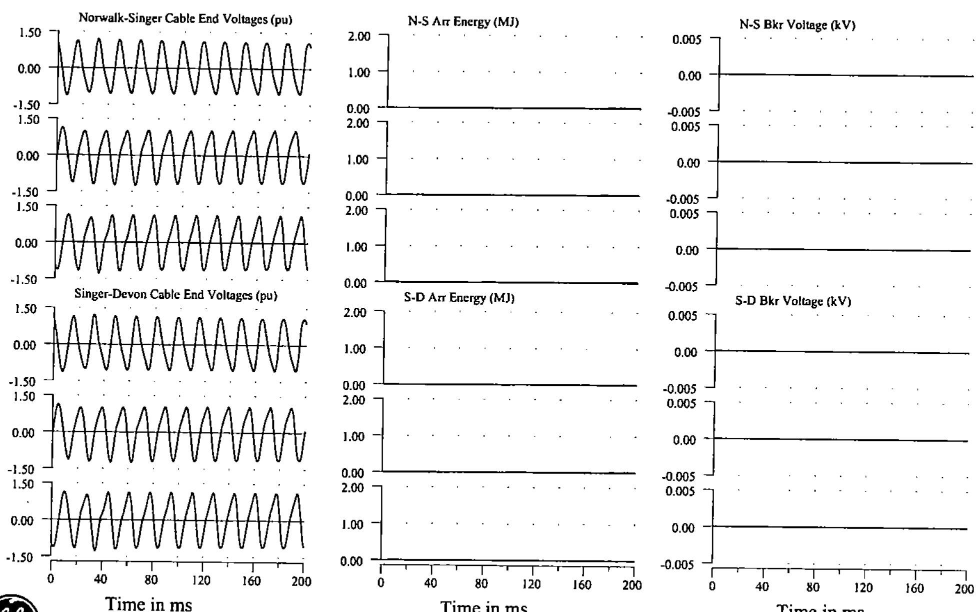
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



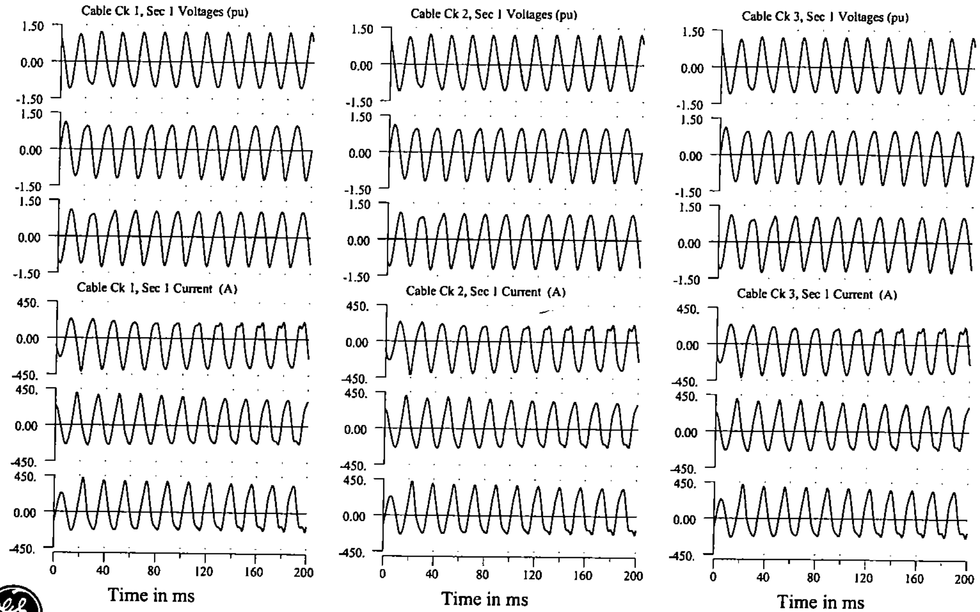
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_04

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_04
Devon-Beseck 345 kV Cables



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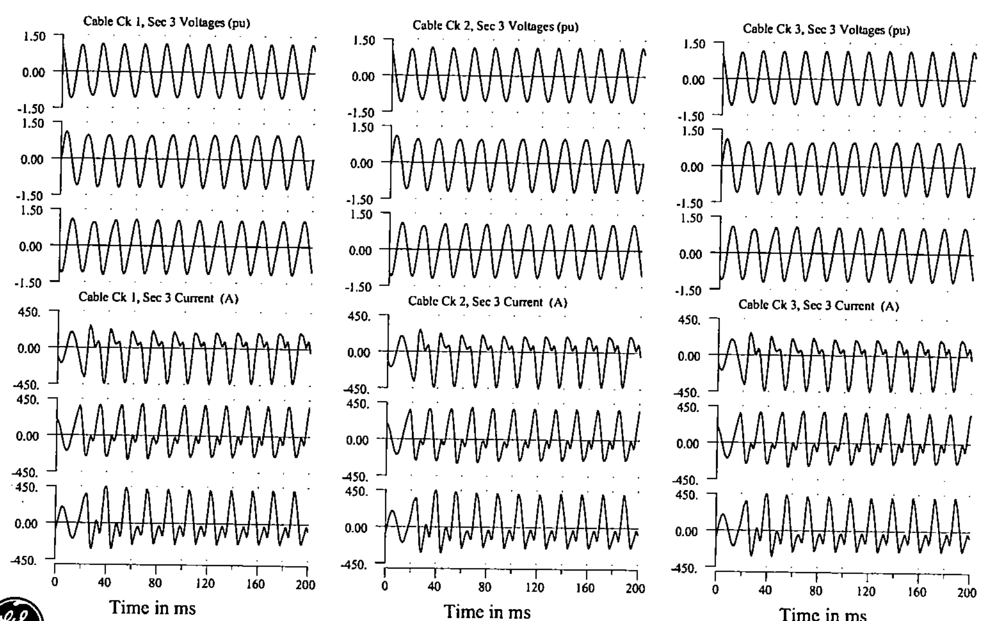
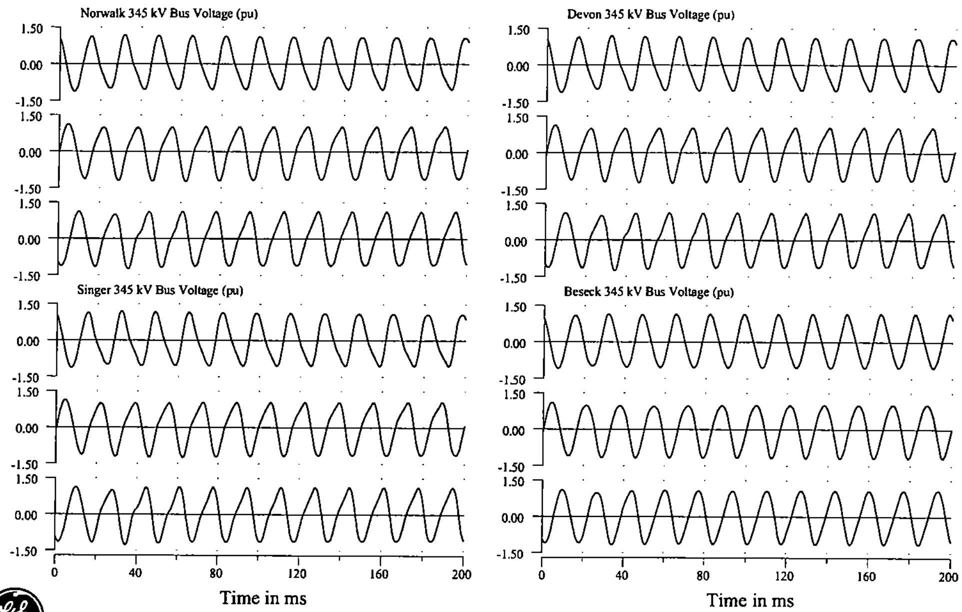
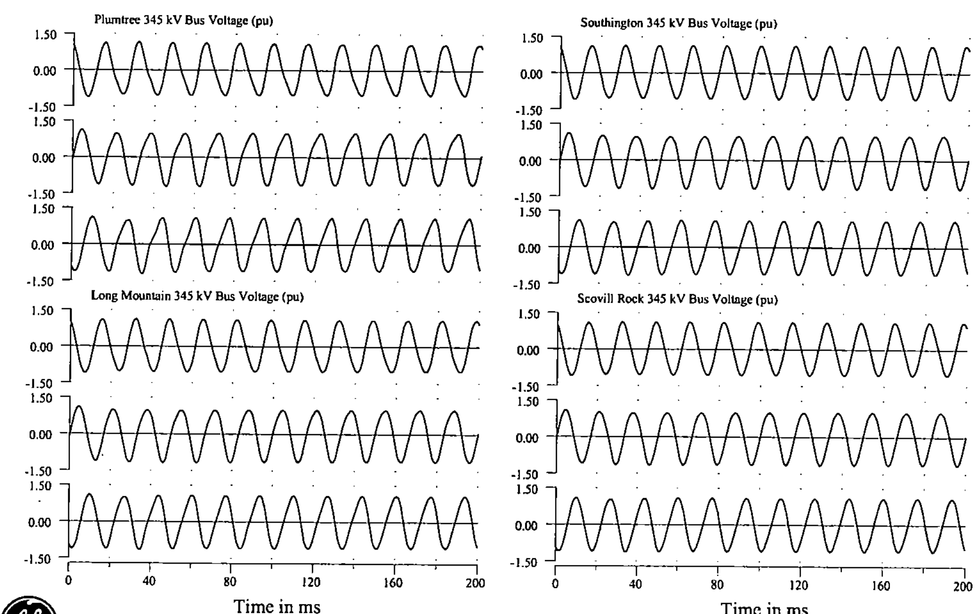
Devon-Beseck 345 kV Cables



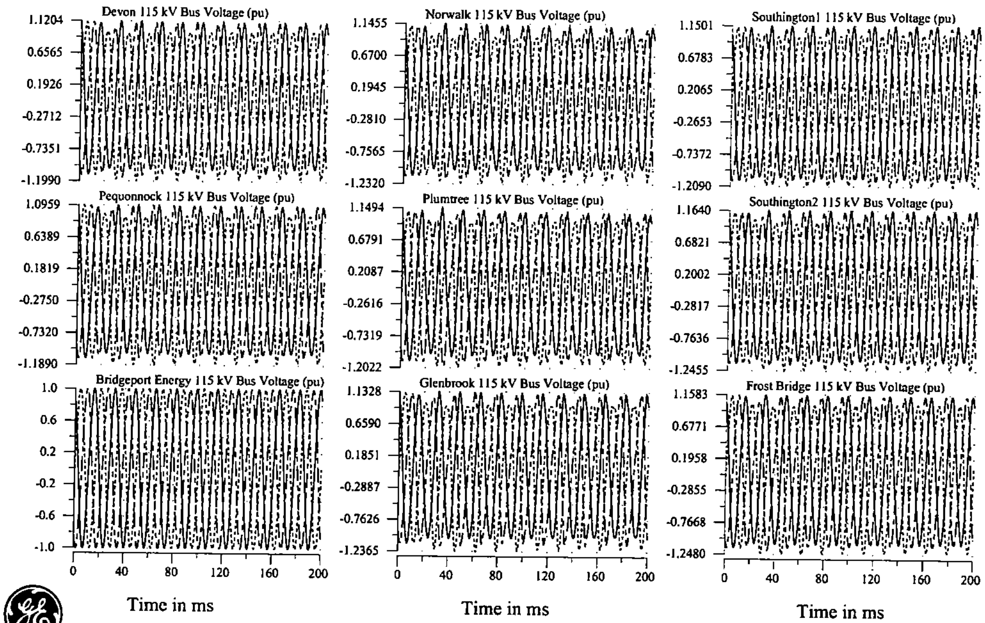
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_04
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_04
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_04
115 kV Bus Voltages and Capacitor Bank Locations



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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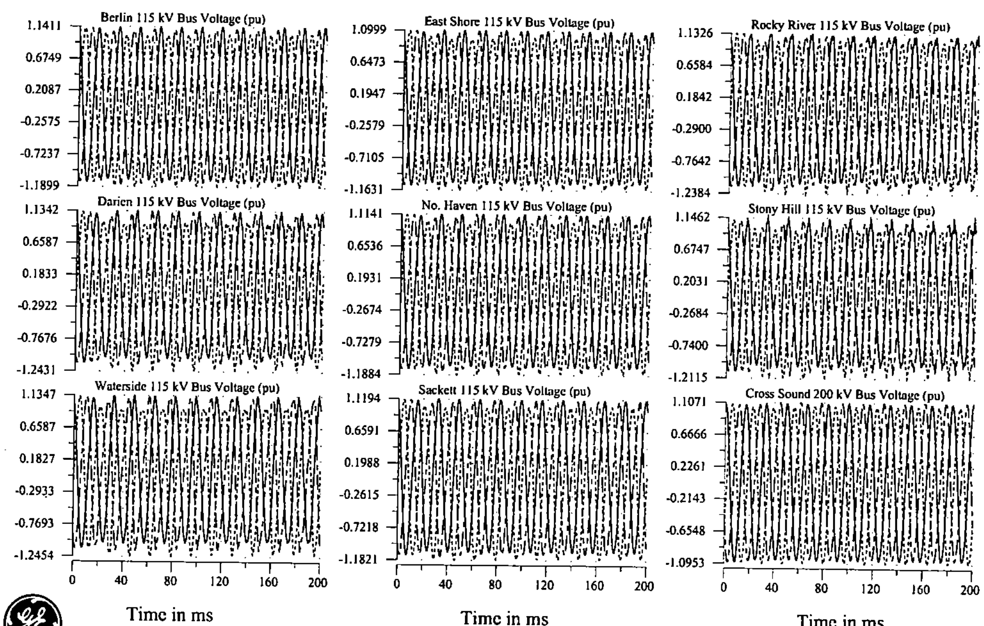
115 kV Bus Voltages and Capacitor Bank Locations



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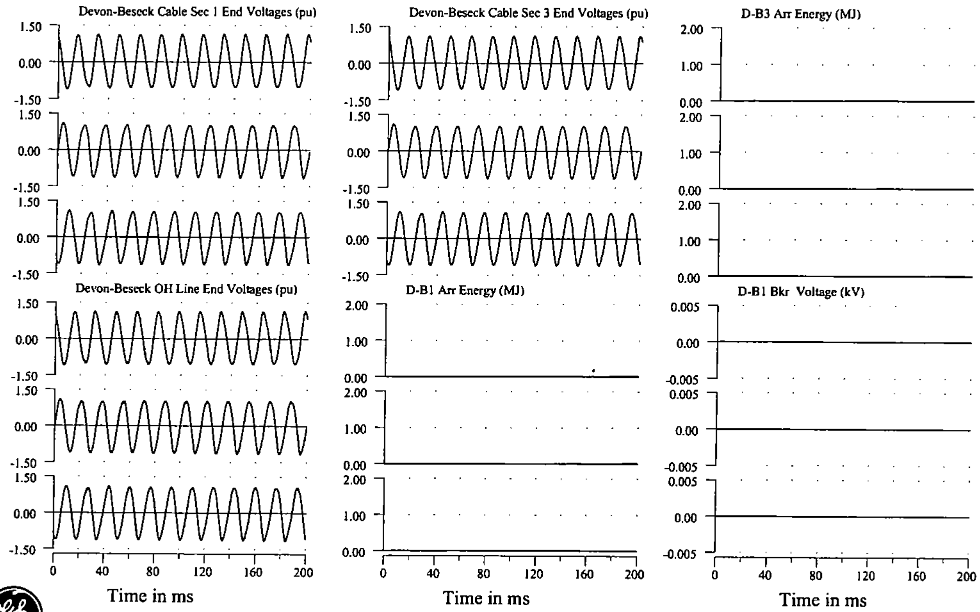
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_05
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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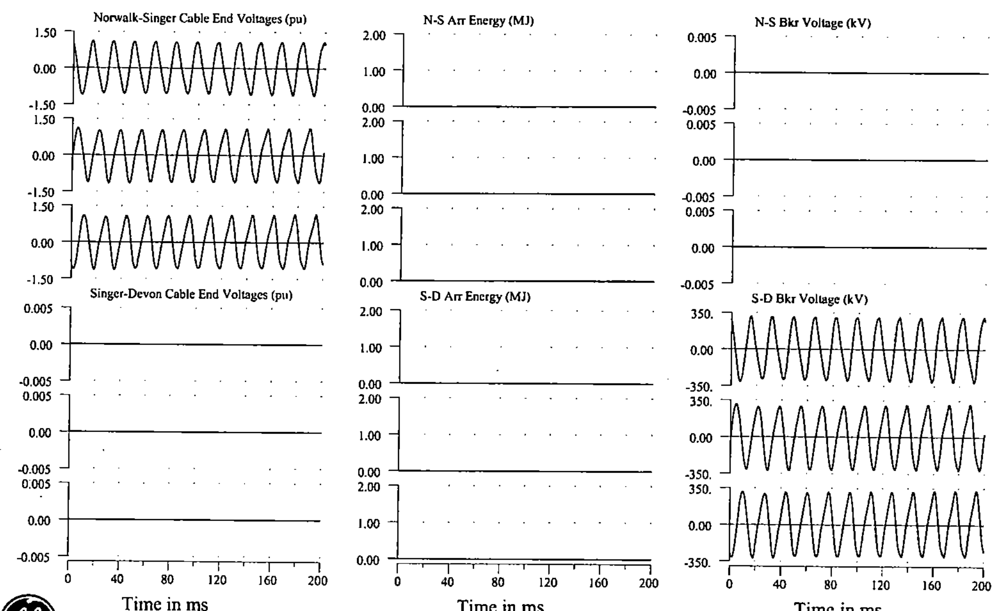
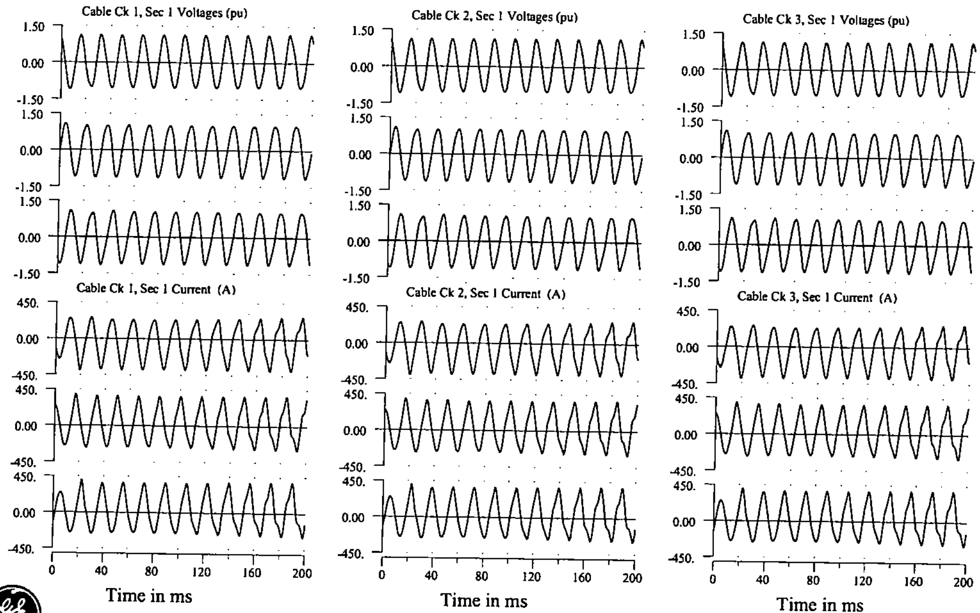
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_05

Devon-Beseck 345 kV Cables



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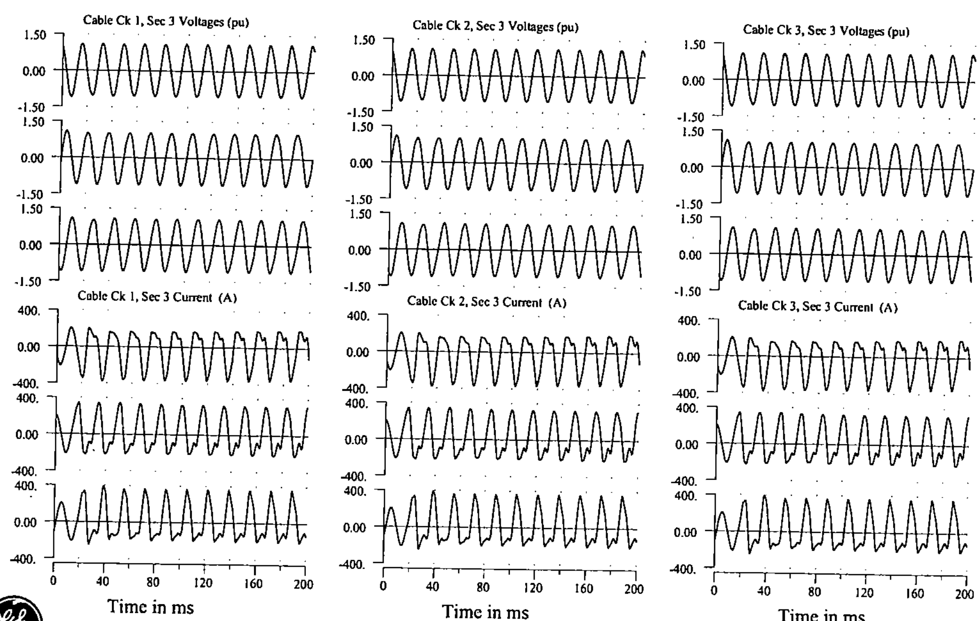
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_05

Devon-Beseck 345 kV Cables



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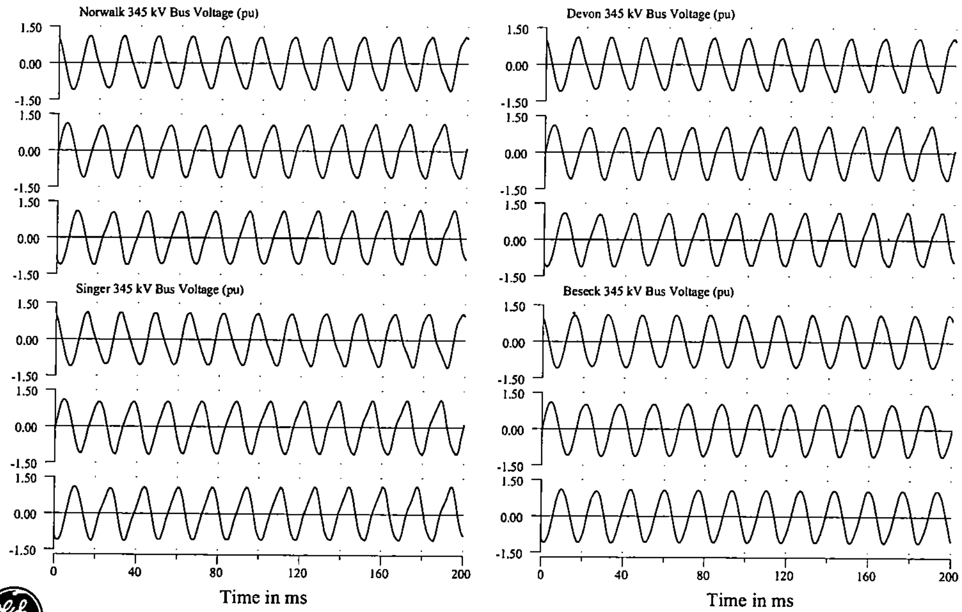
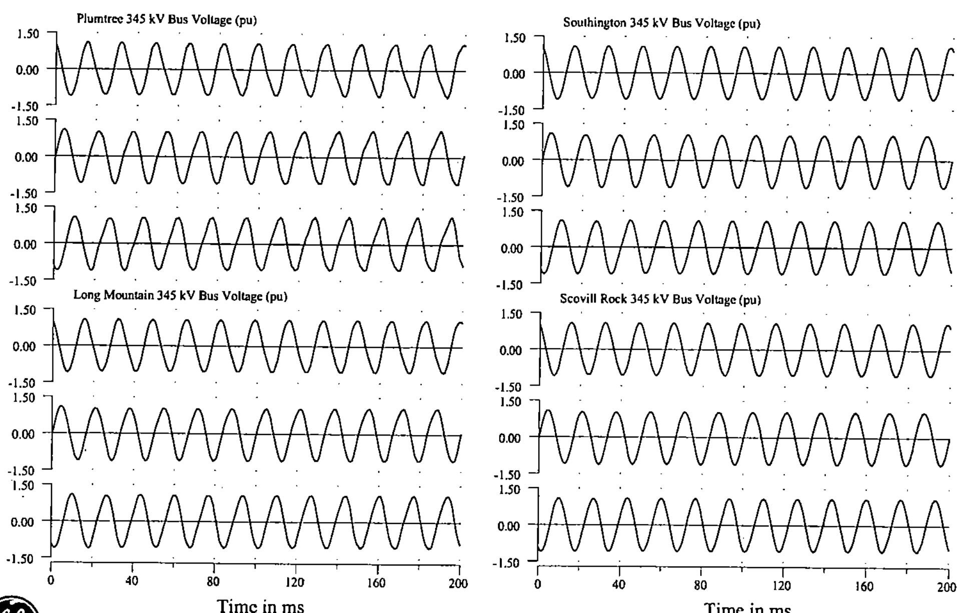
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_05
345 kV Bus Voltages



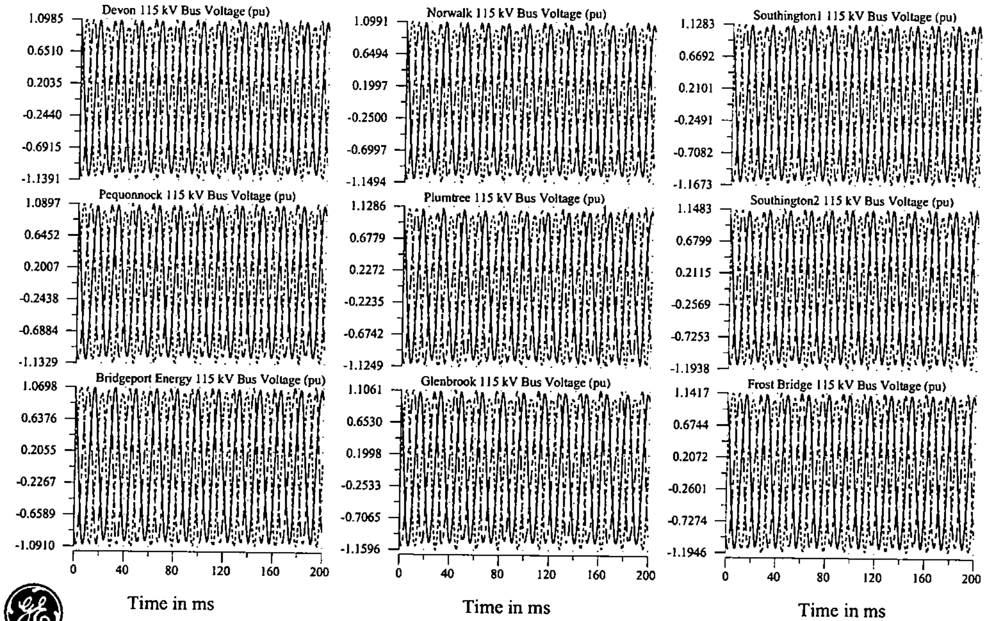
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
2_05
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_05

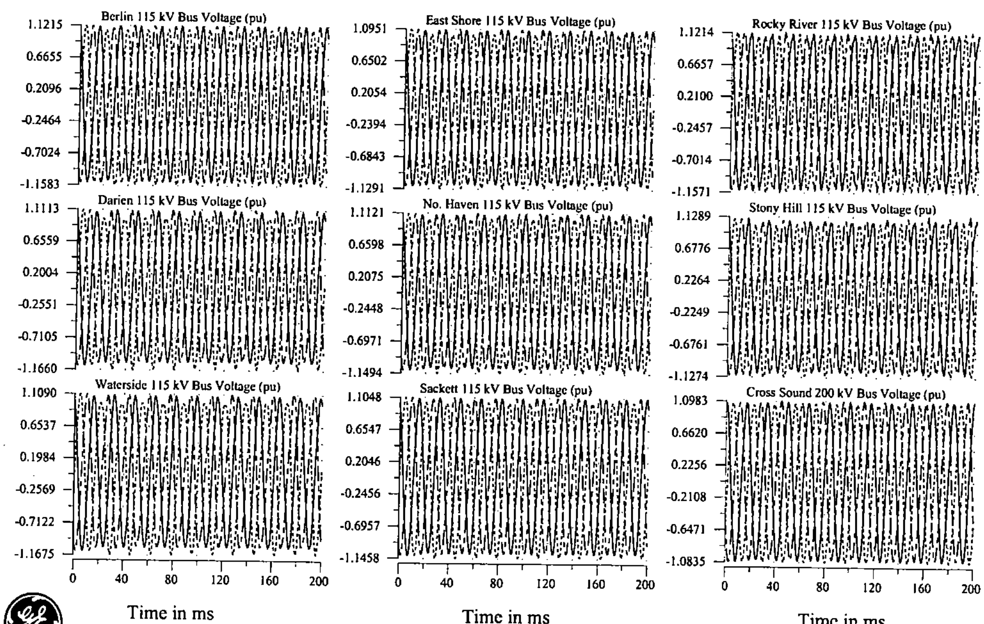
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

2_05

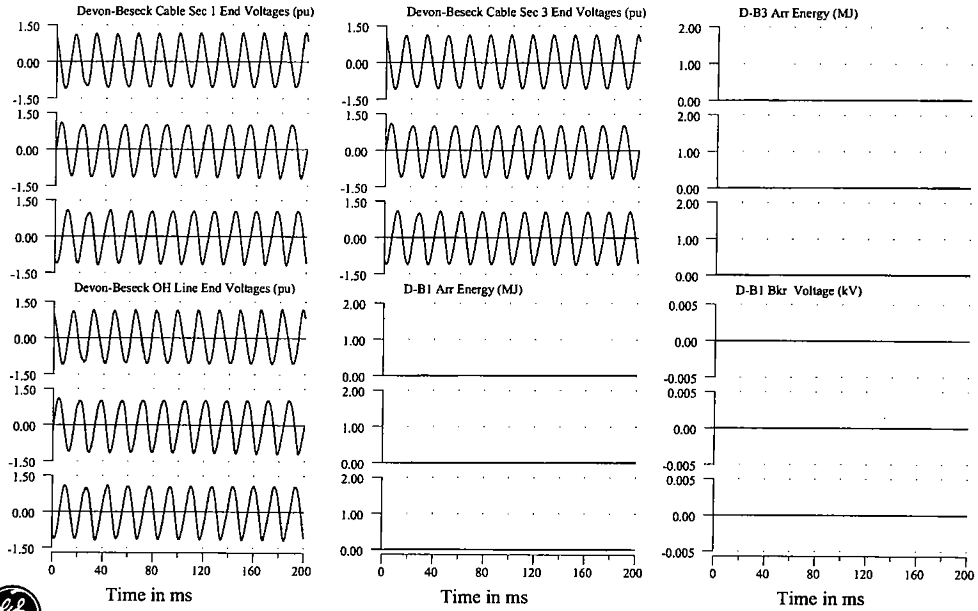
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_01

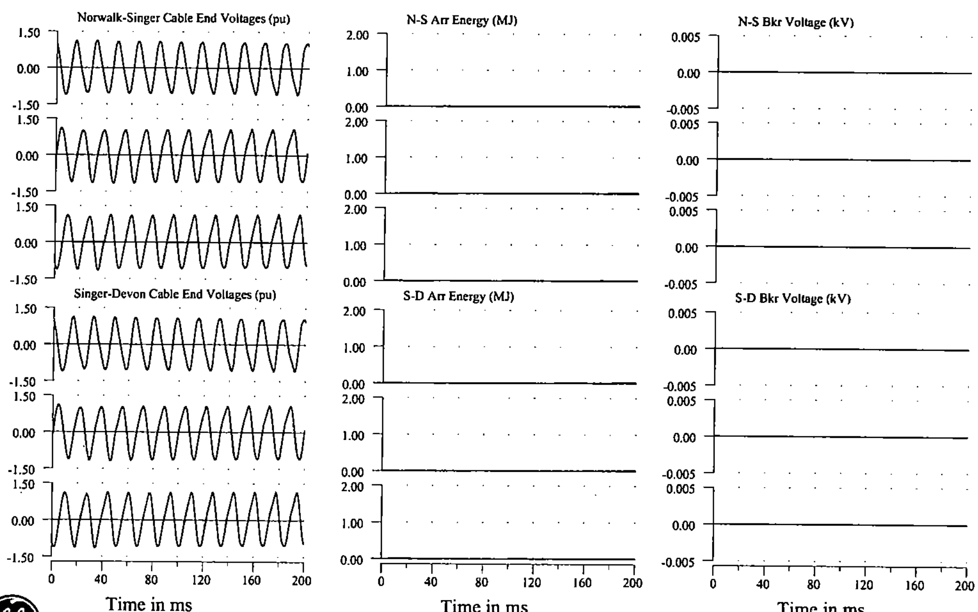
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



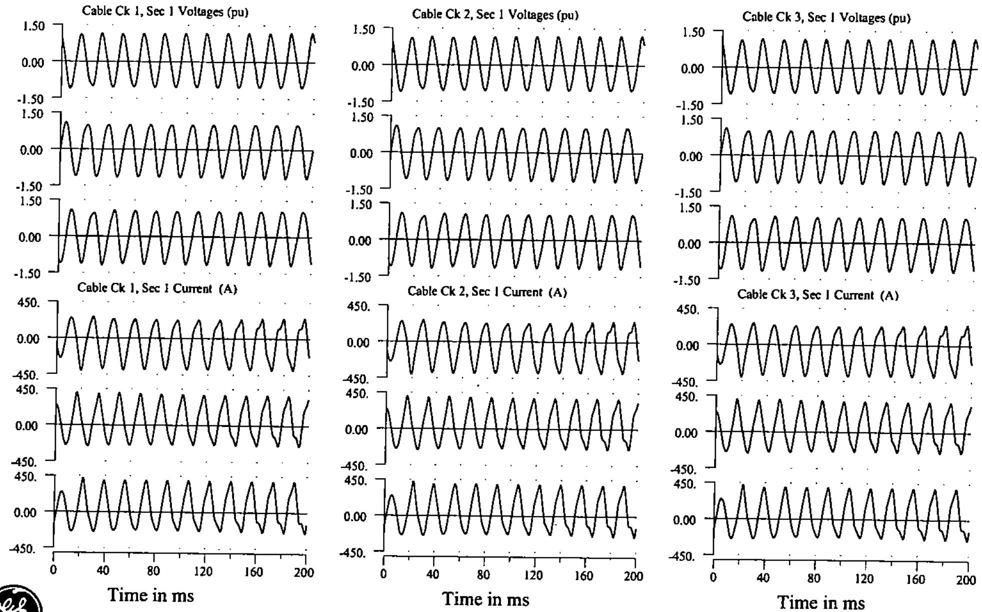
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_01

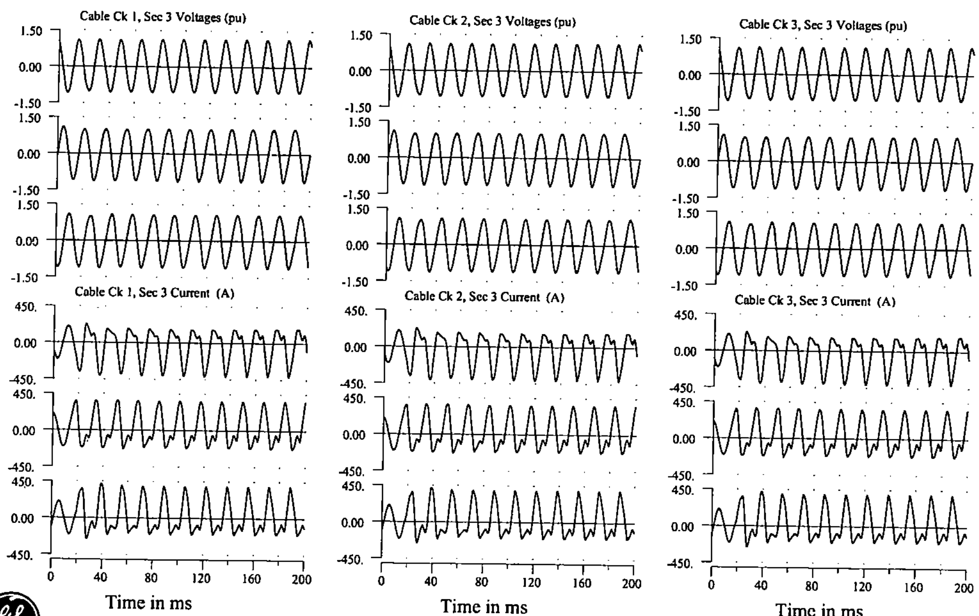
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_01
Devon-Beseck 345 kV Cables



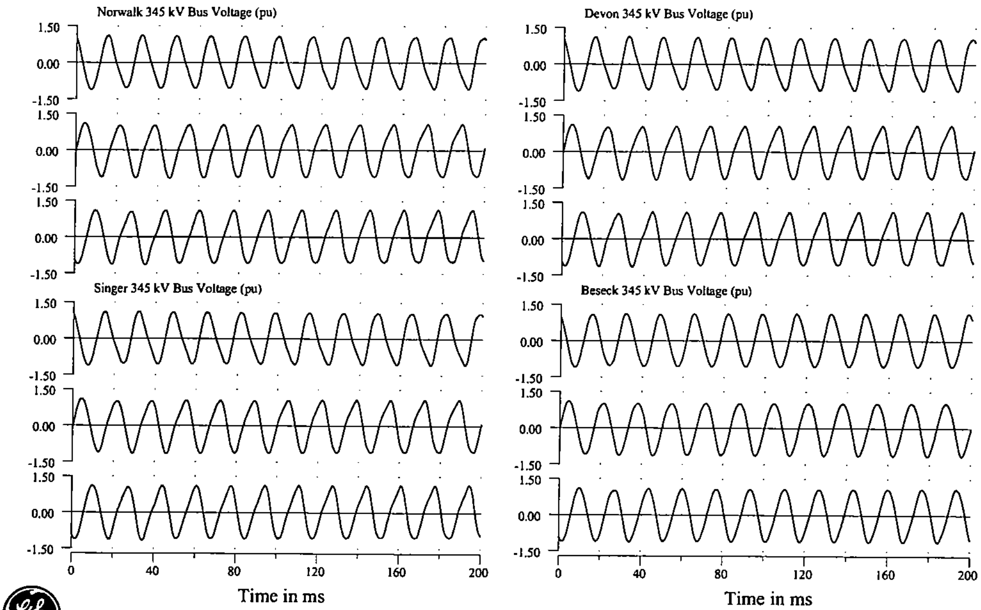
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_01
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_01

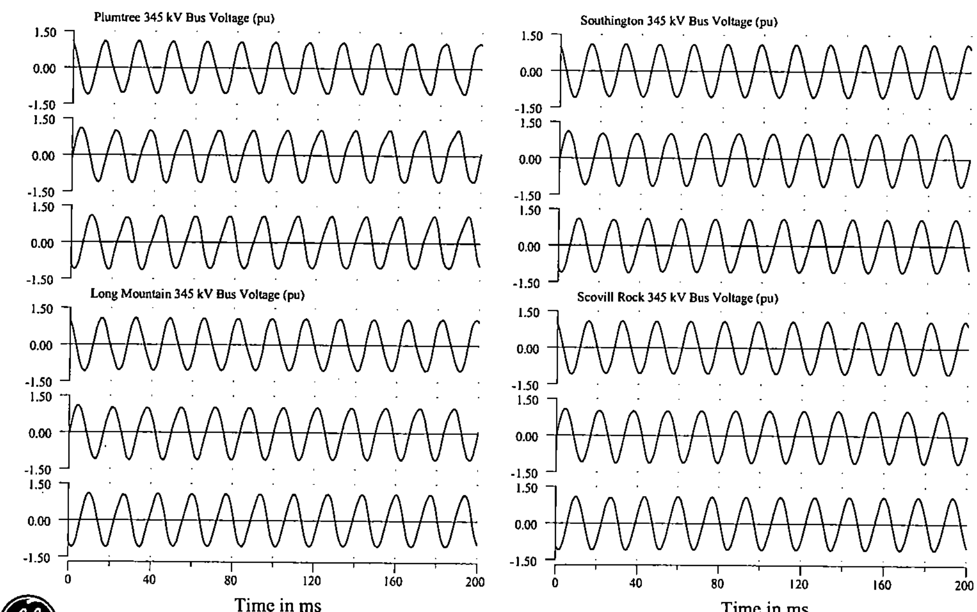
345 kV Bus Voltages



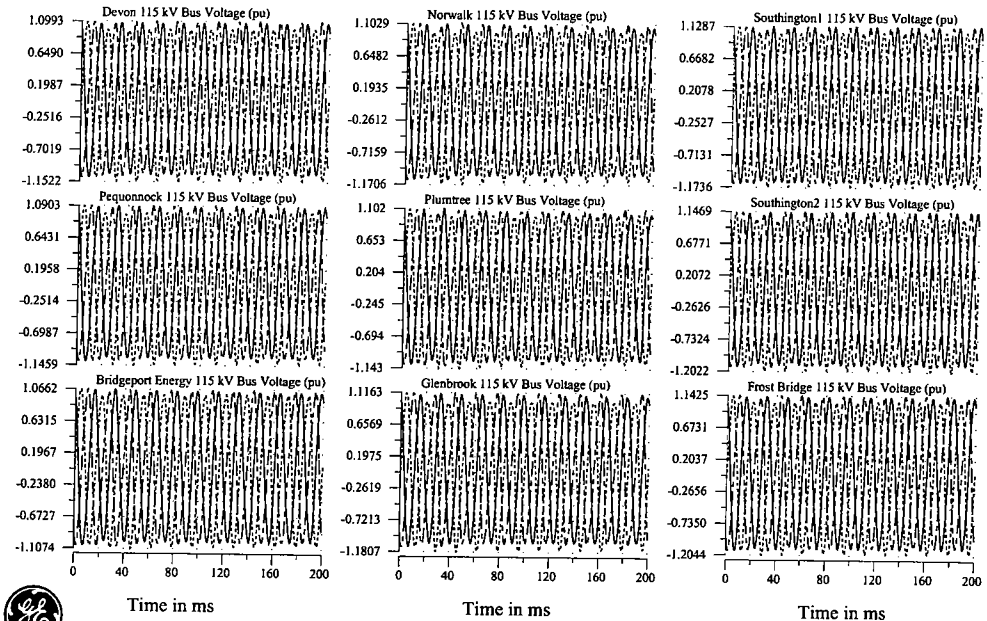
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_01

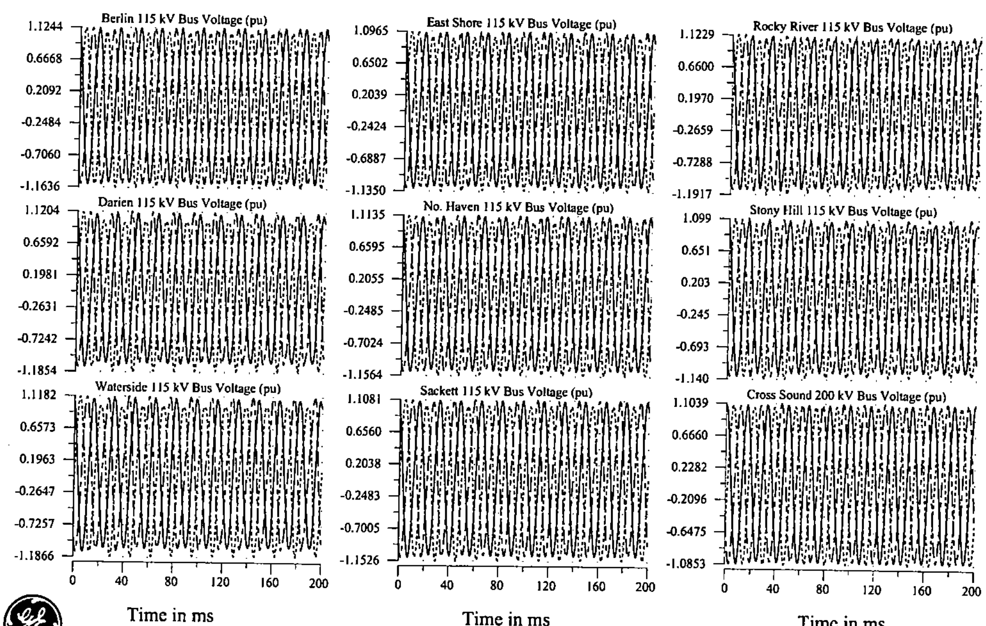
345 kV Bus Voltages



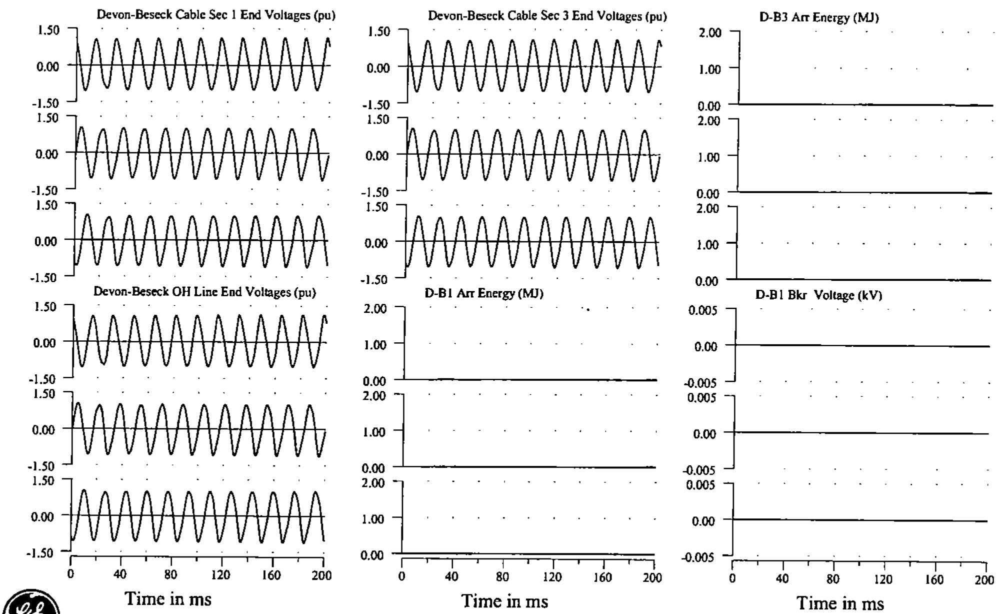
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_01
115 kV Bus Voltages and Capacitor Bank Locations



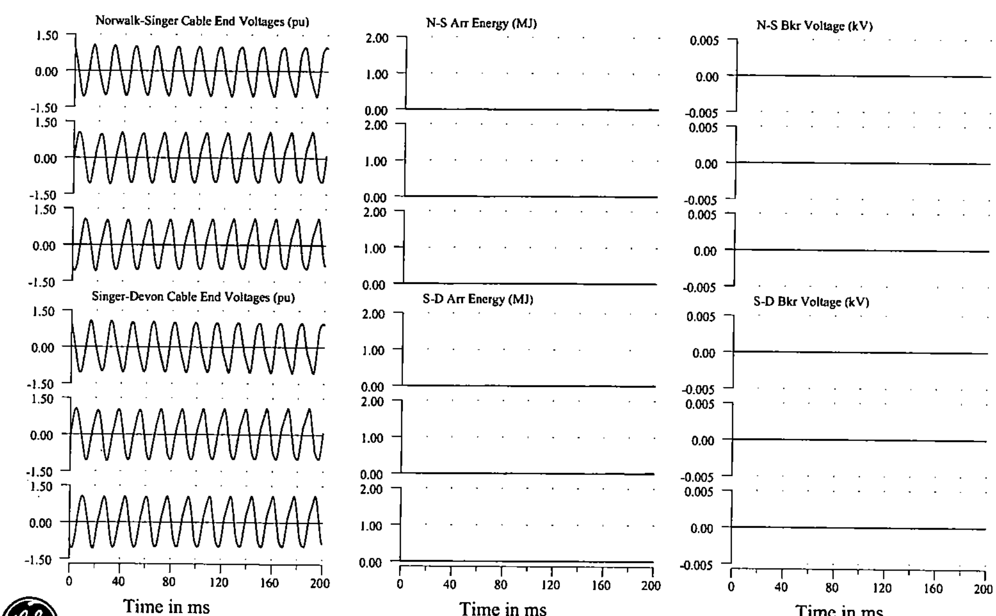
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_01
115 kV Bus Voltages and Capacitor Bank Locations



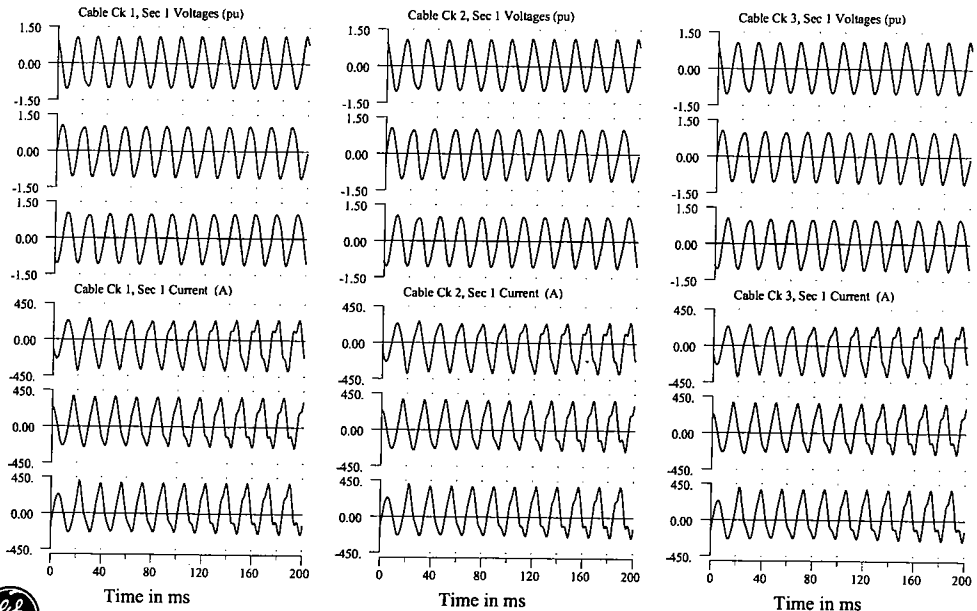
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_02
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_02
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_02
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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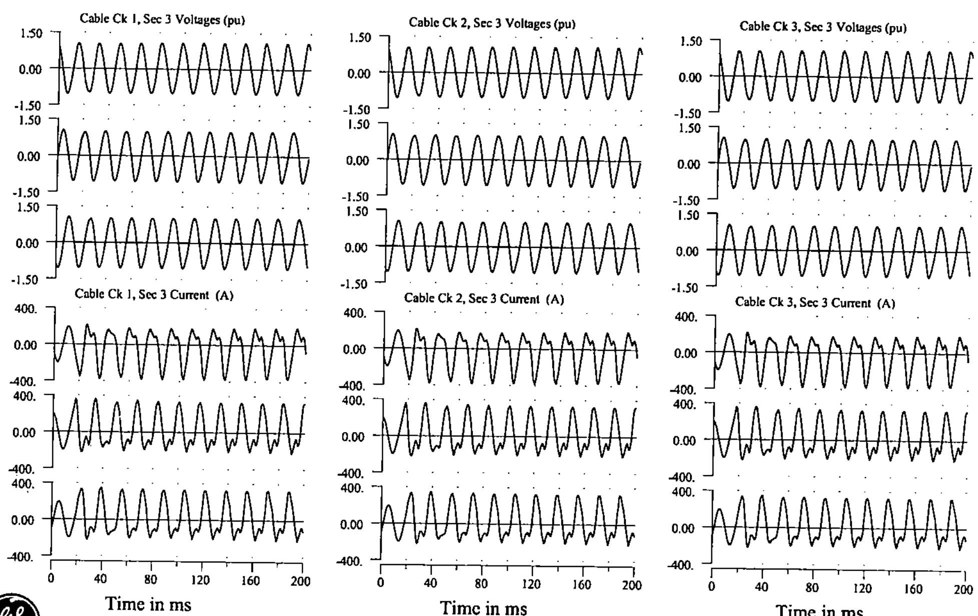
Devon-Beseck 345 kV Cables



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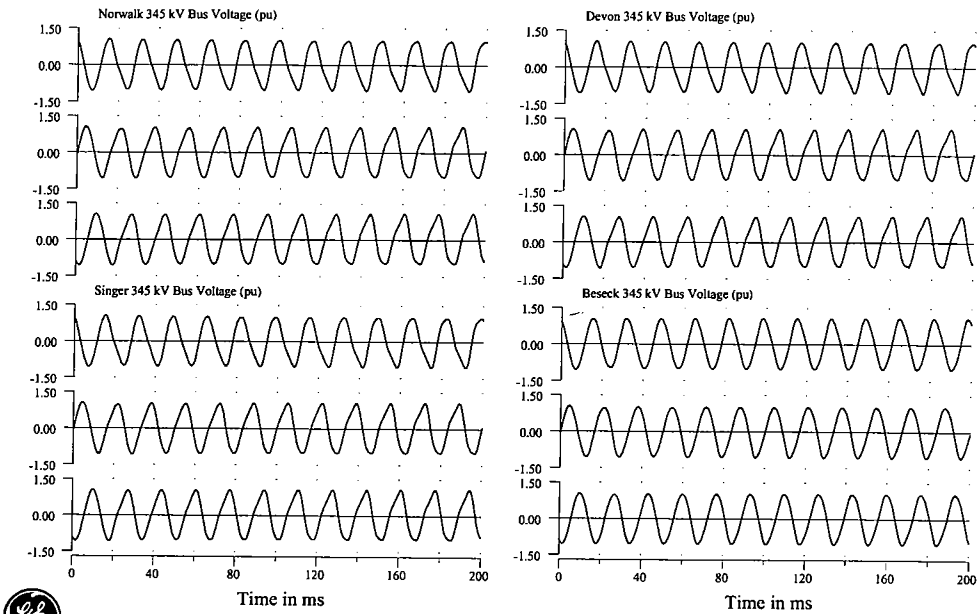
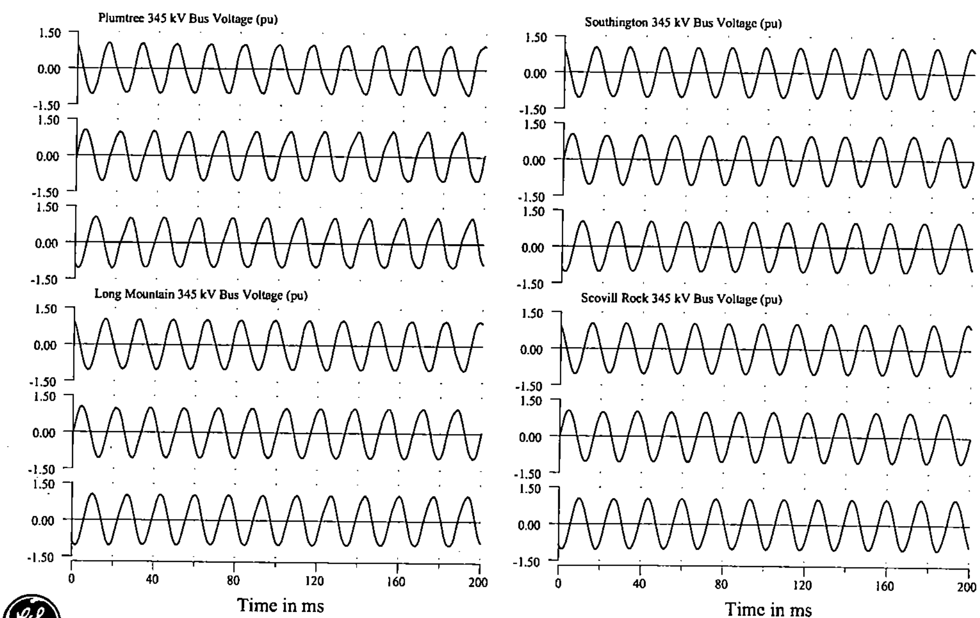
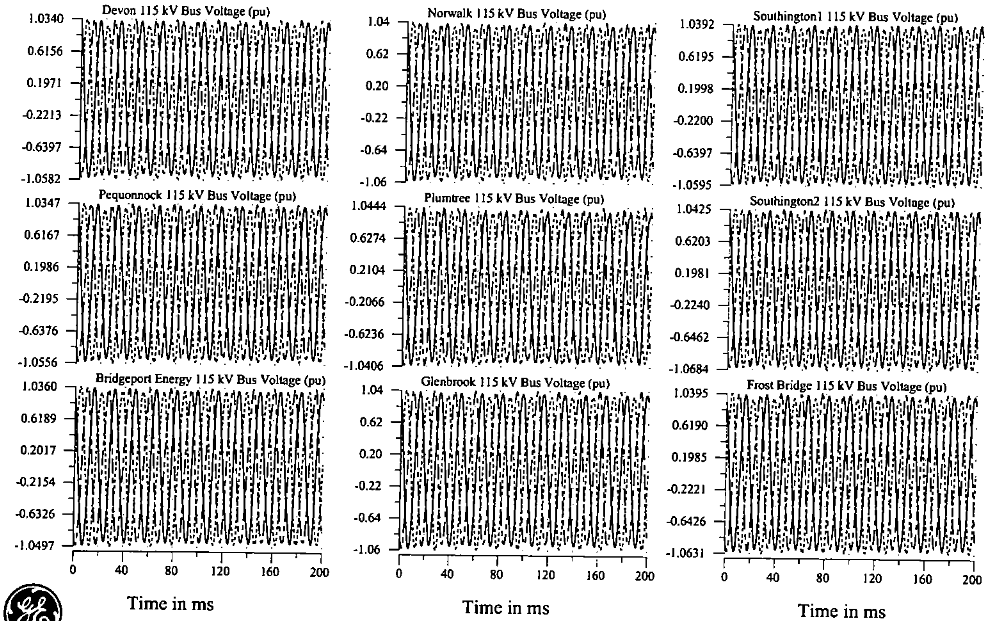
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_02
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_02
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_02
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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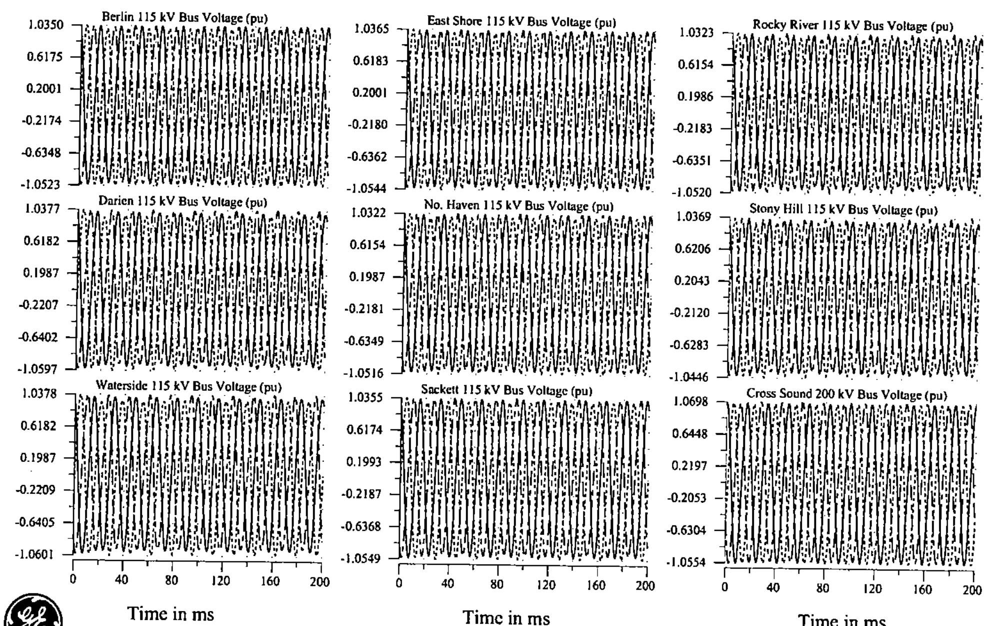
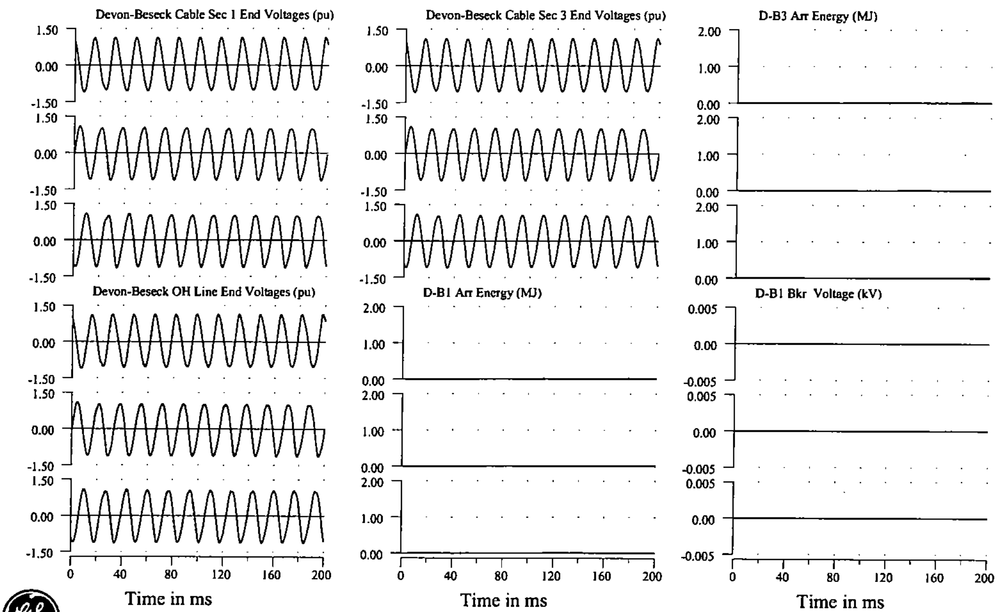
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_03

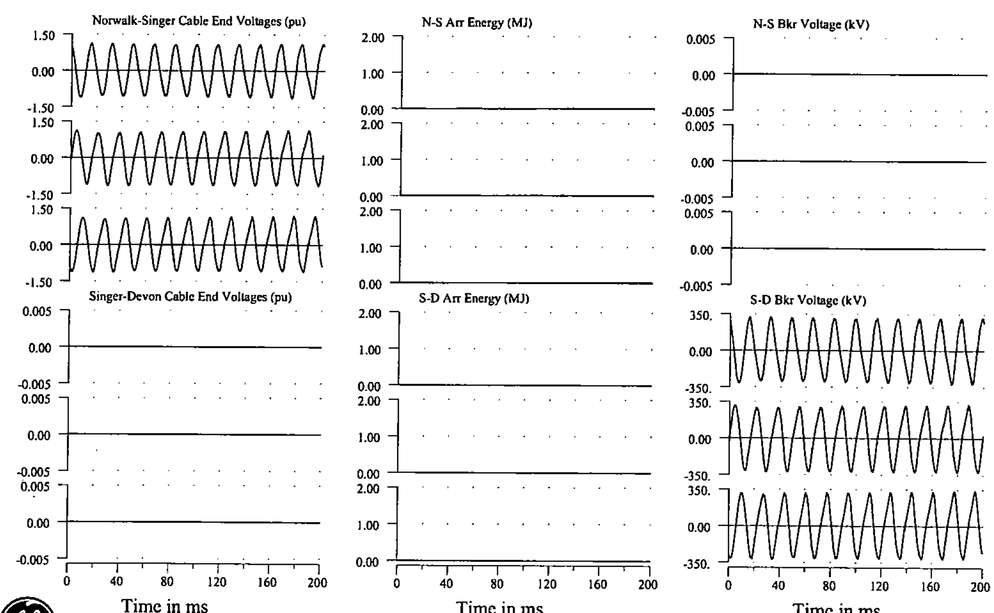
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_03

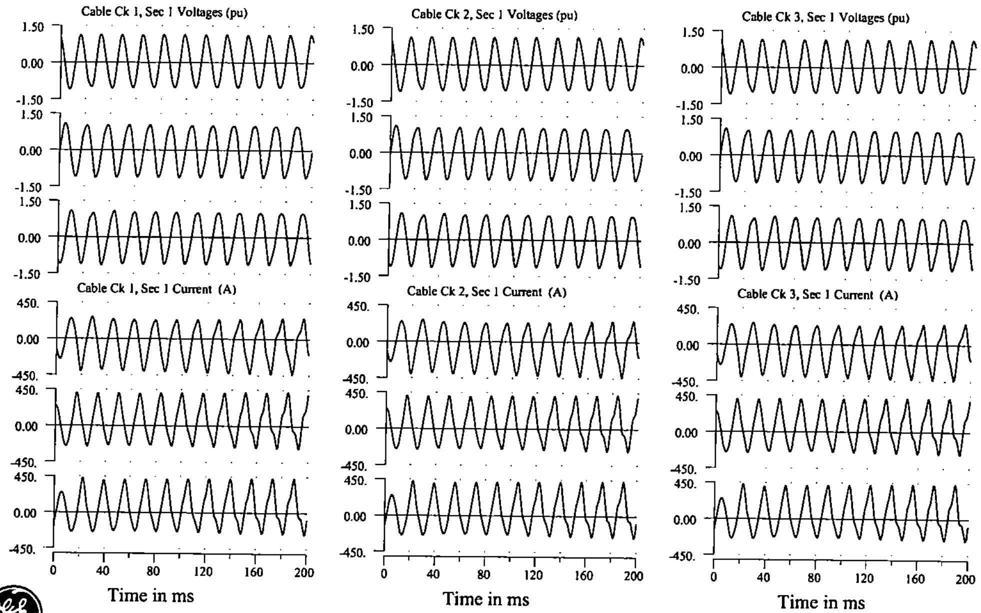
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_03

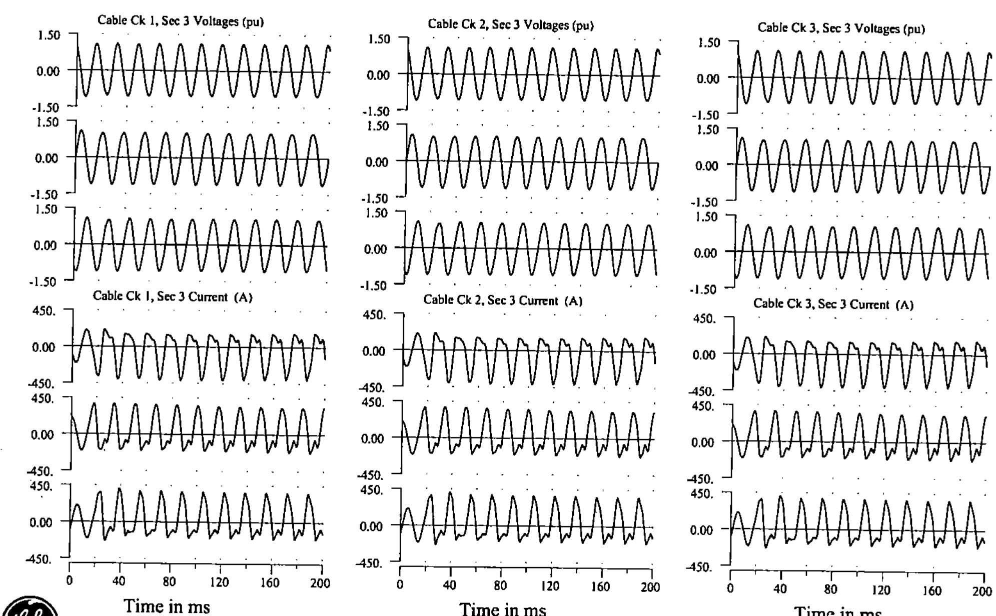
Devon-Beseck 345 kV Cables



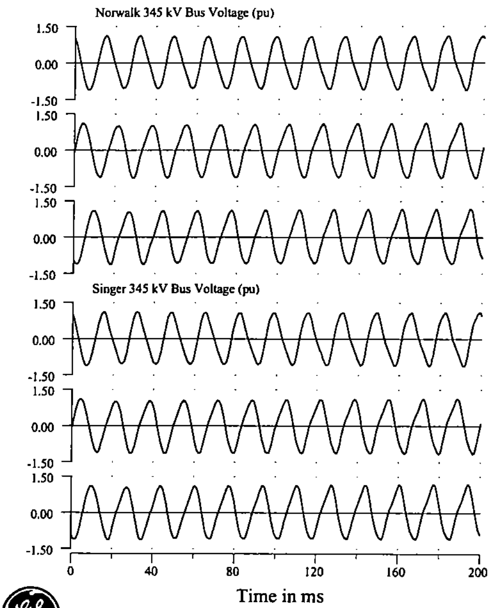
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

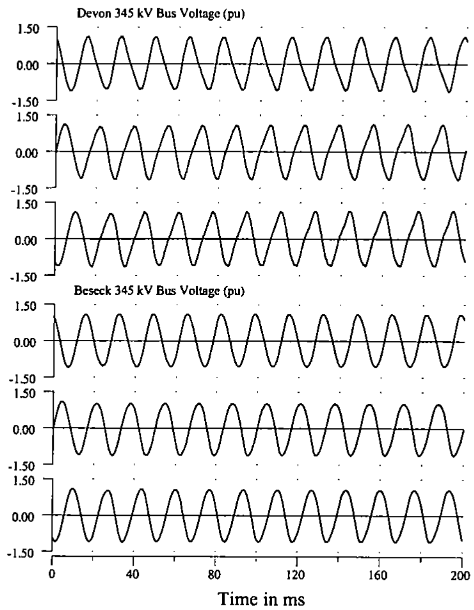
6_03

Devon-Beseck 345 kV Cables

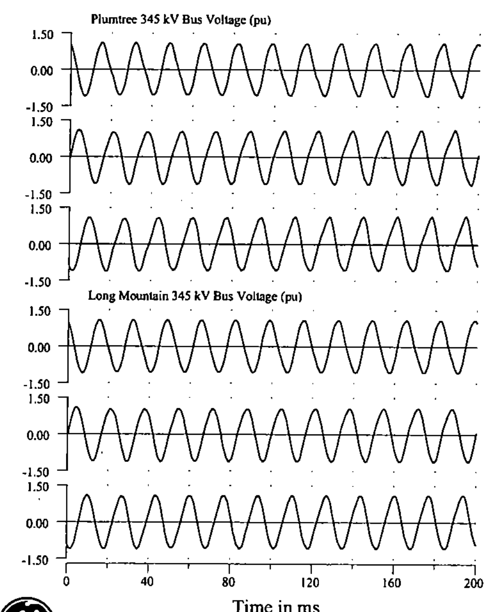


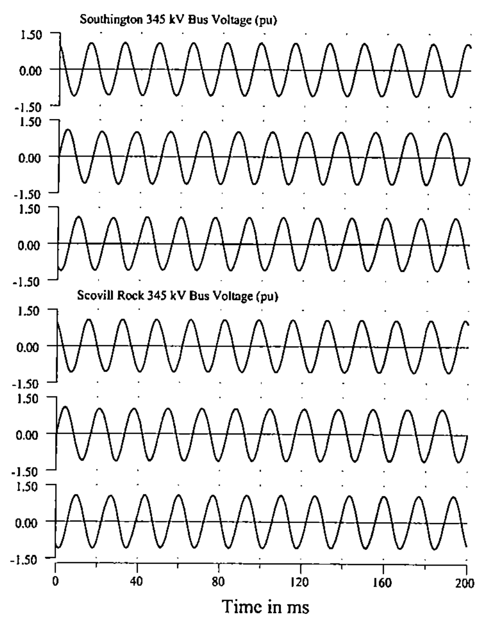
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_03
345 kV Bus Voltages



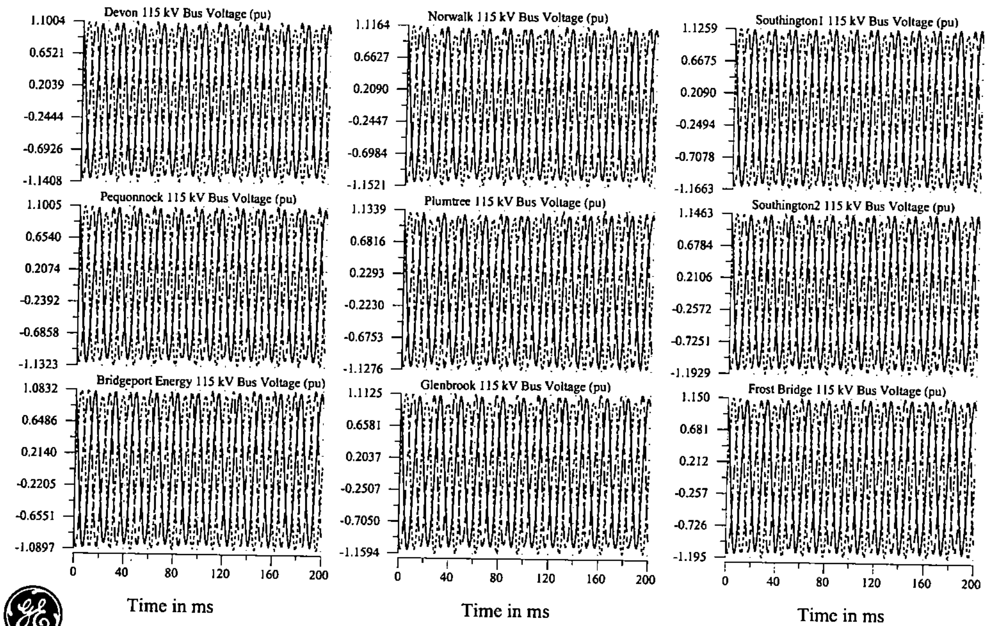


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_03
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_03
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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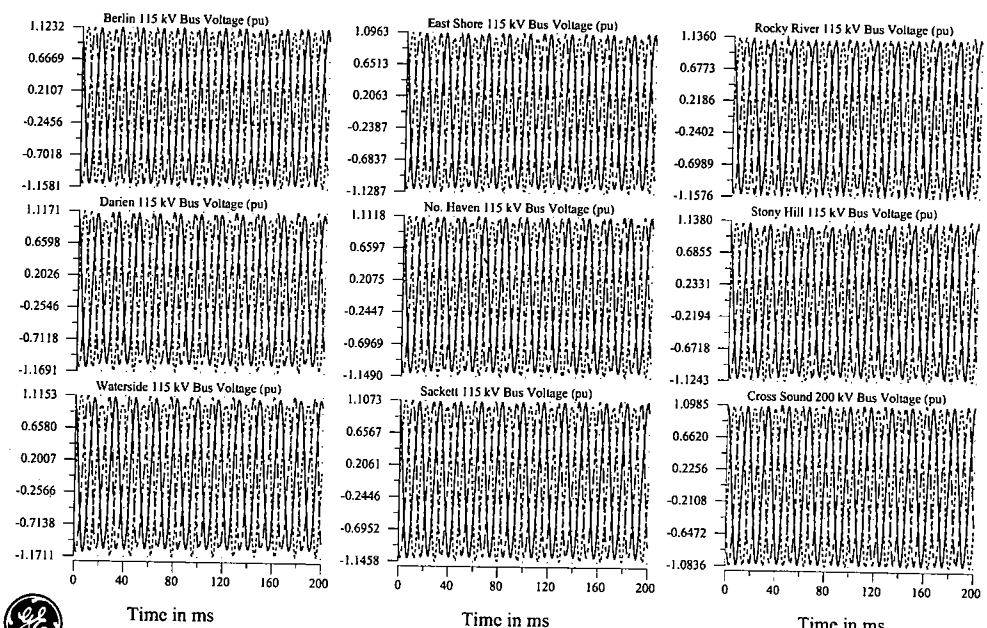
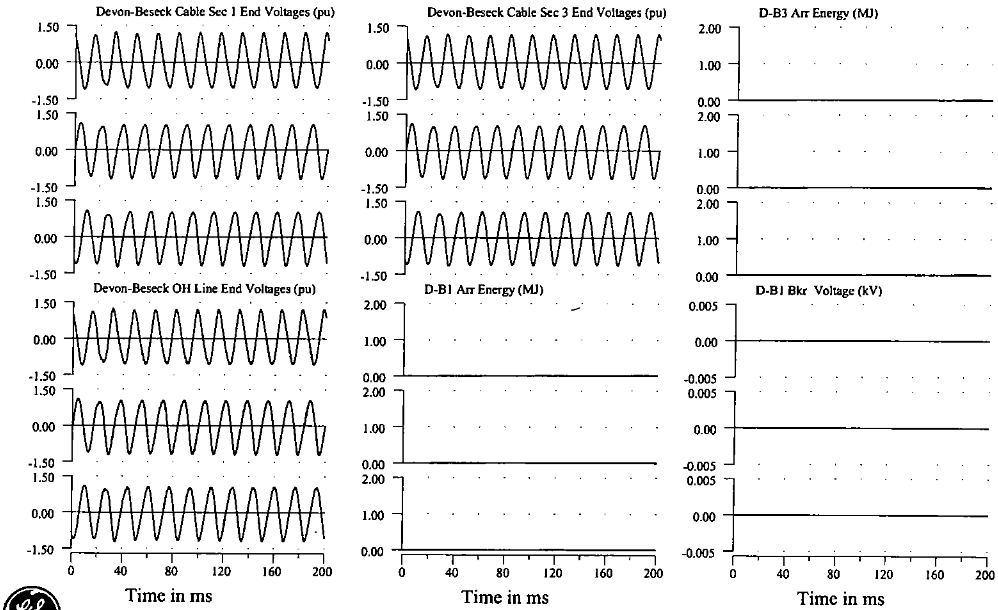
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_04

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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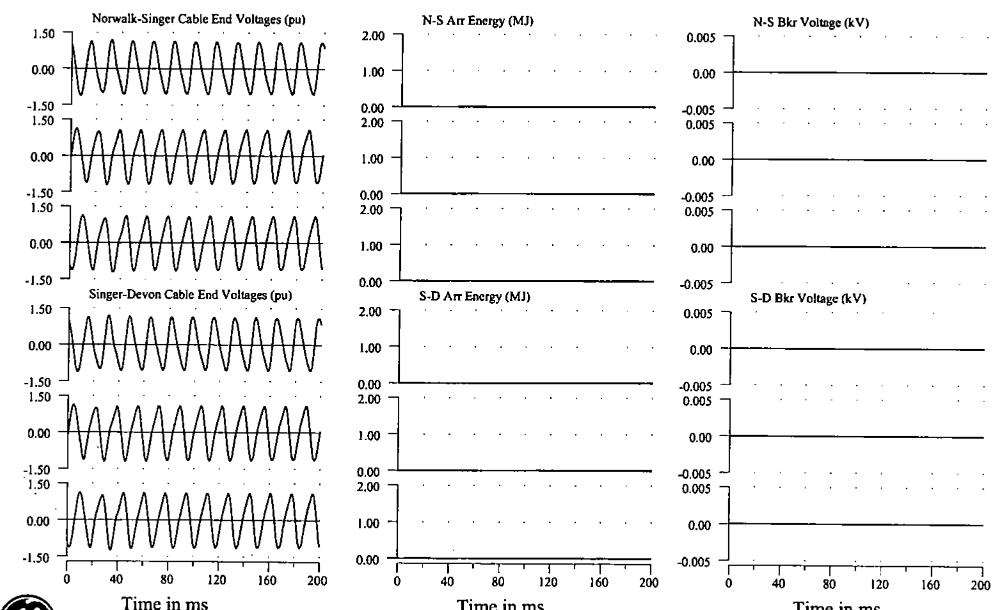
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_04

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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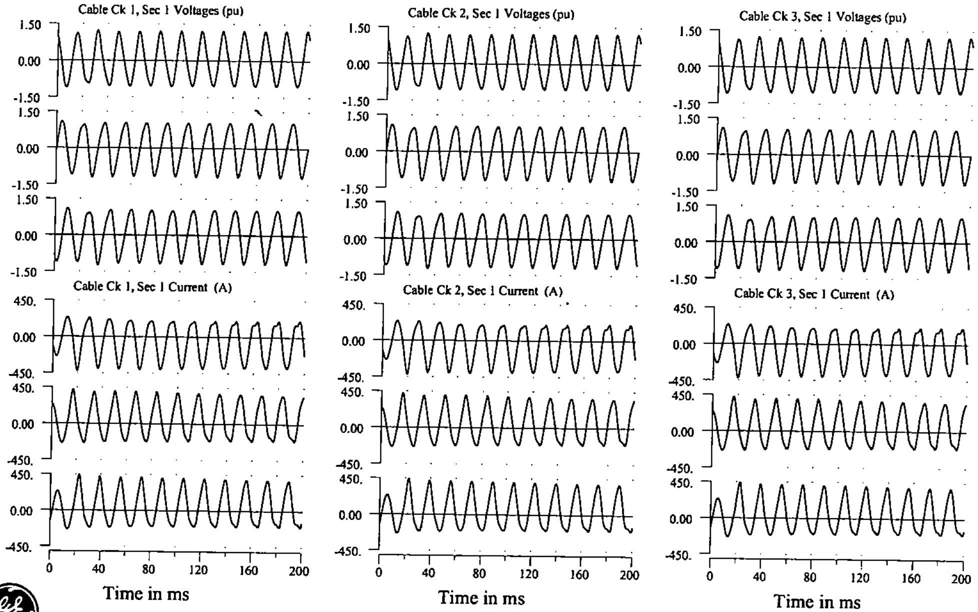
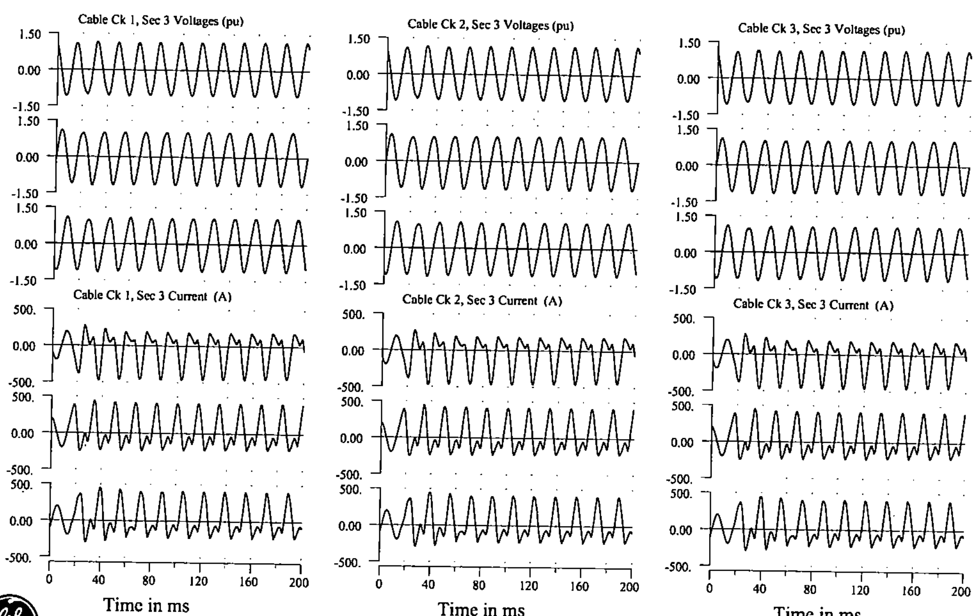
Devon-Beseck 345 kV Cables



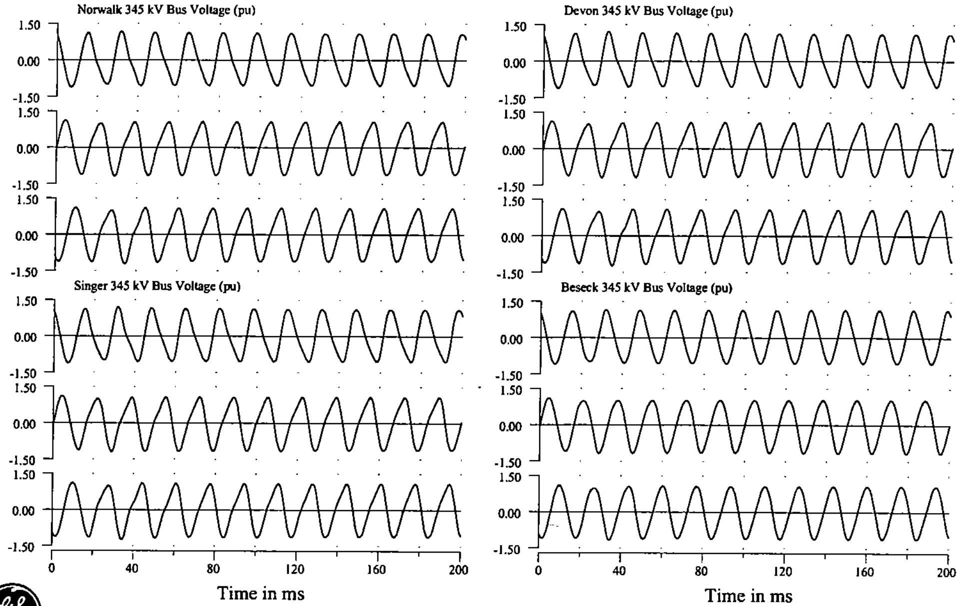
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_04
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_04

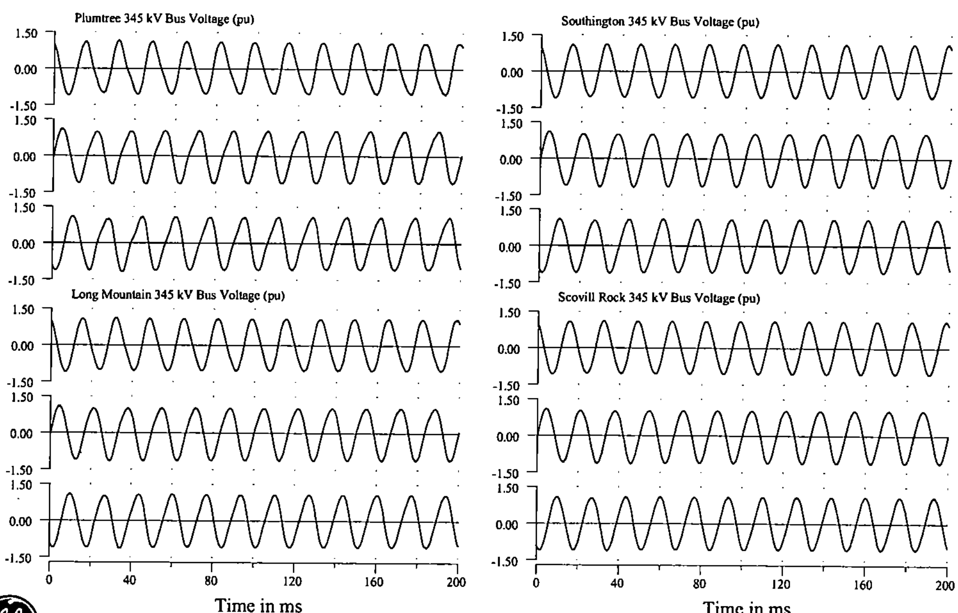
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_04

345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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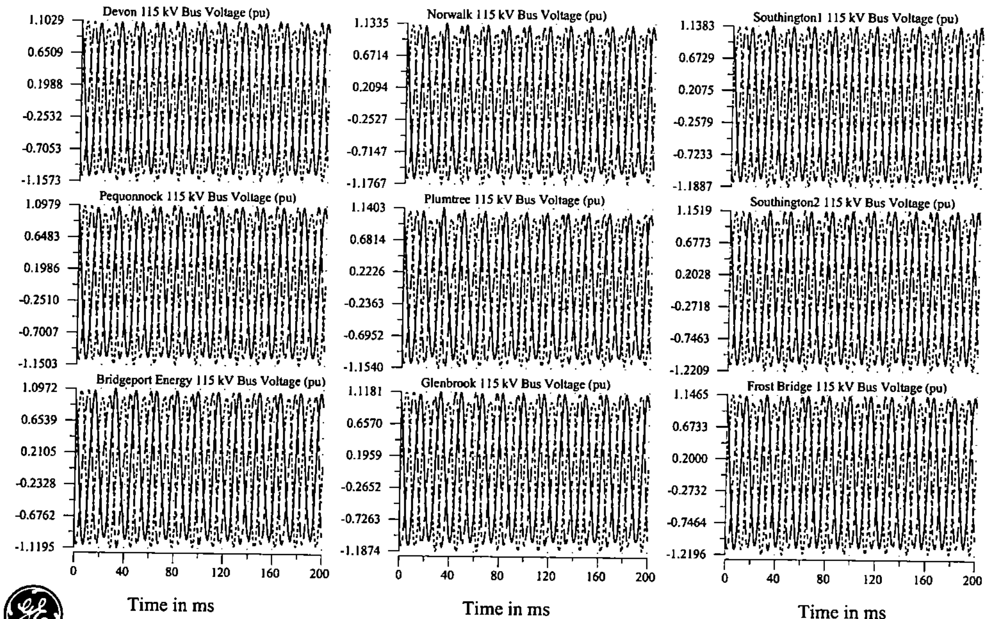
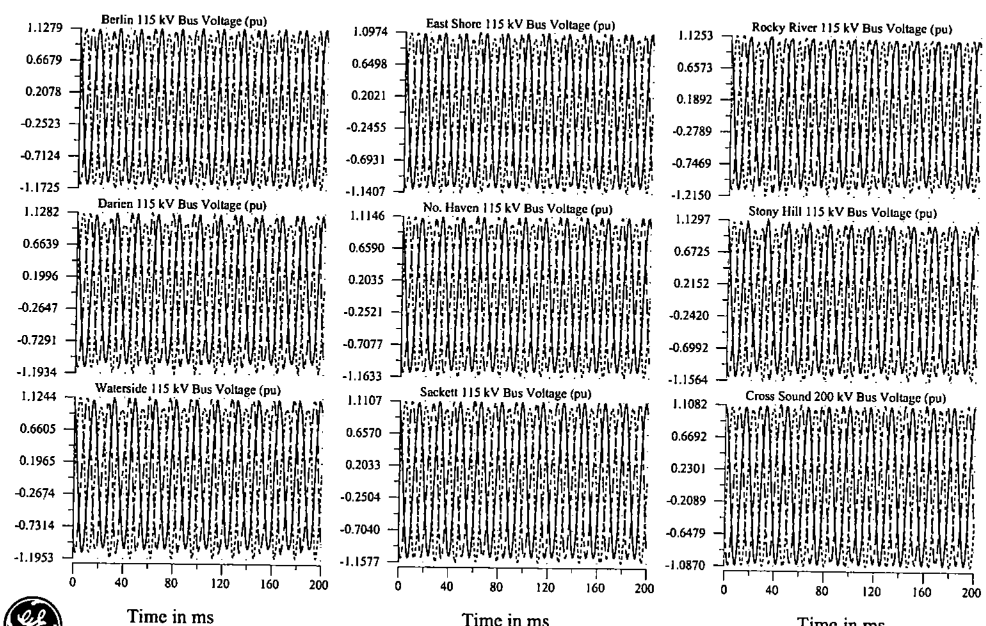
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_04
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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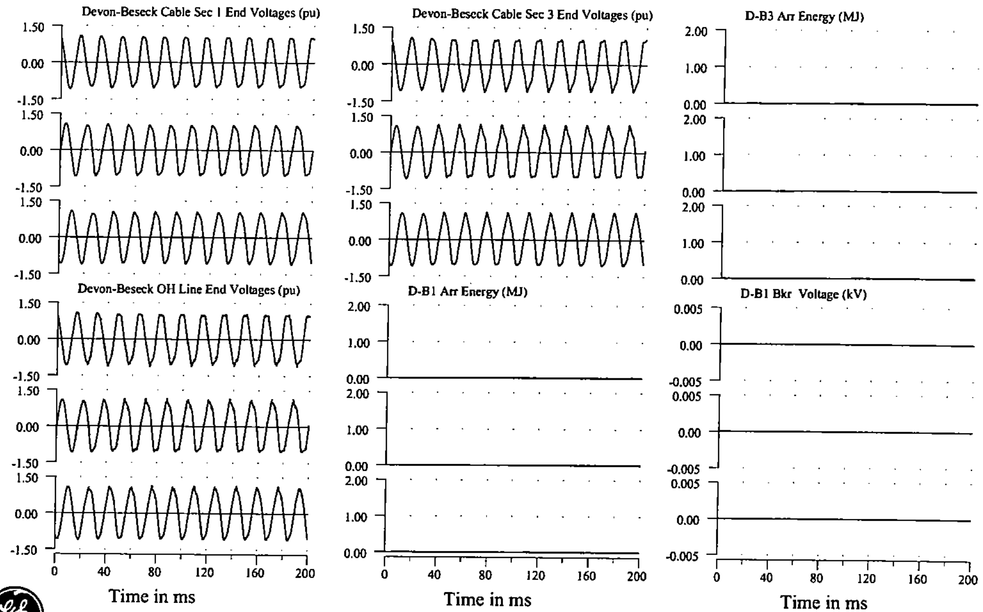
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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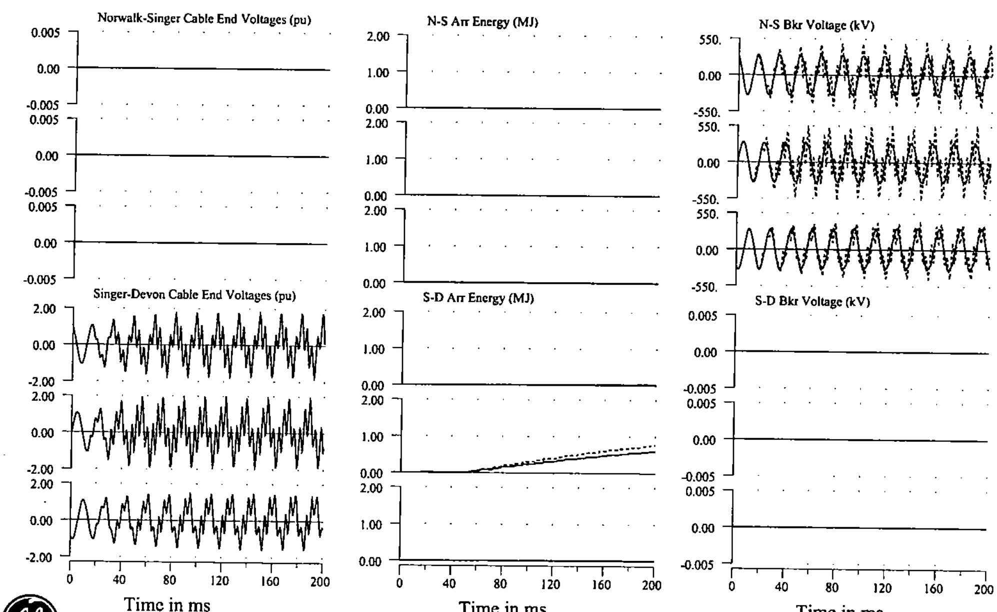
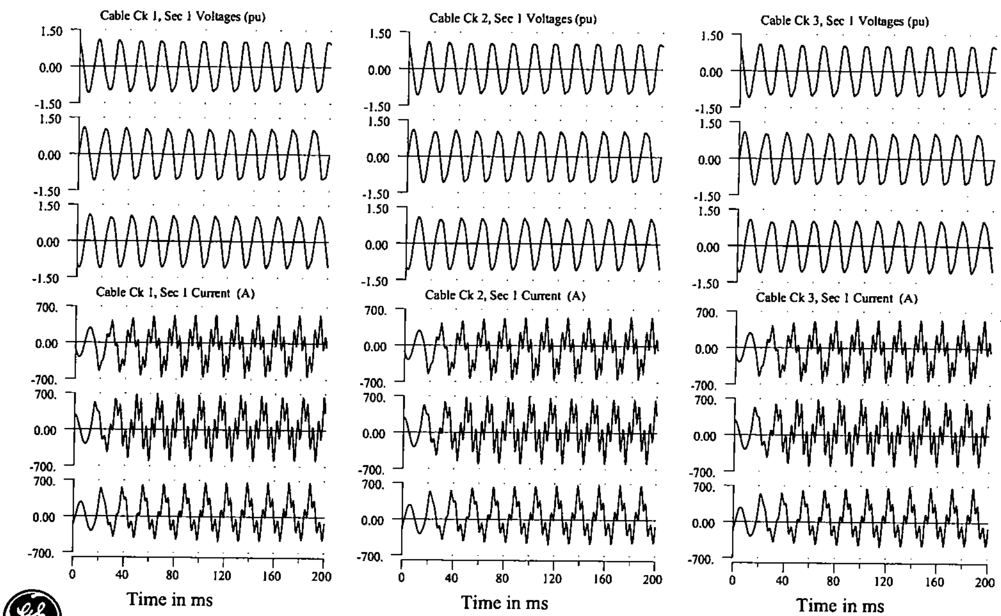
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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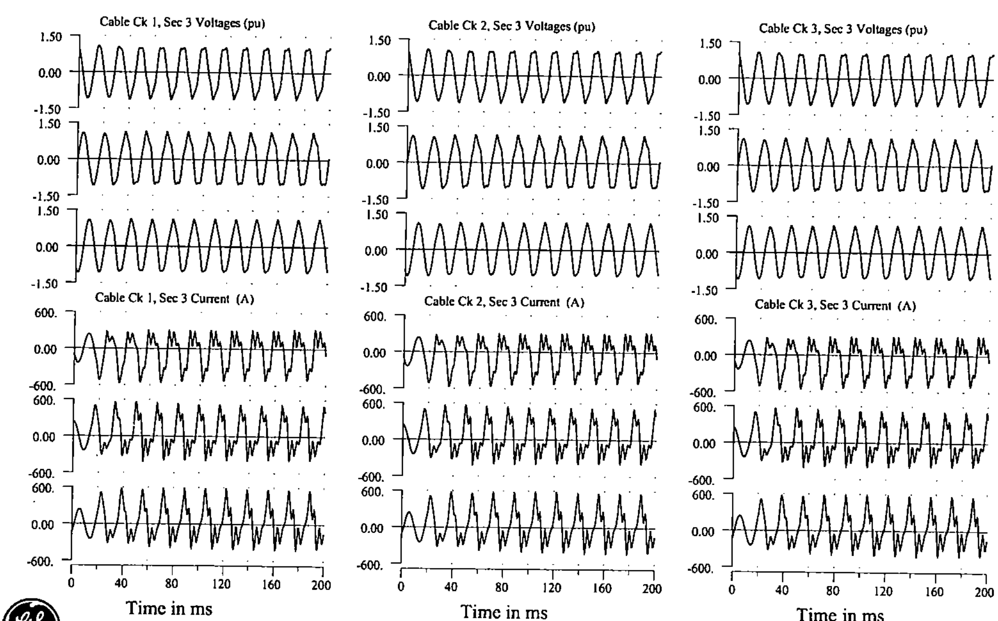
Devon-Beseck 345 kV Cables



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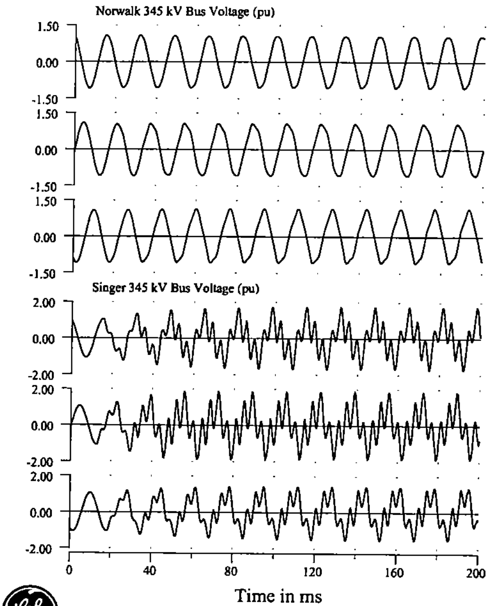
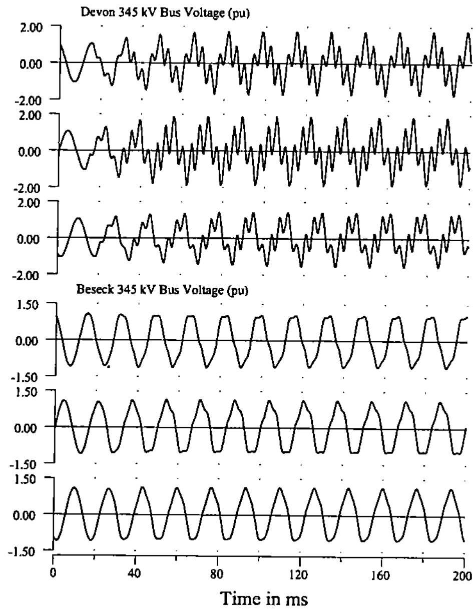
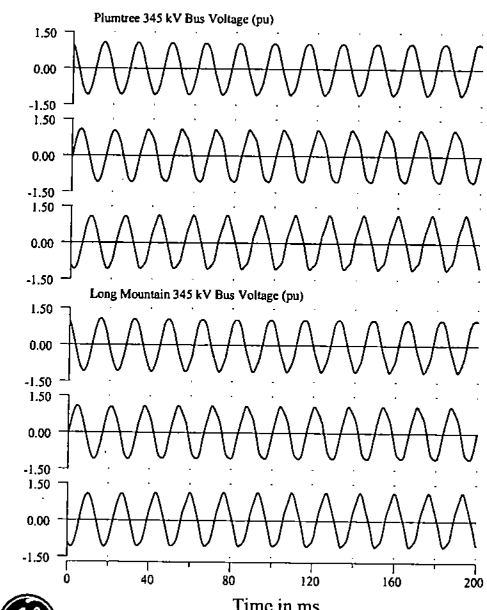
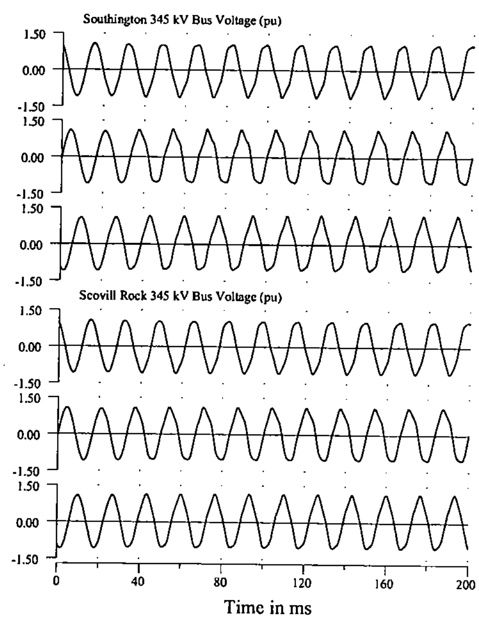
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05
345 kV Bus Voltages



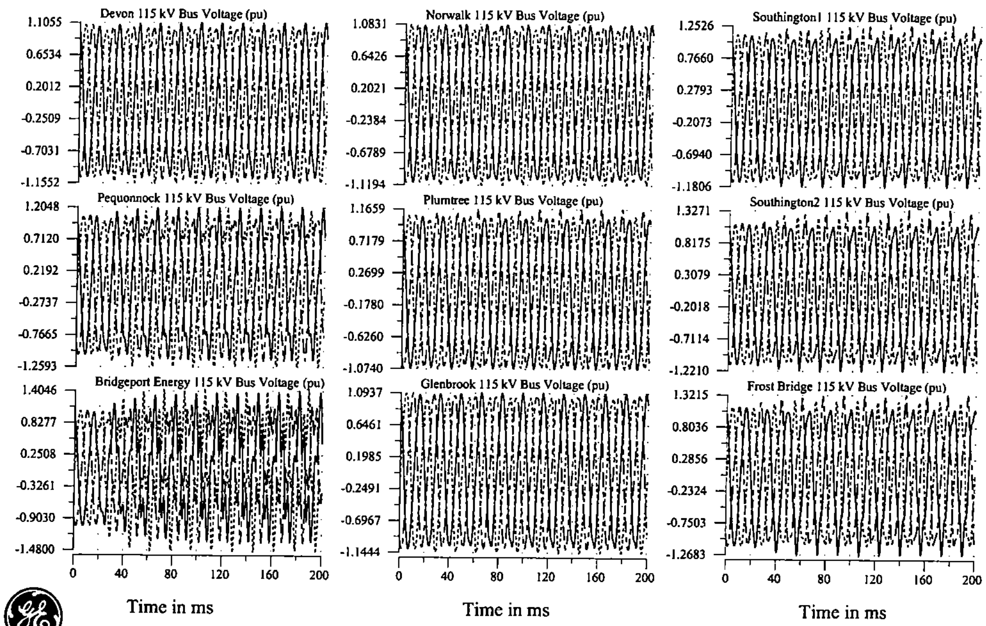


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05
345 kV Bus Voltages

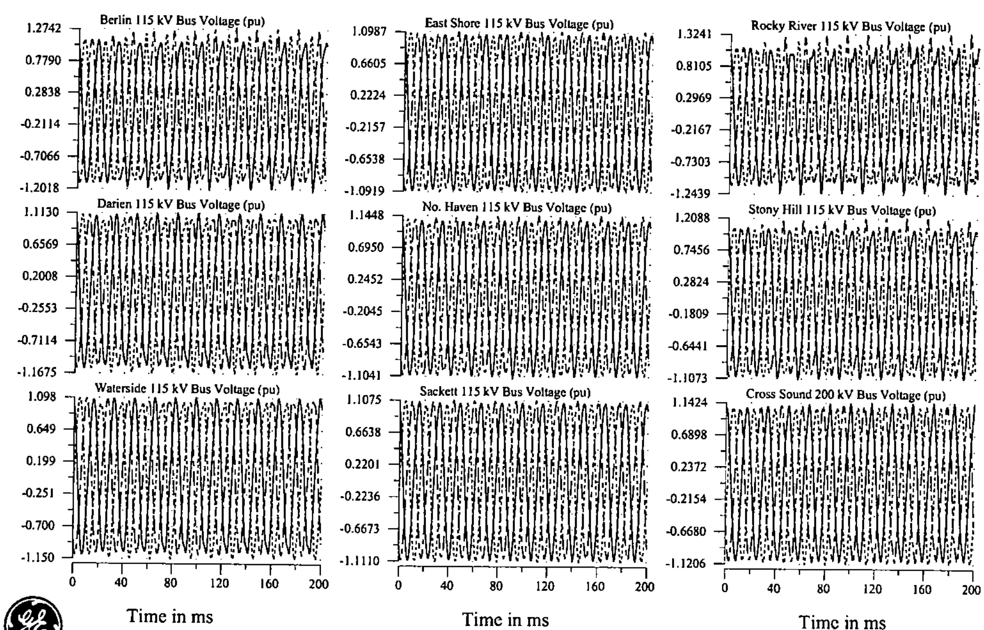




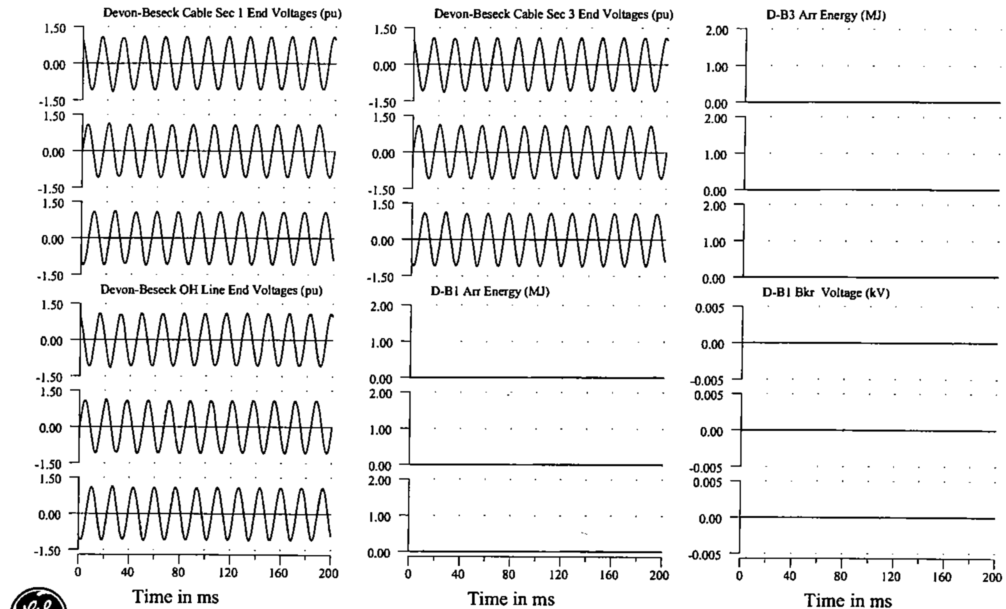
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05R
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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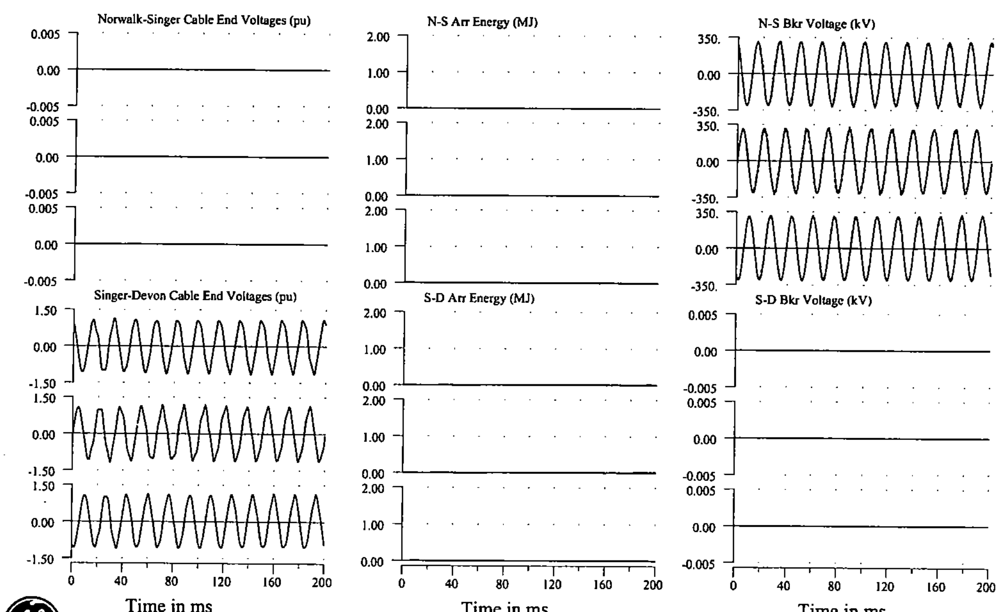
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05R
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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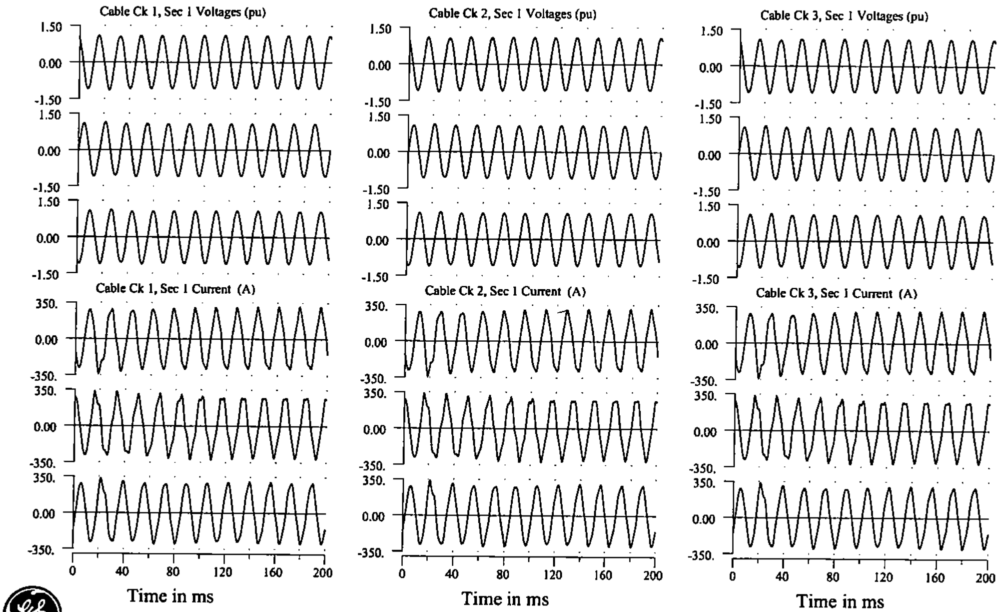
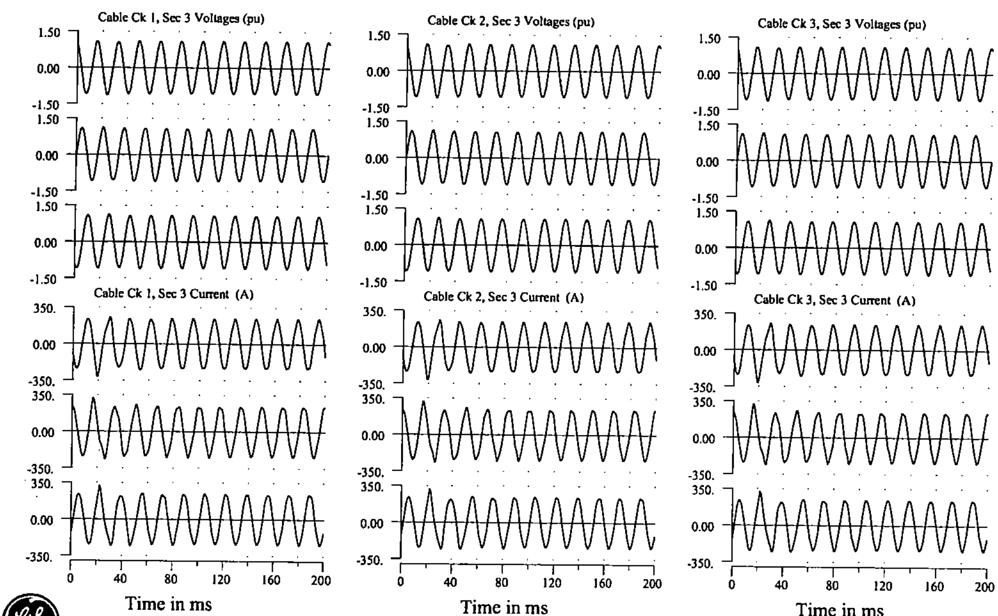
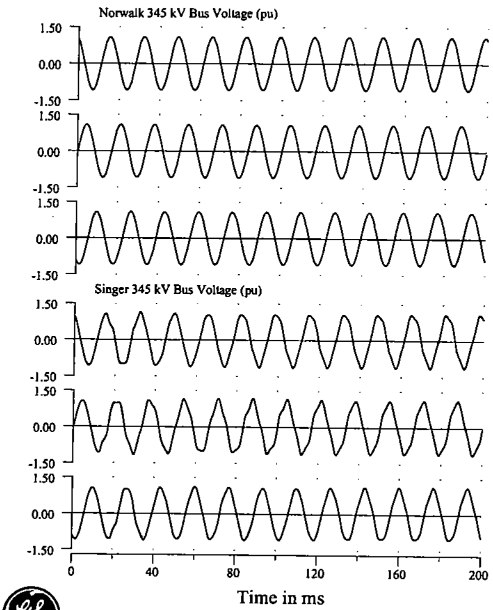
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05R
Devon-Beseck 345 kV Cables

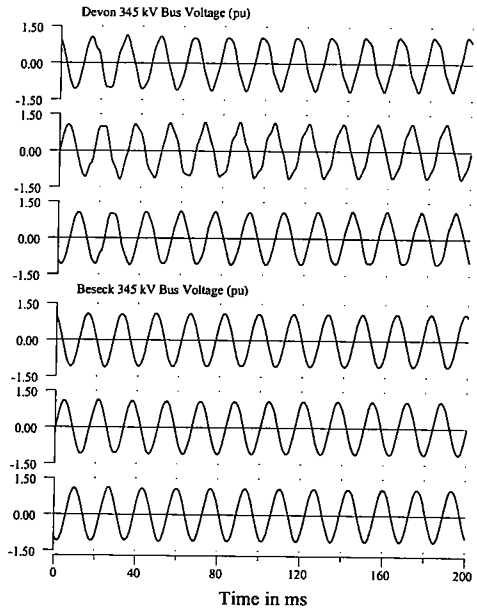


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05R
Devon-Beseck 345 kV Cables

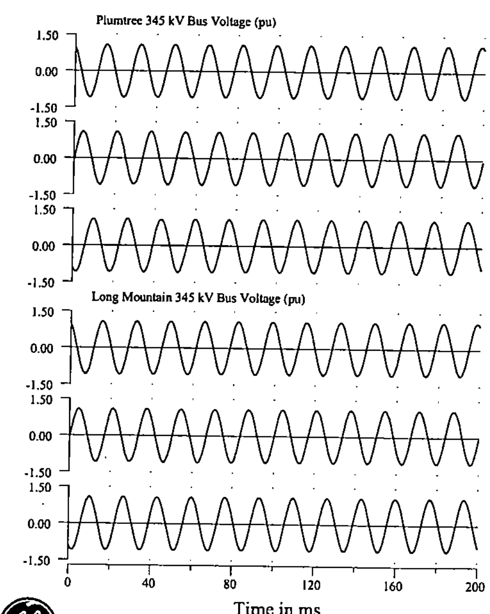


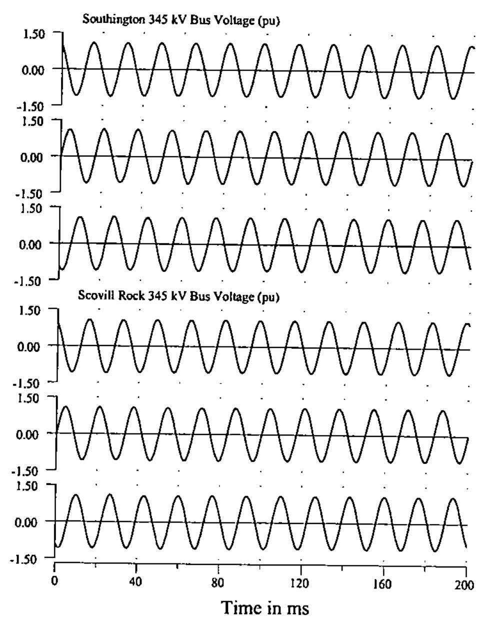
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05R
345 kV Bus Voltages



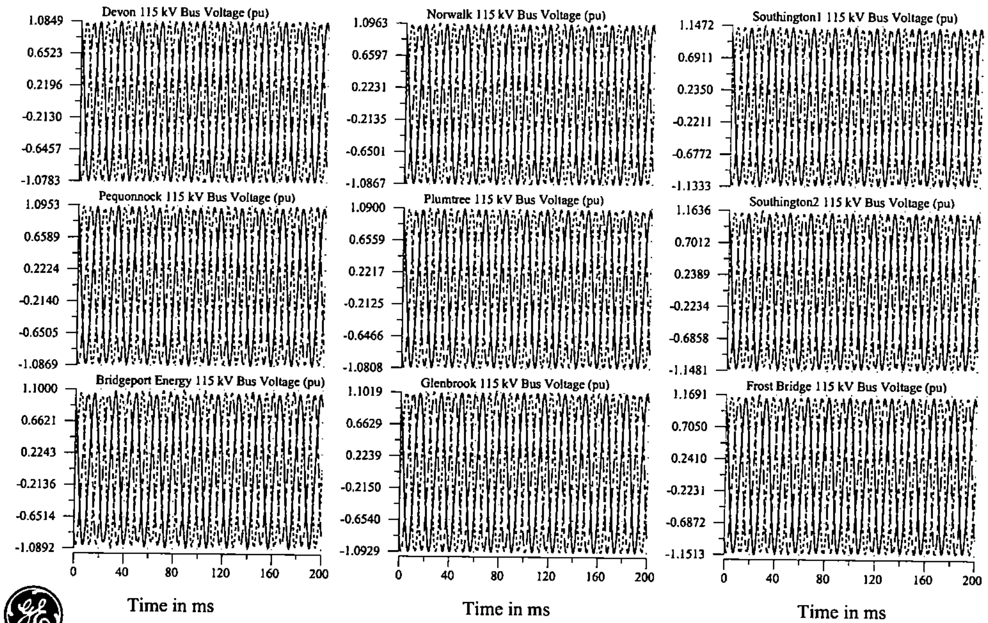


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05R
345 kV Bus Voltages

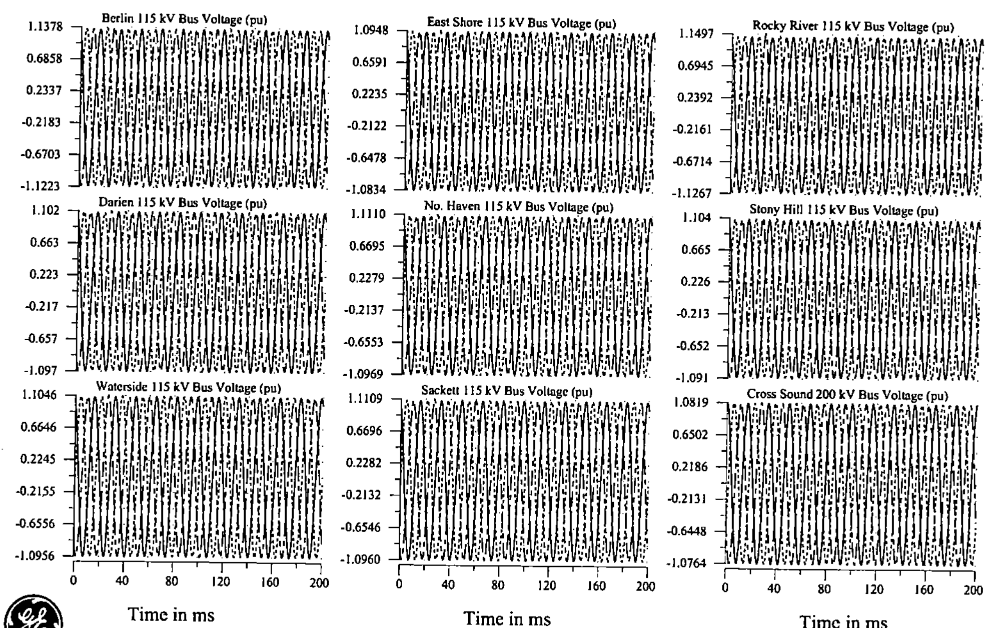




Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05R
115 kV Bus Voltages and Capacitor Bank Locations



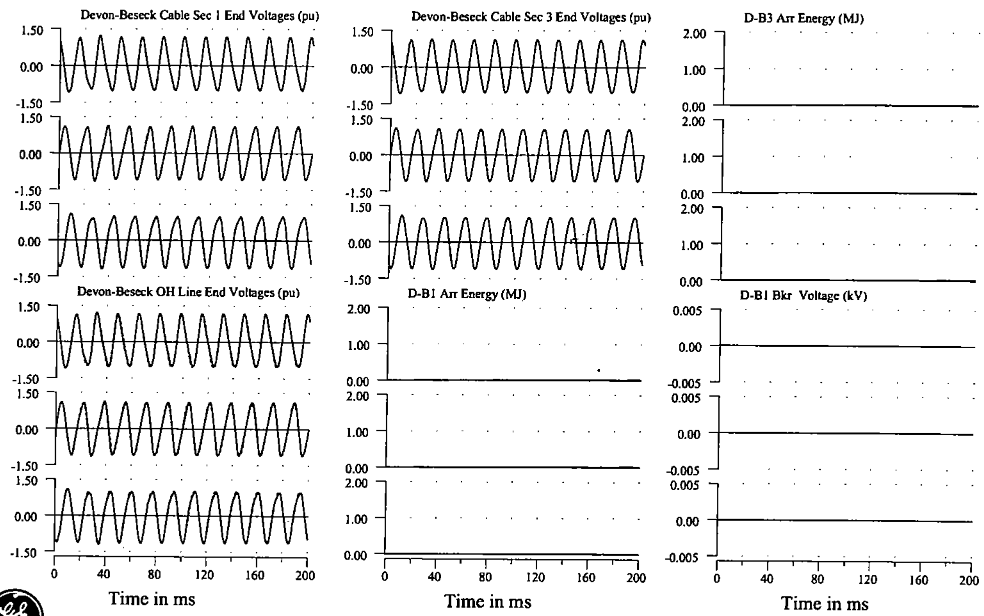
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_05R
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_06

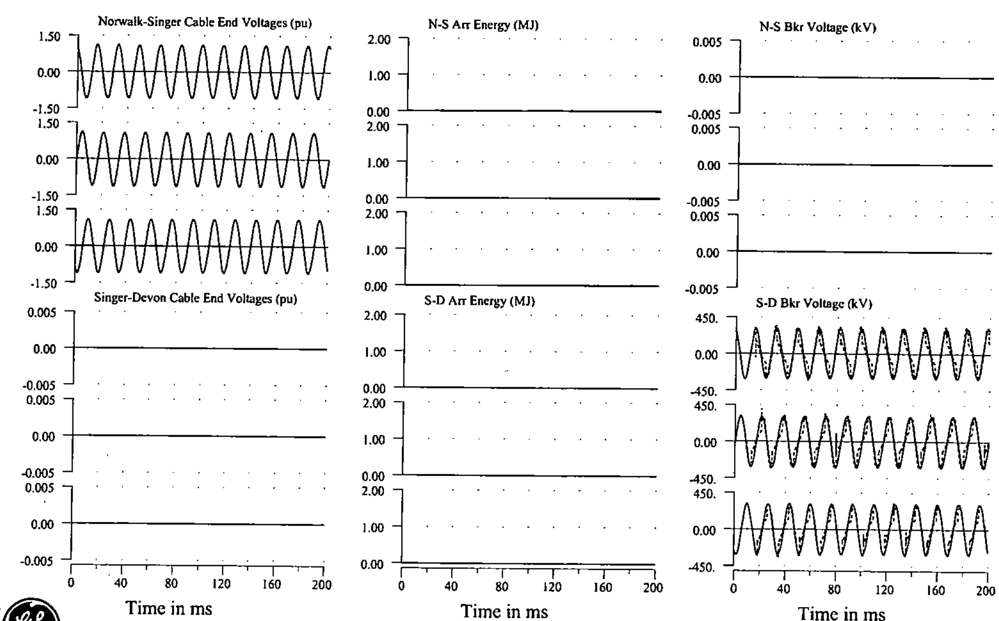
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_06

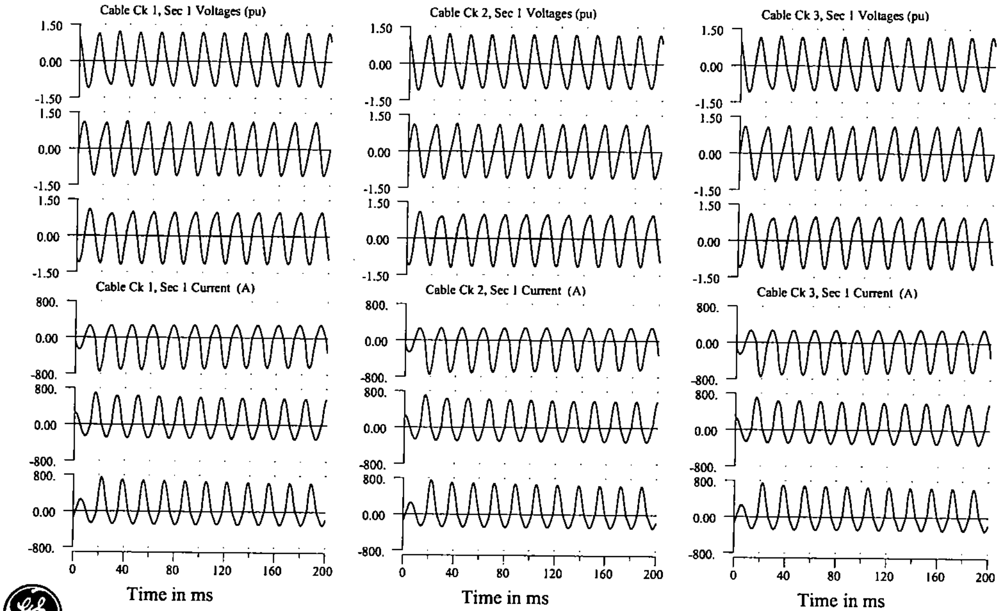
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_06

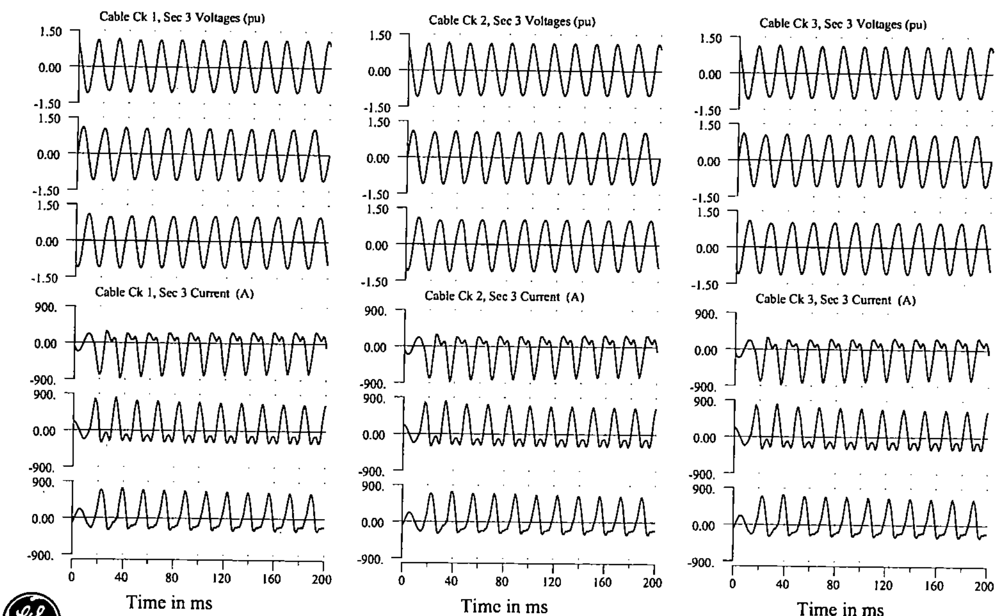
Devon-Beseck 345 kV Cables



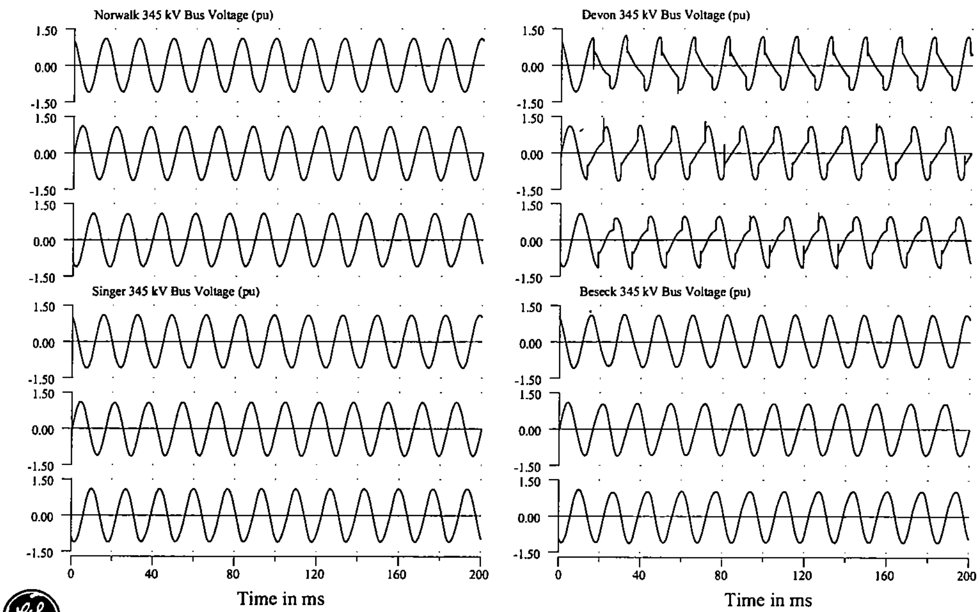
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

6_06

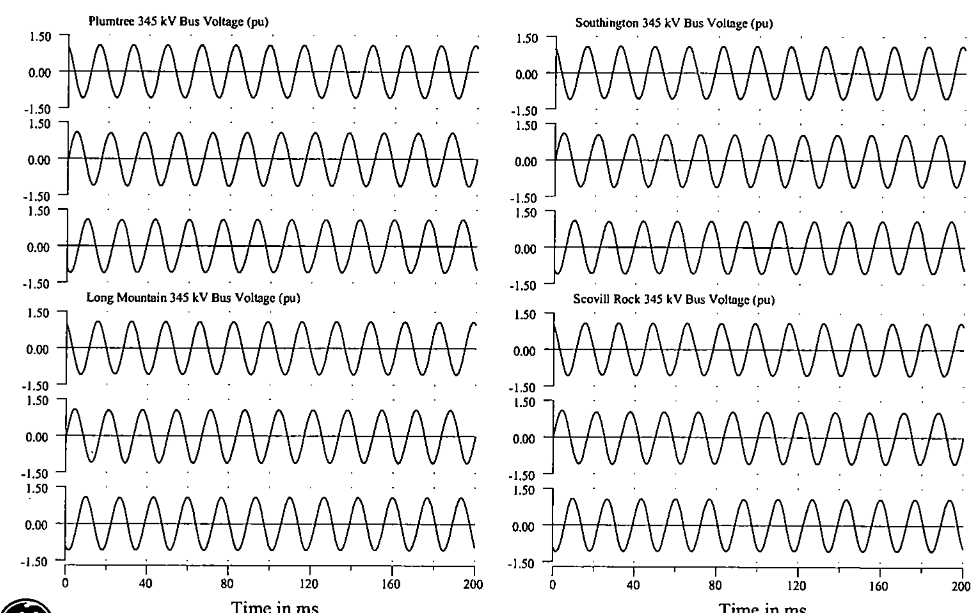
Devon-Beseck 345 kV Cables



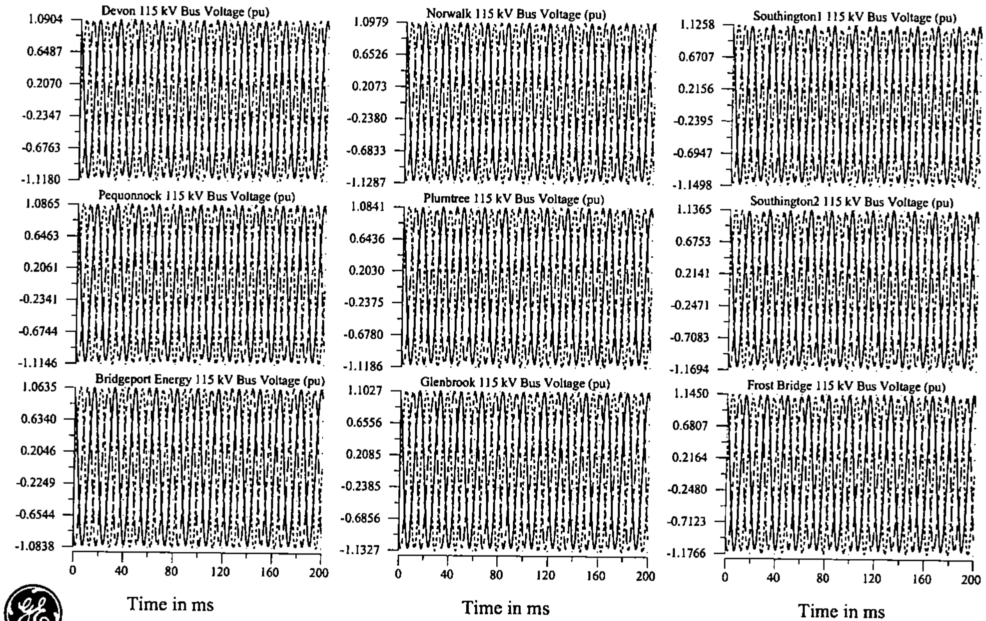
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_06
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_06
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
6_06
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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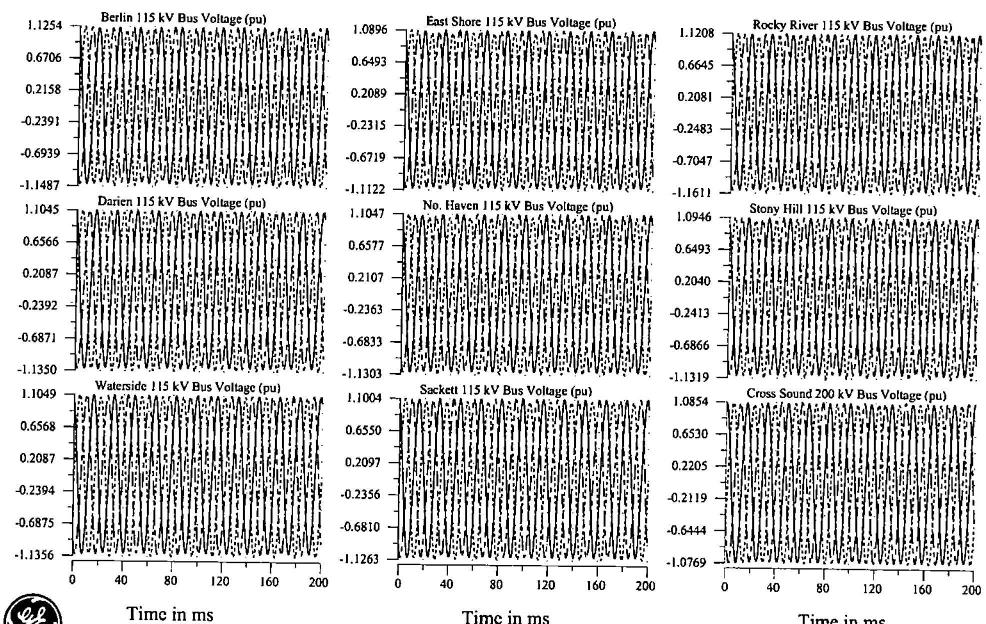
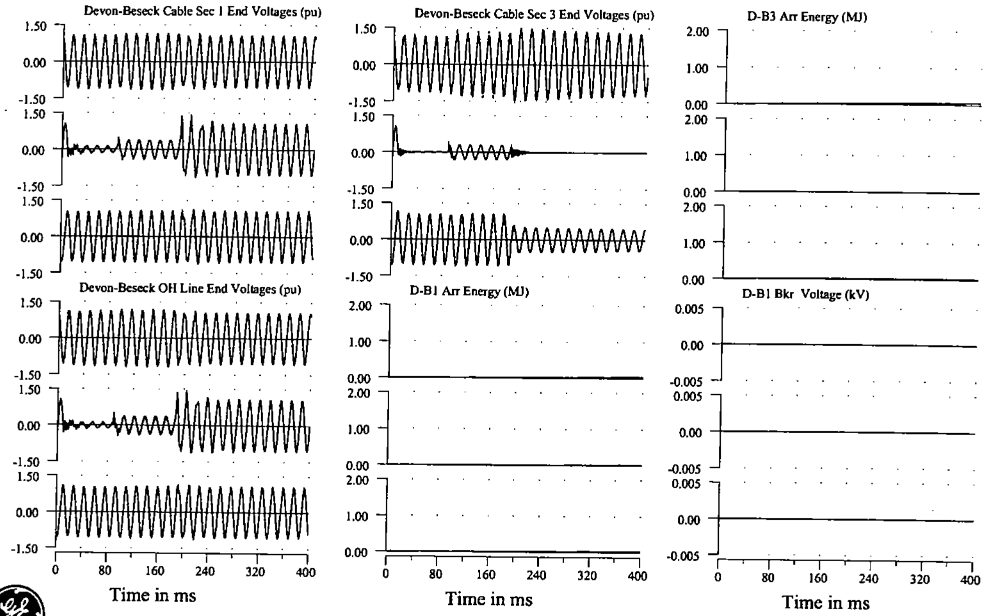
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_01_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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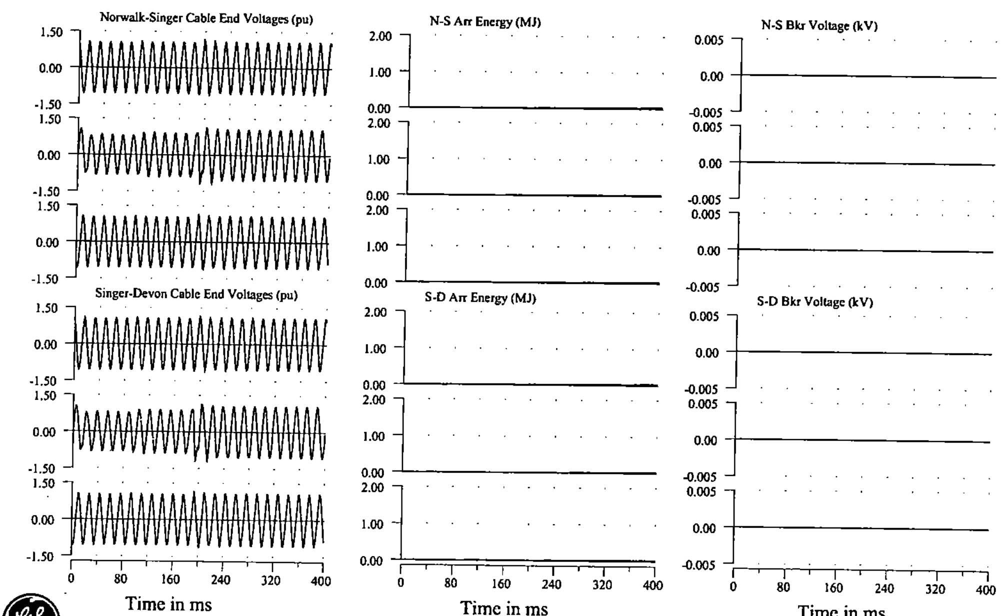
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_01_0
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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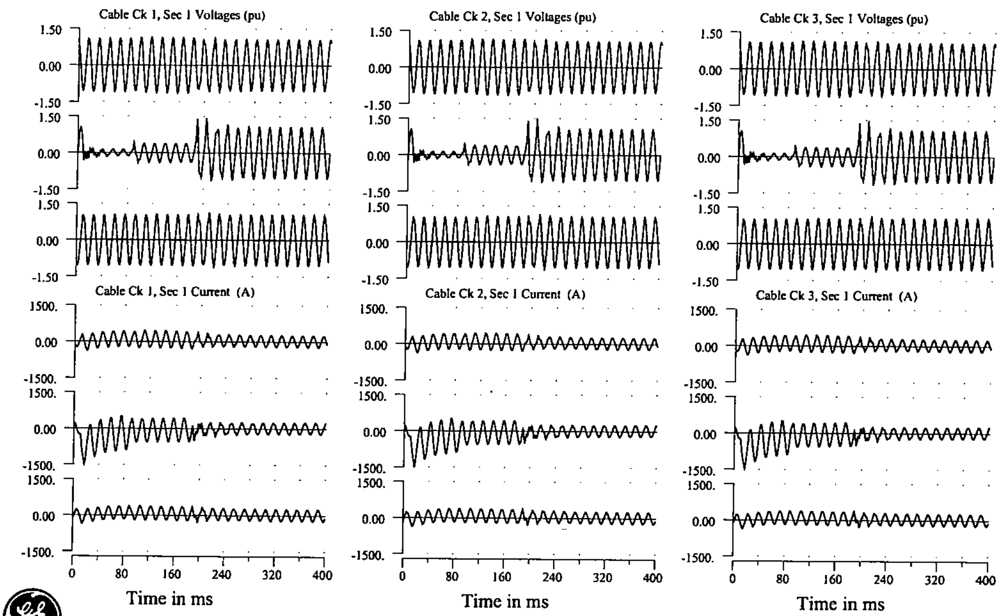
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_01_0
Devon-Beseck 345 kV Cables



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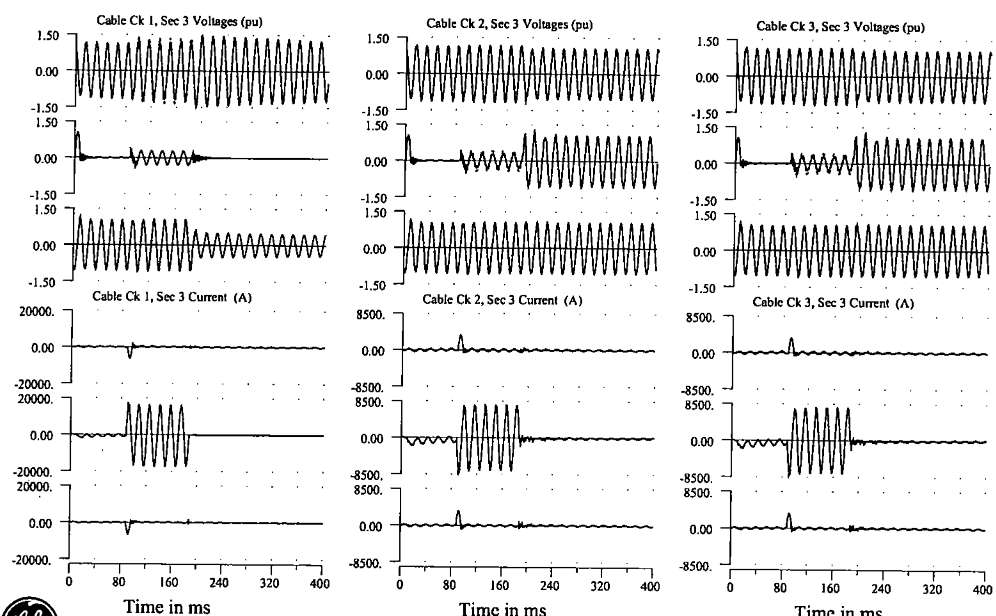
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_01_0
Devon-Beseck 345 kV Cables



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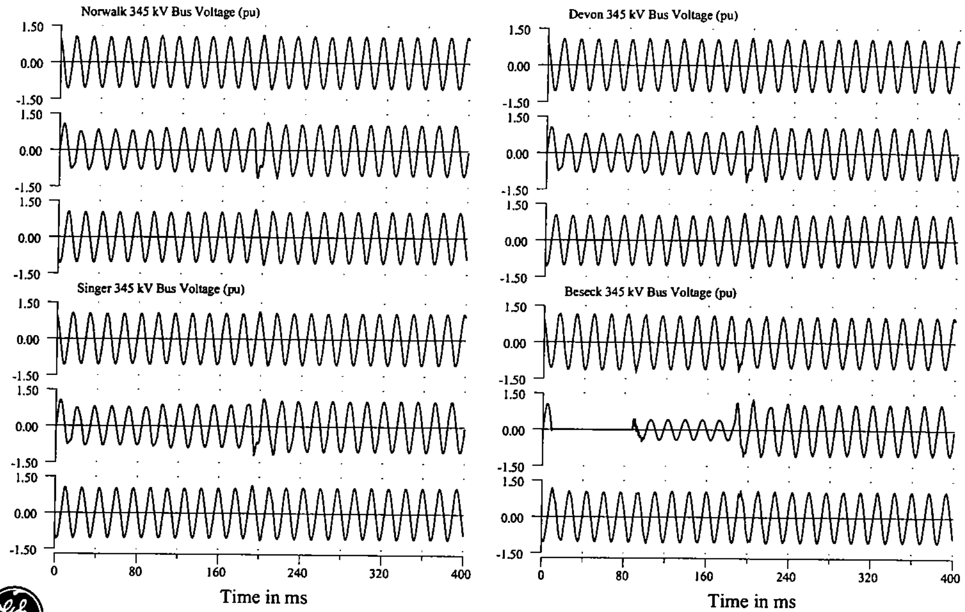
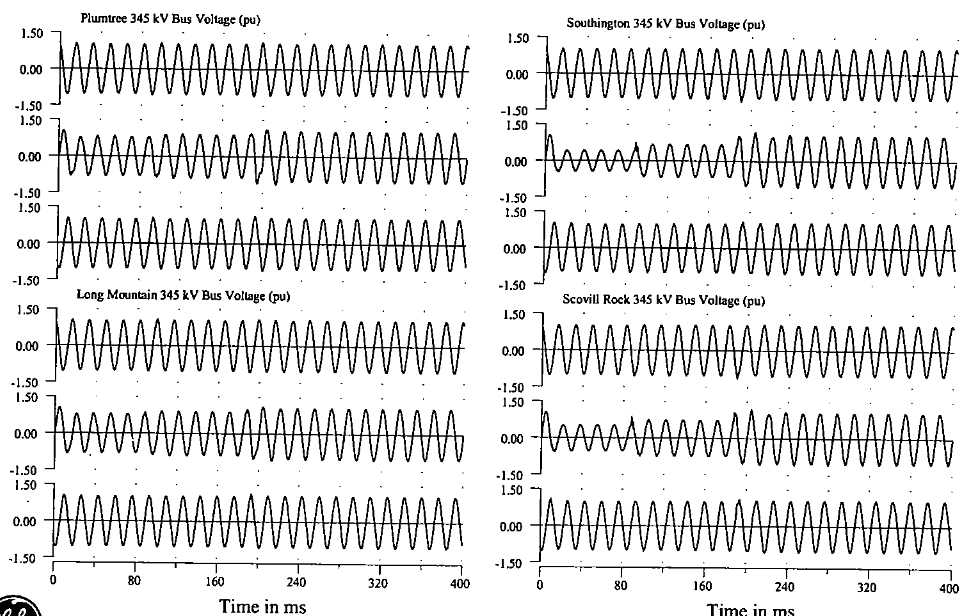
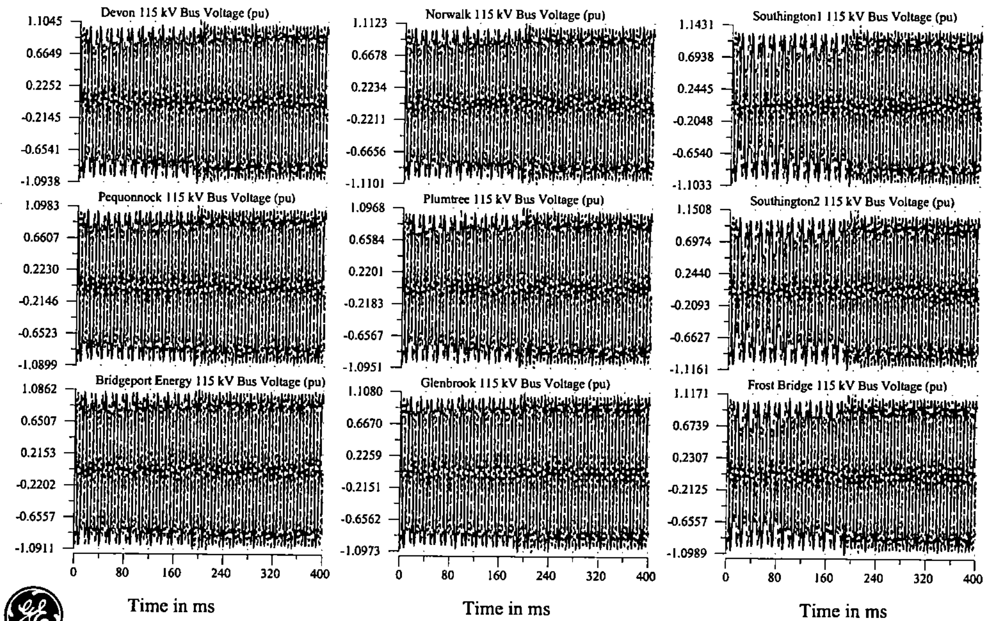
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_01_0
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_01_0
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_01_0
115 kV Bus Voltages and Capacitor Bank Locations



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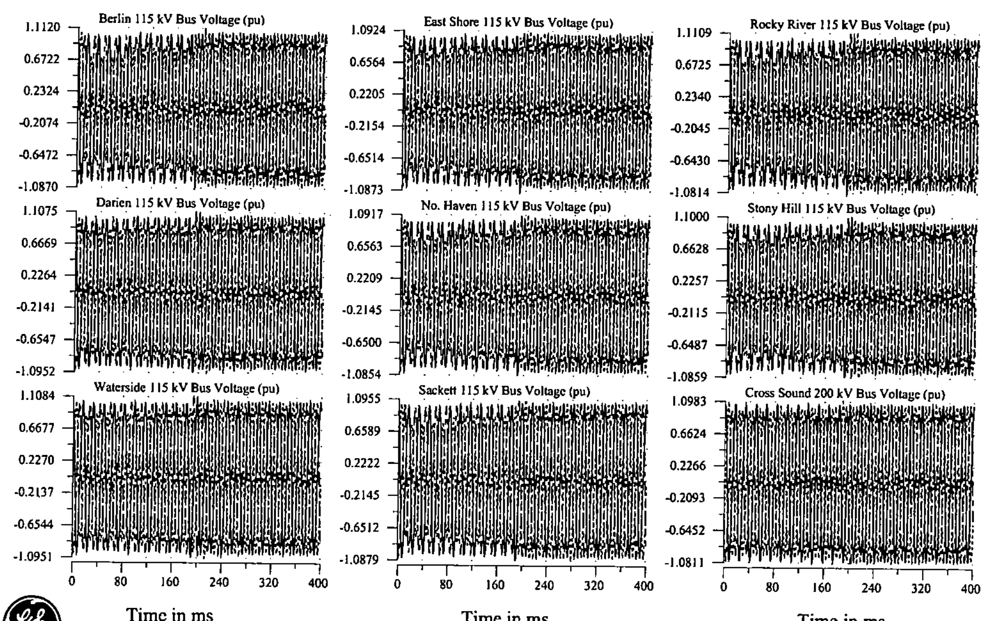
115 kV Bus Voltages and Capacitor Bank Locations



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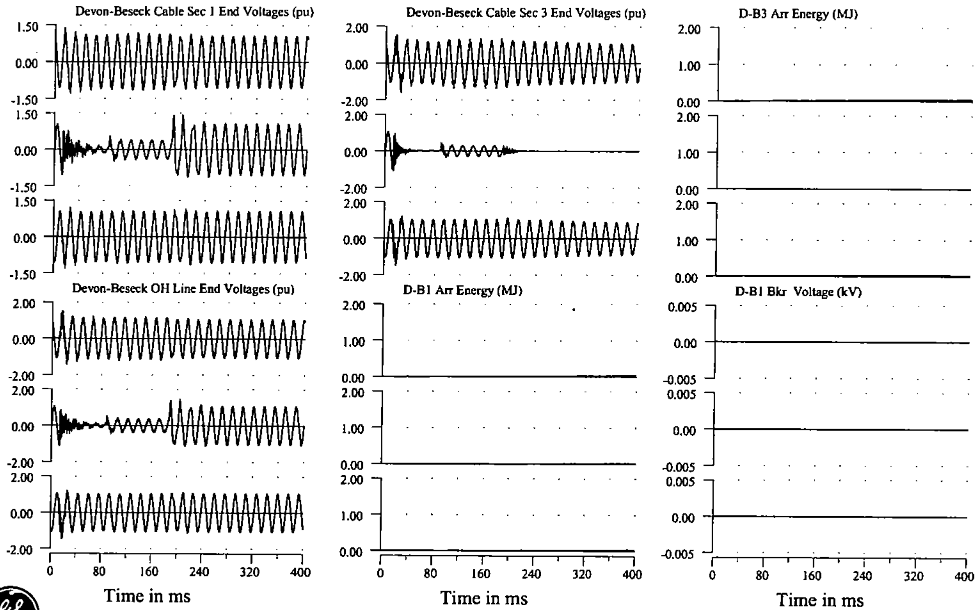
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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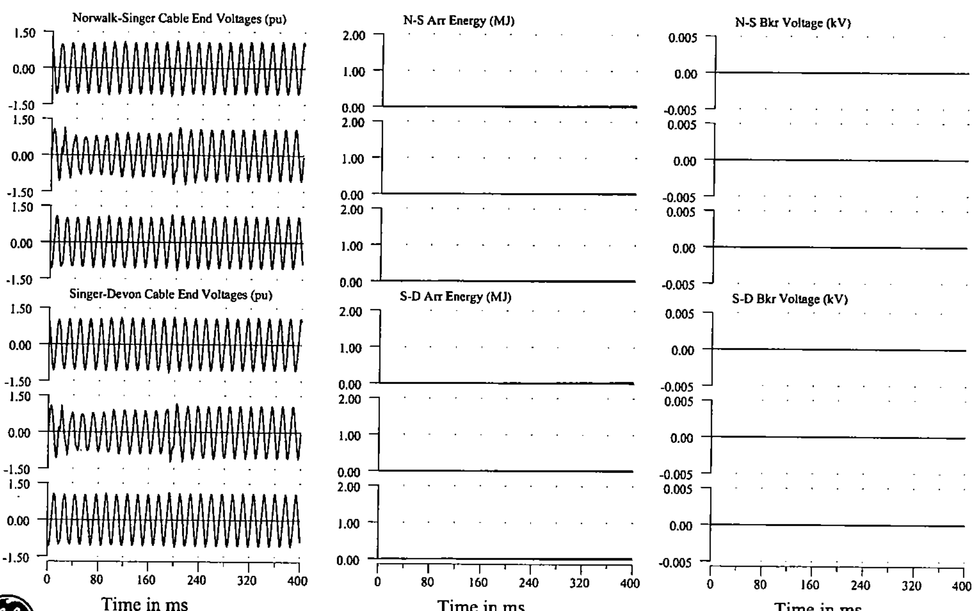
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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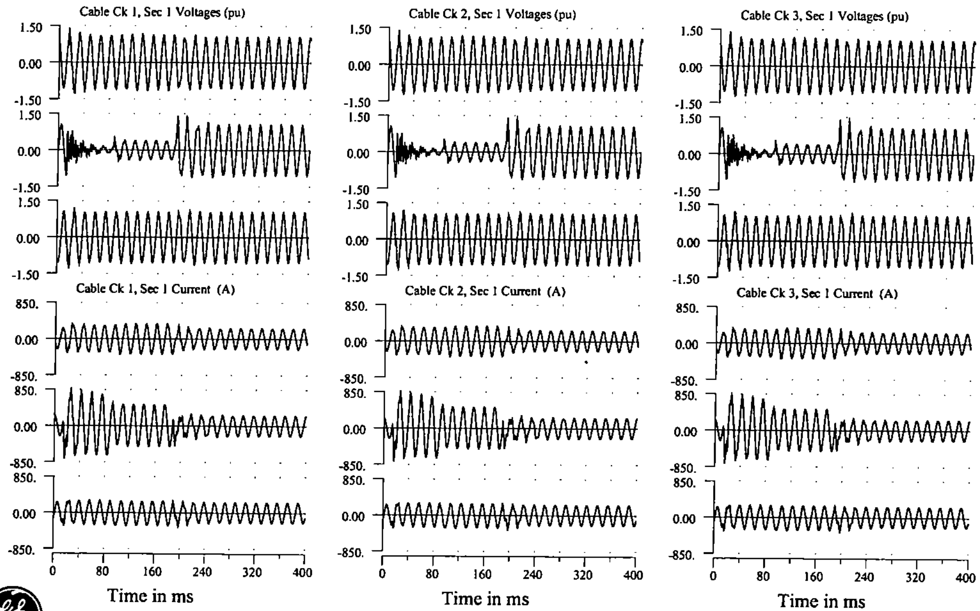
Devon-Beseck 345 kV Cables



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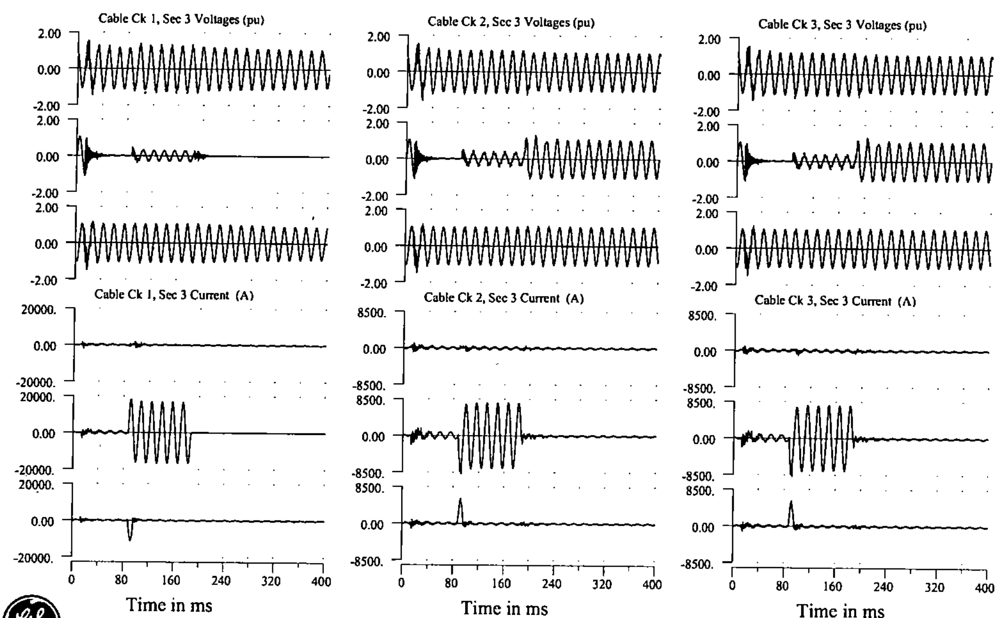
Devon-Beseck 345 kV Cables



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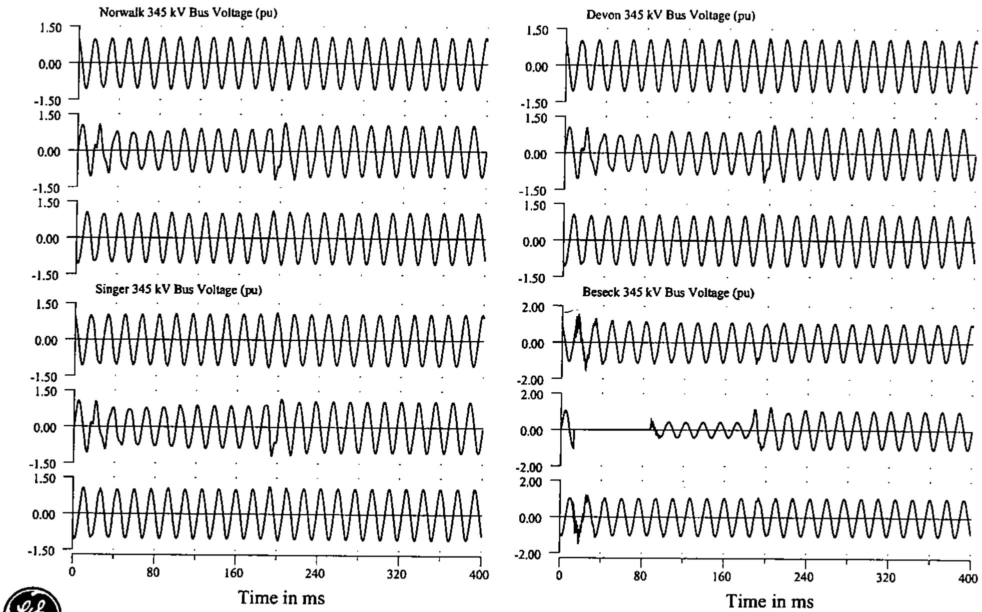
345 kV Bus Voltages



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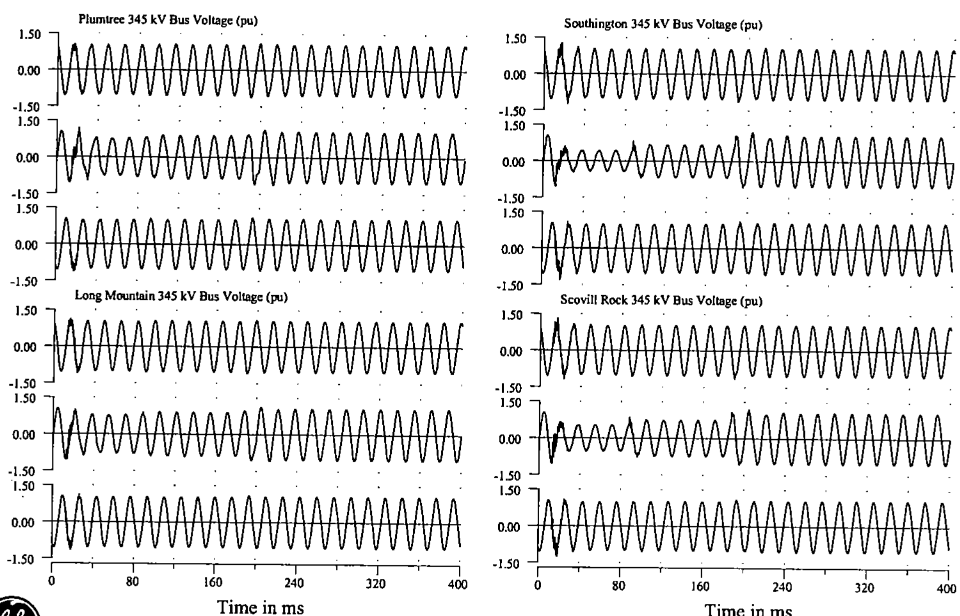

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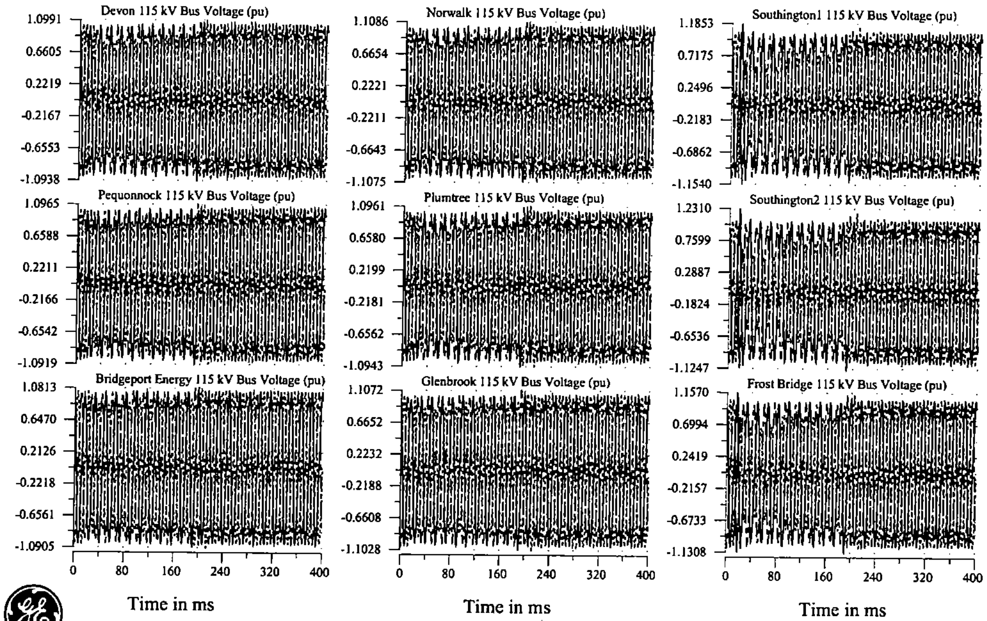
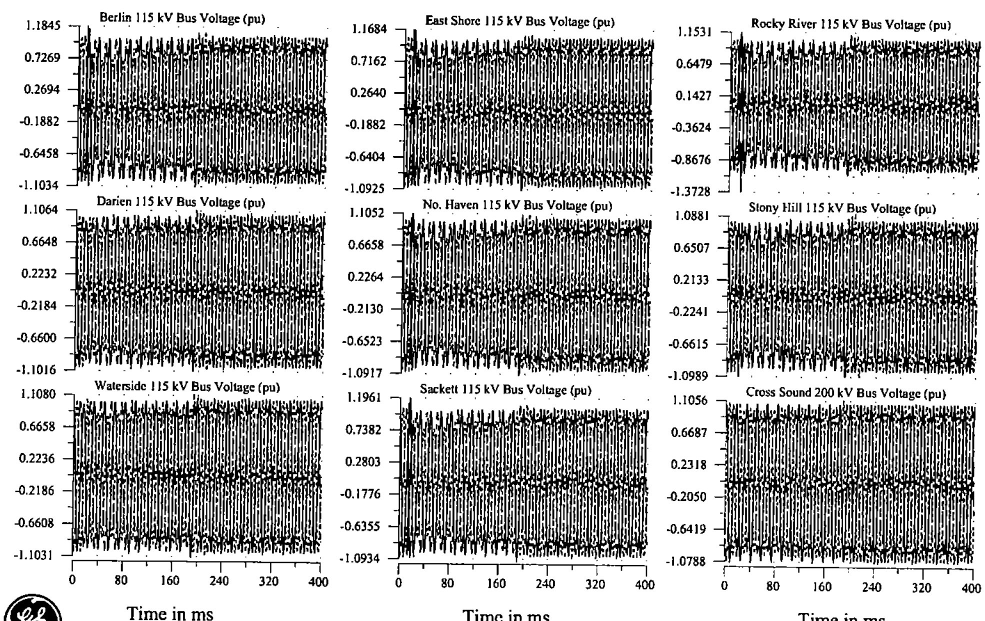
115 kV Bus Voltages and Capacitor Bank Locations



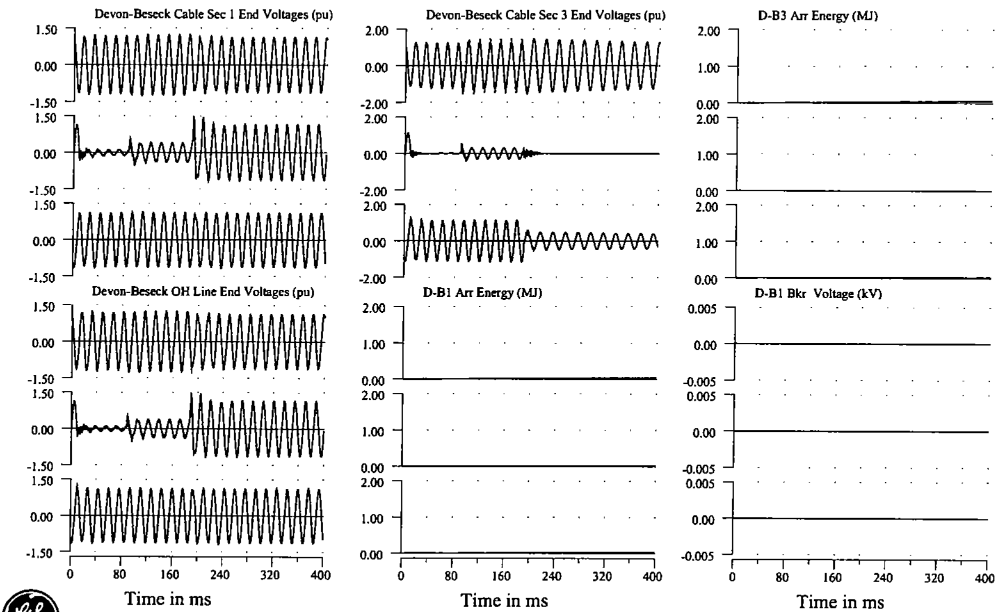
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_01_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_02_0

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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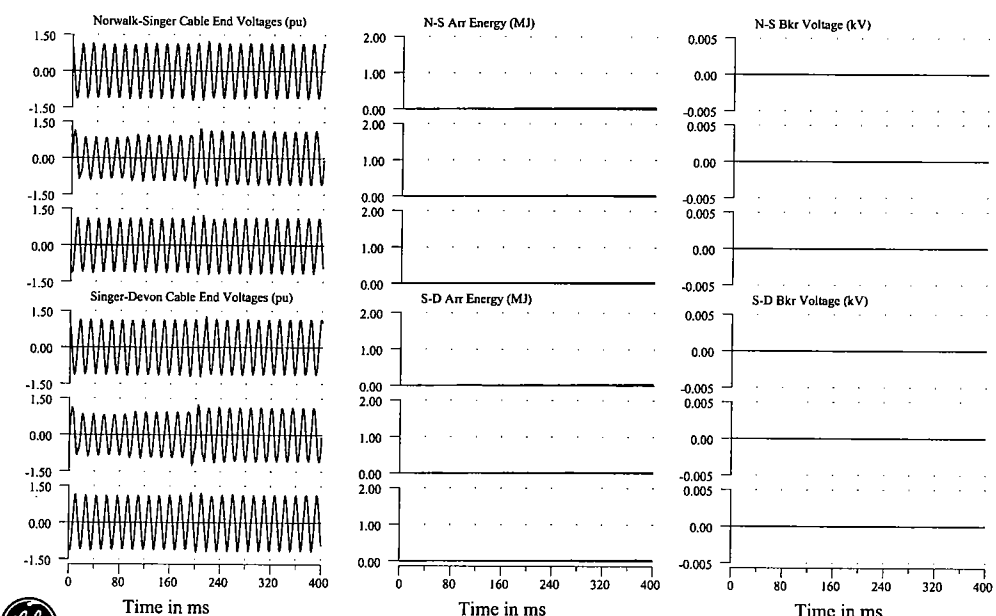
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_02_0

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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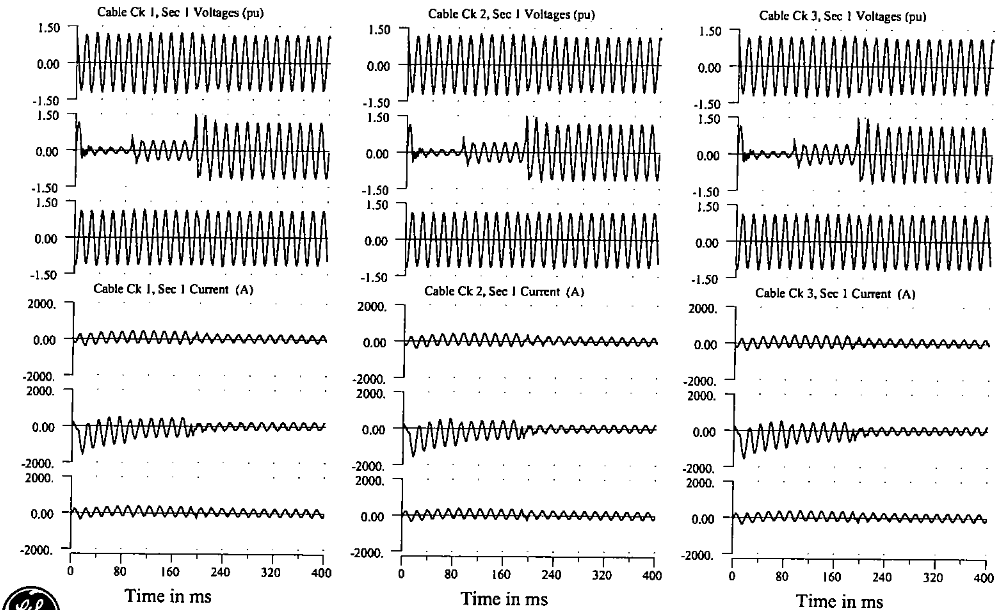
Devon-Beseck 345 kV Cables



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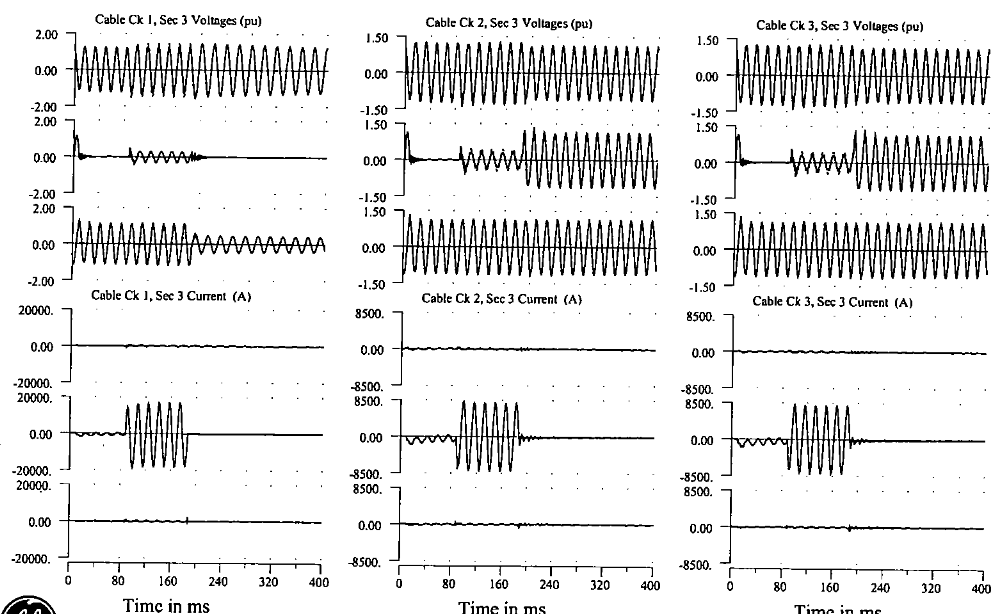
Devon-Beseck 345 kV Cables



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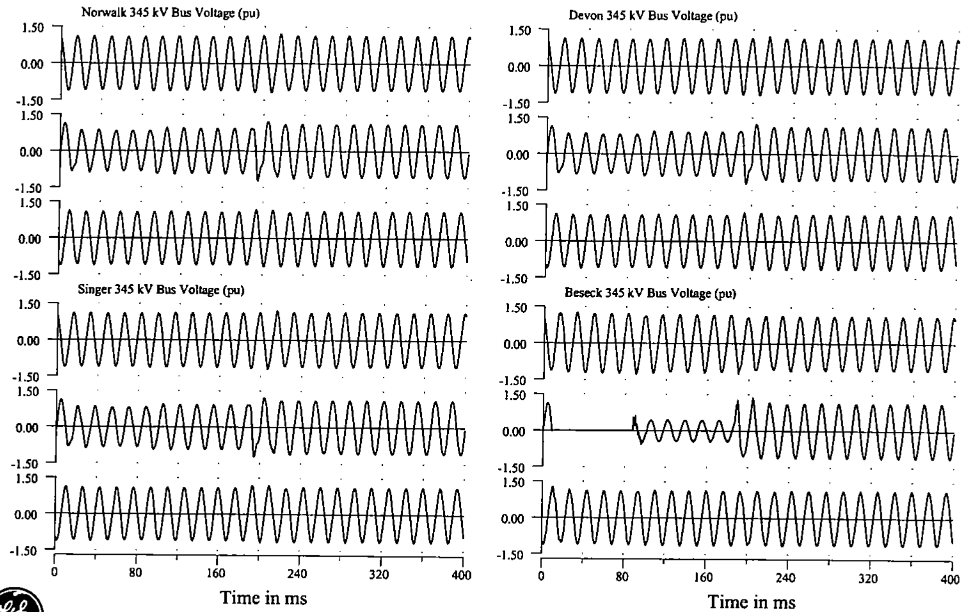
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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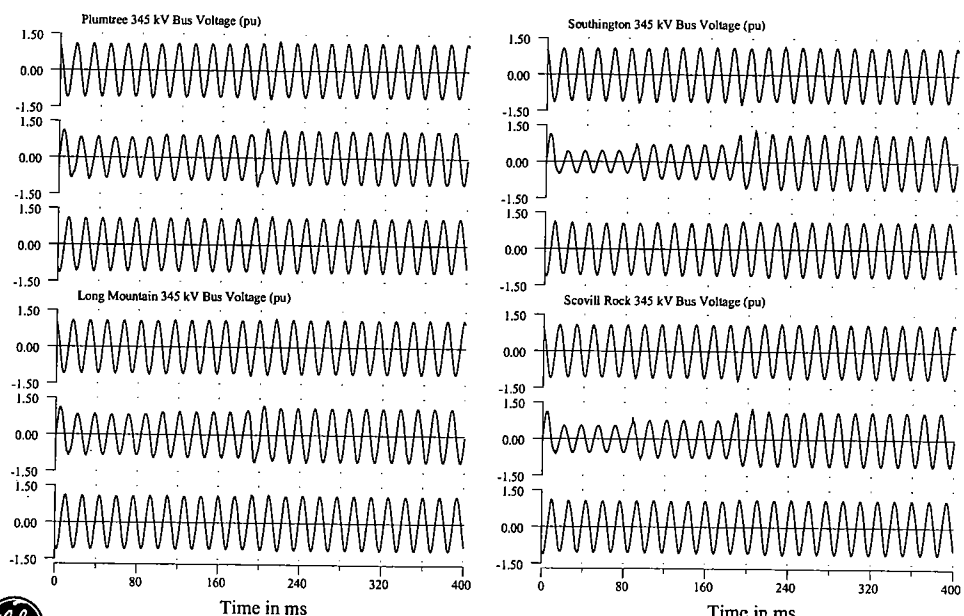
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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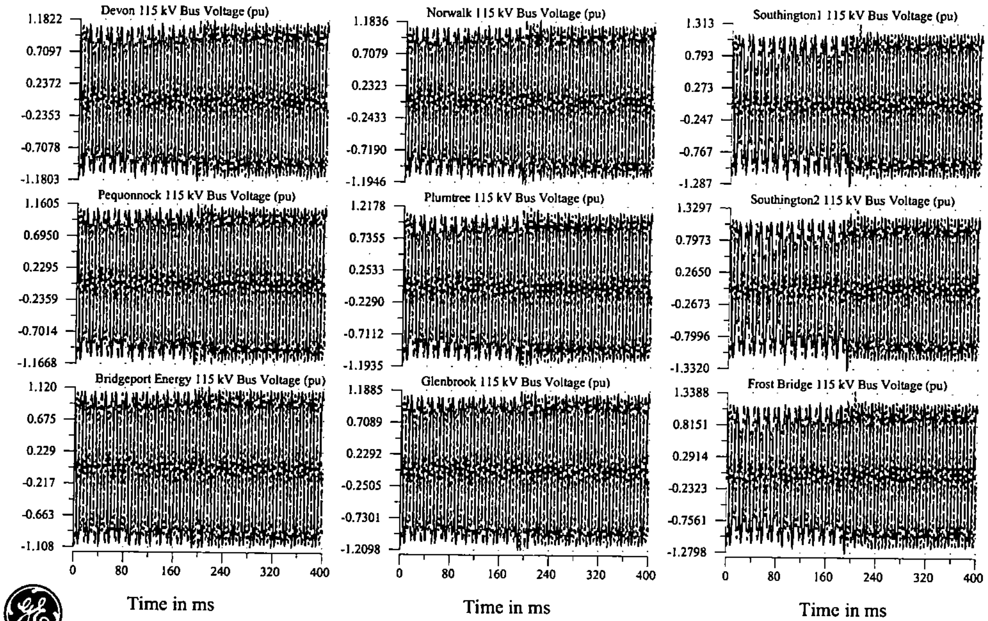
115 kV Bus Voltages and Capacitor Bank Locations



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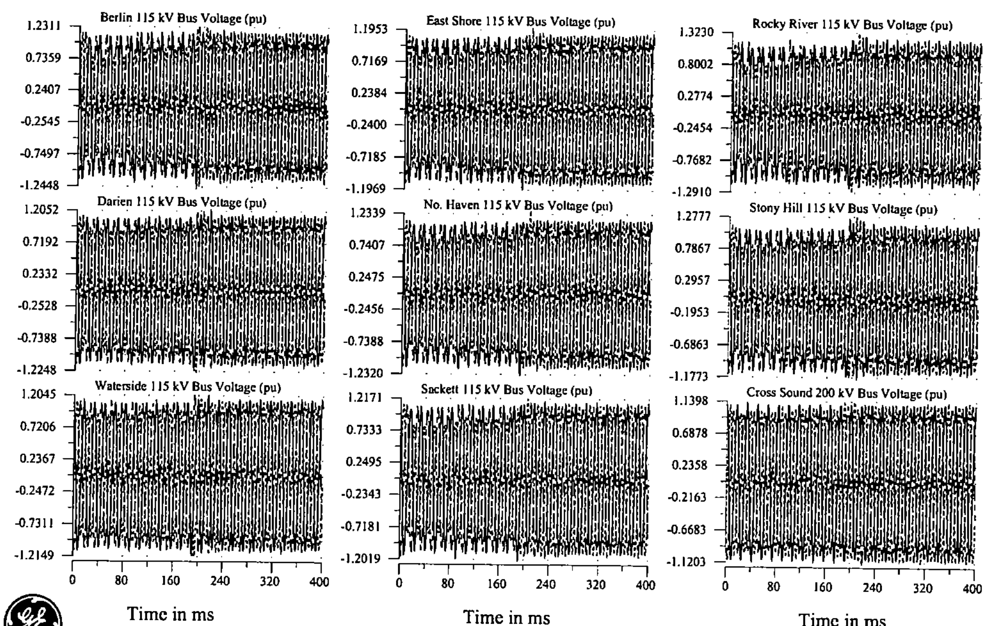
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_02_0
115 kV Bus Voltages and Capacitor Bank Locations



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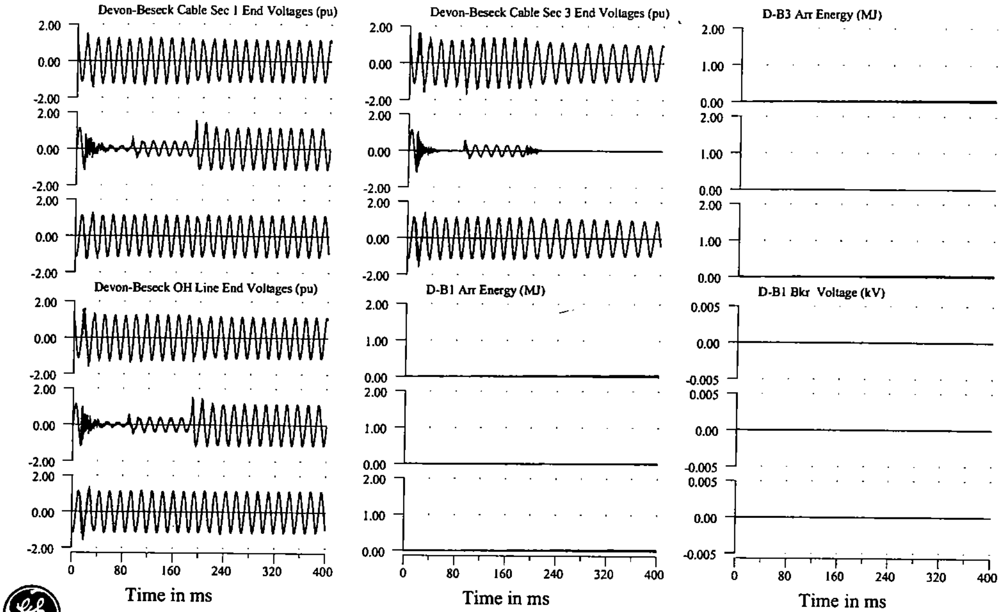
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_02_90
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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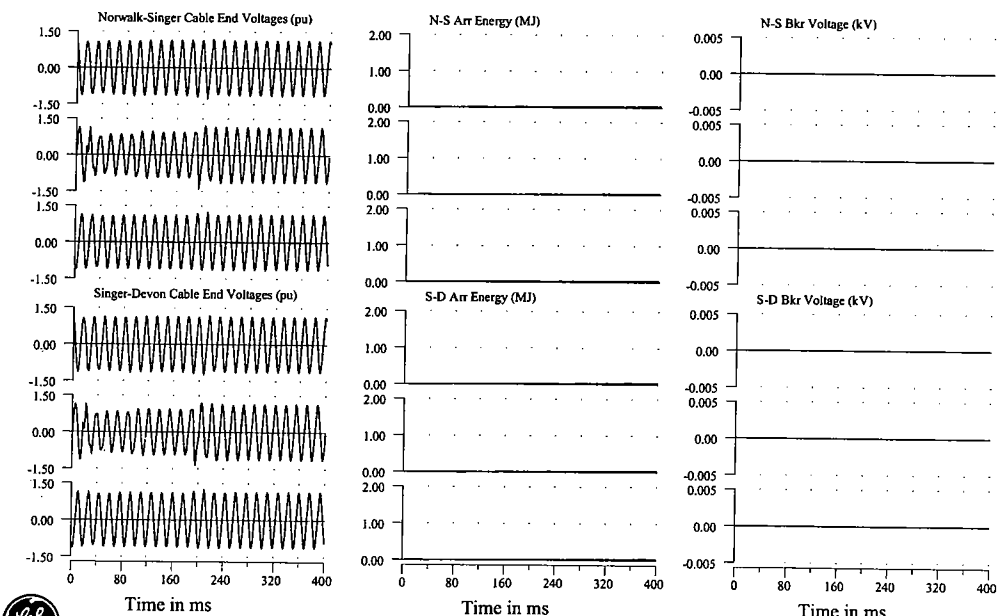
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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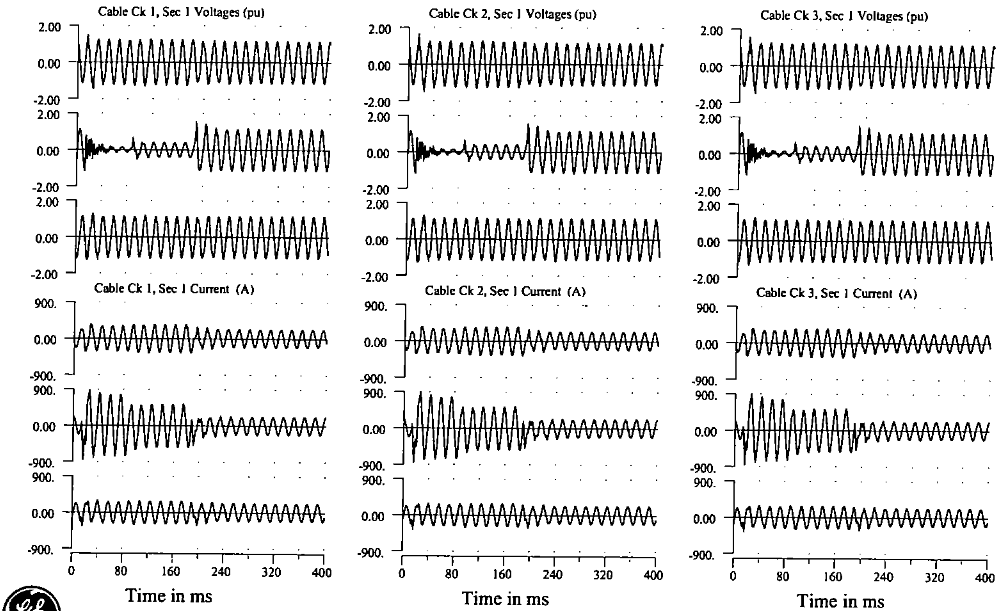
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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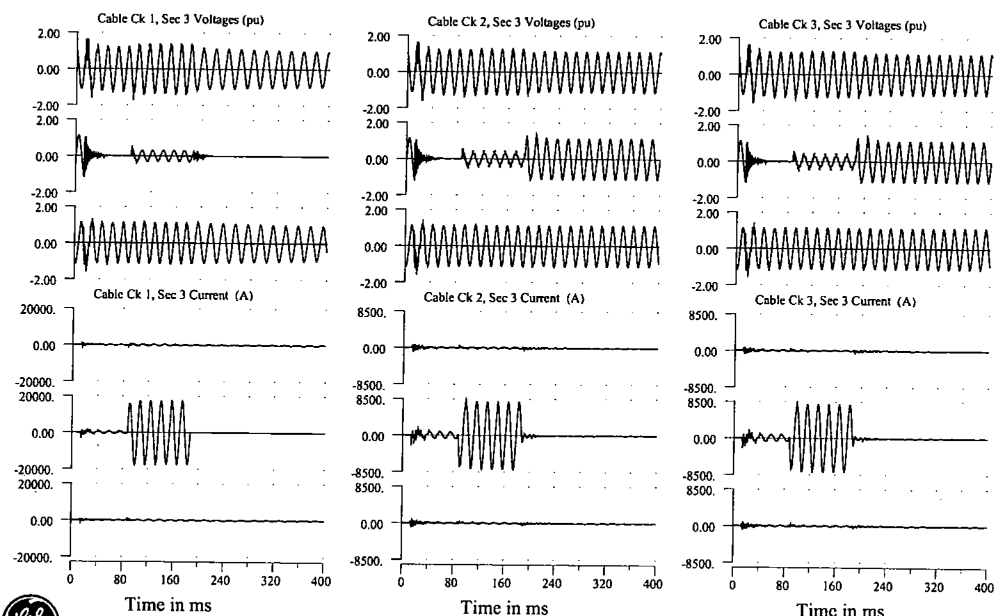
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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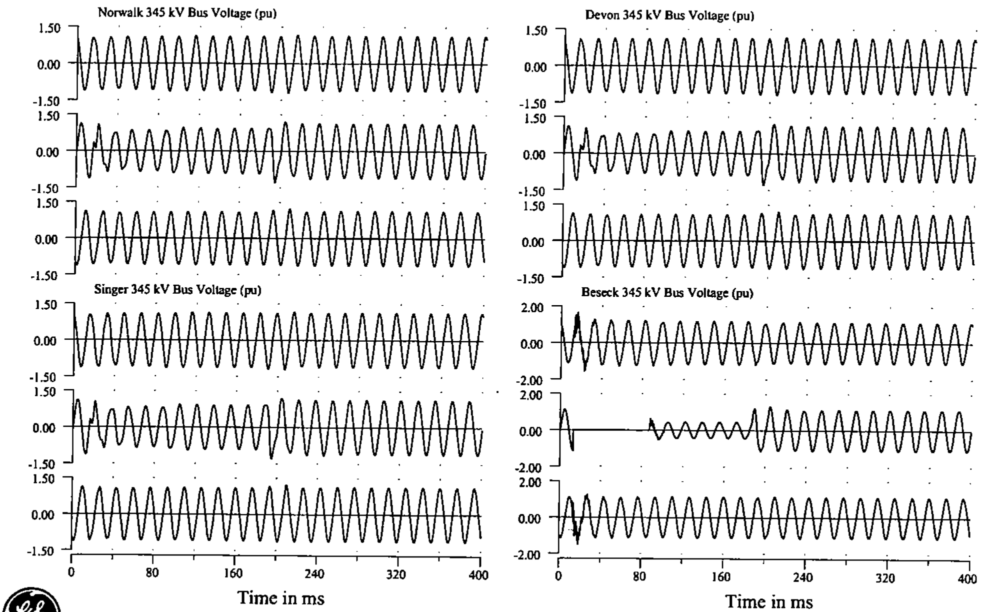
345 kV Bus Voltages



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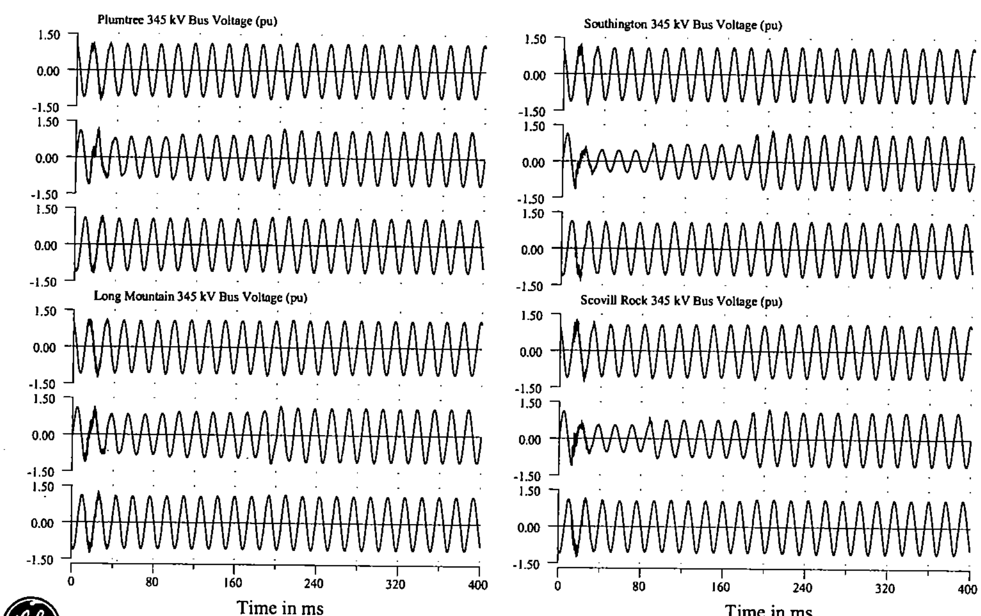
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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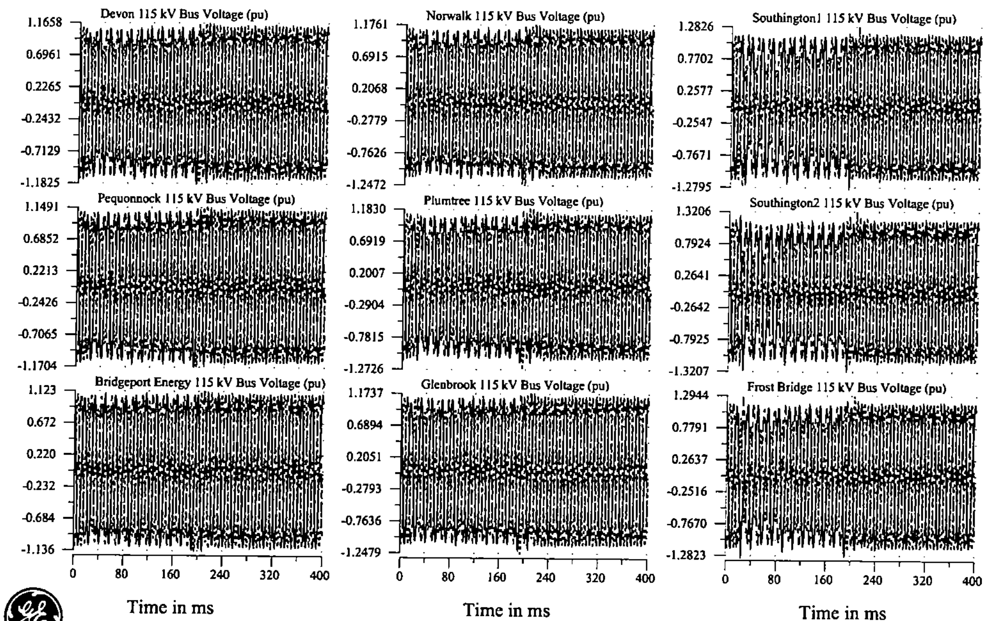
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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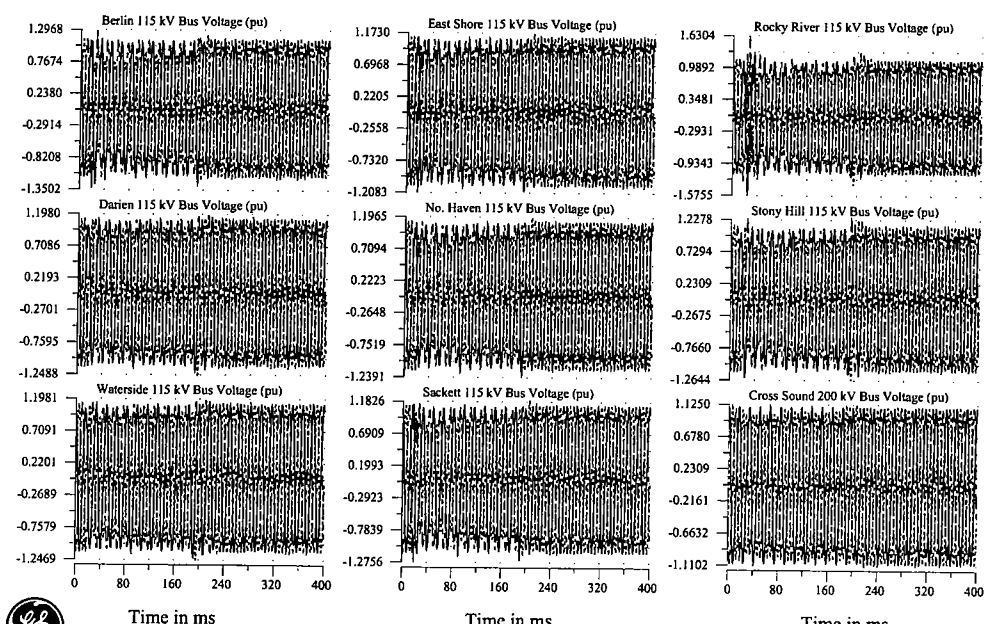
115 kV Bus Voltages and Capacitor Bank Locations



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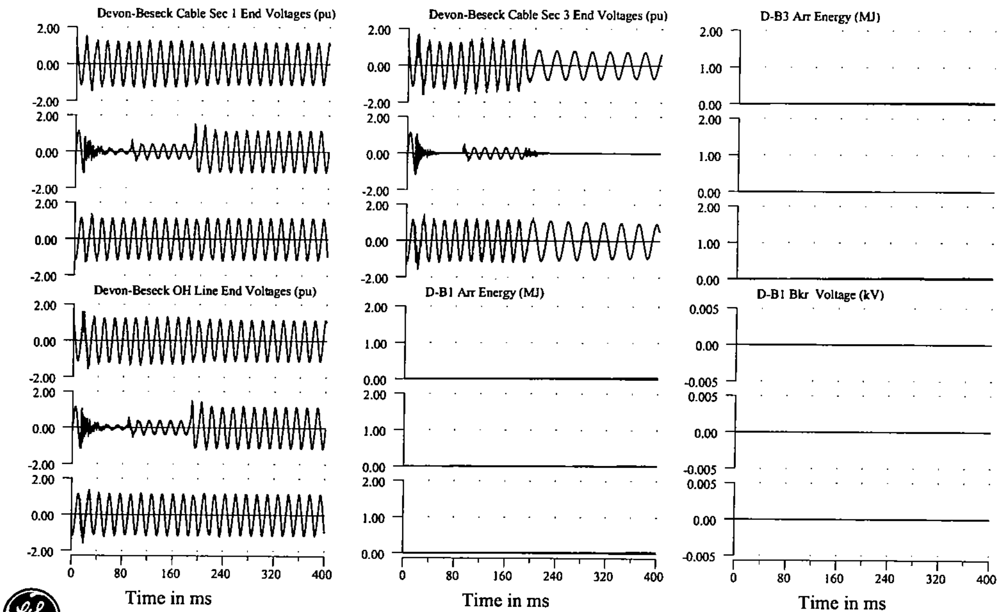
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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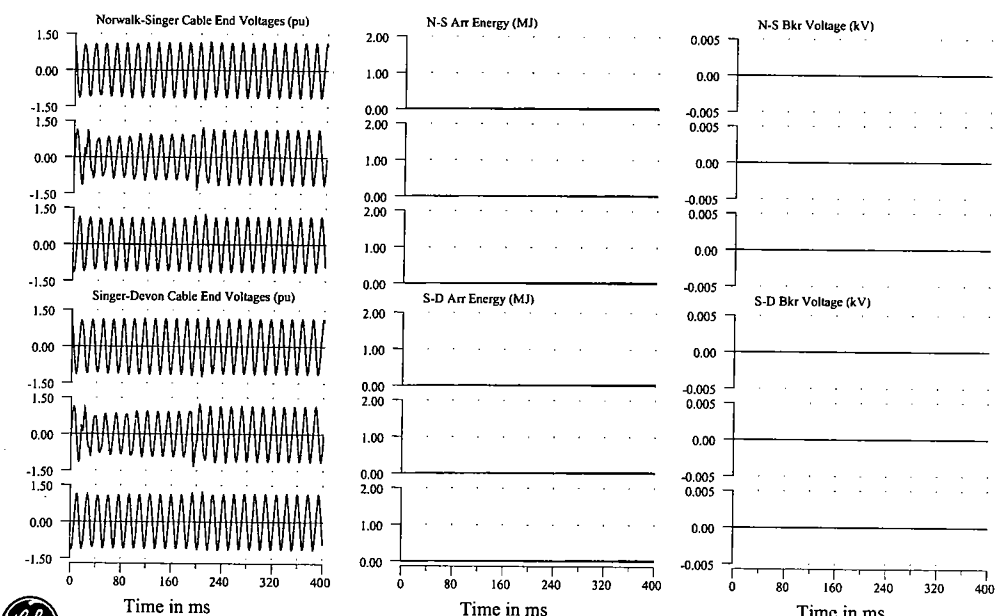
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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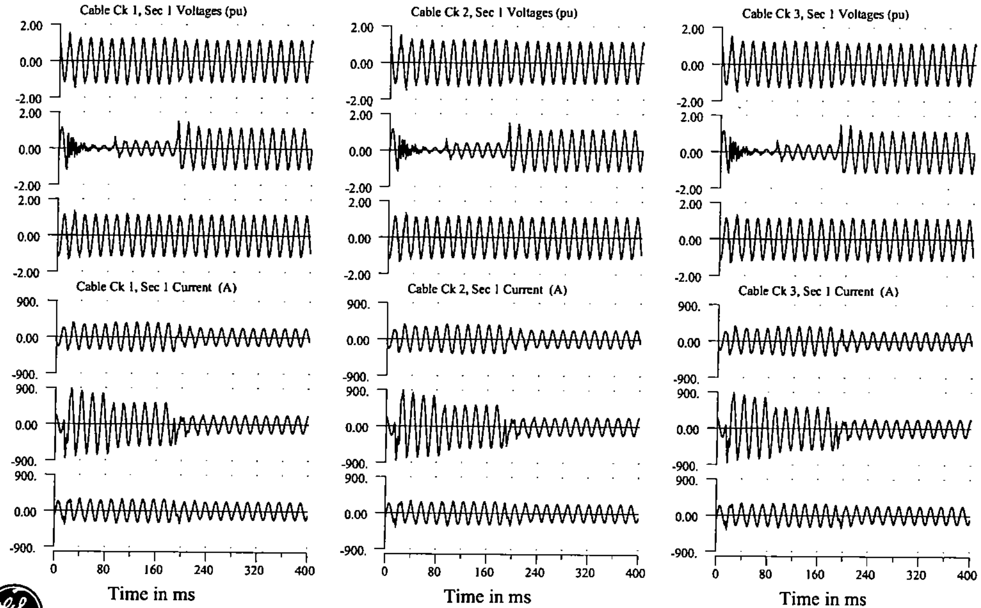
Devon-Beseck 345 kV Cables



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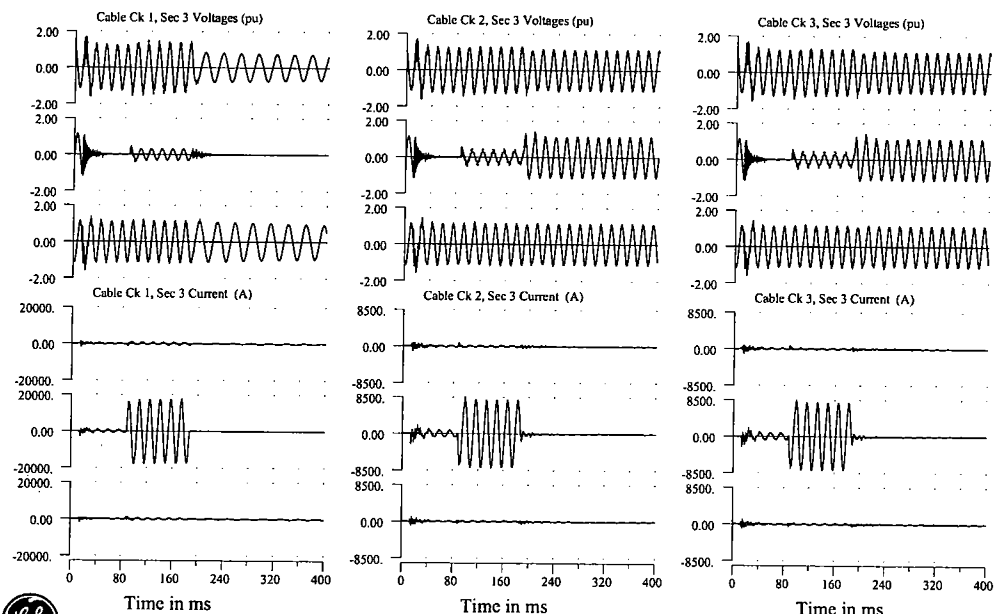
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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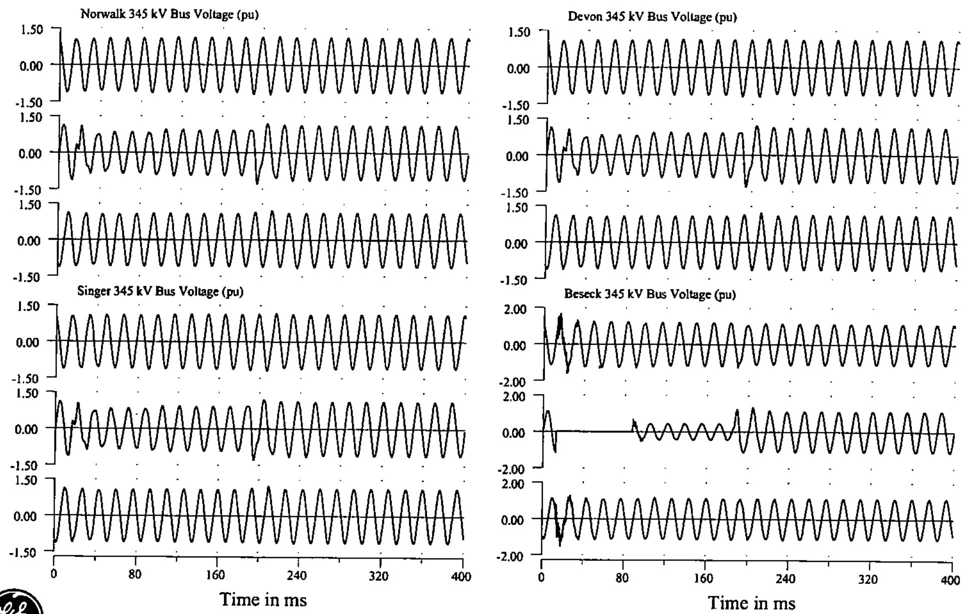
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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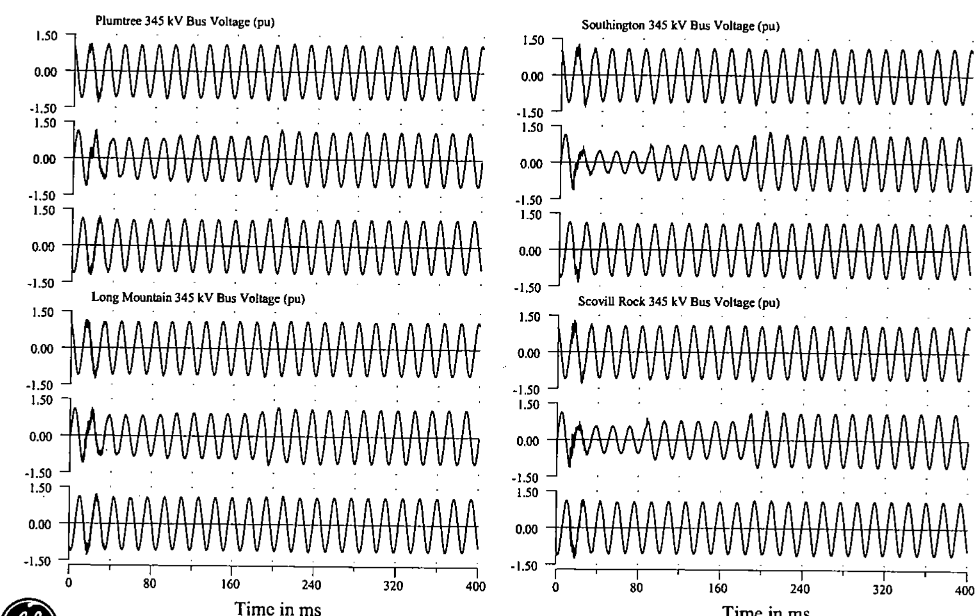
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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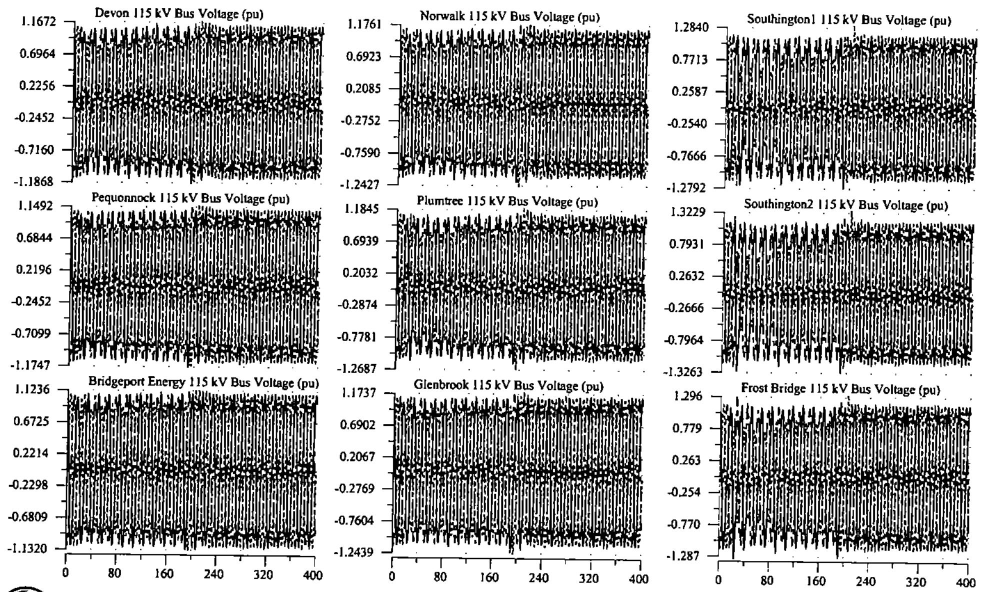
11A5 kV Bus Voltages and Capacitor Bank Locations



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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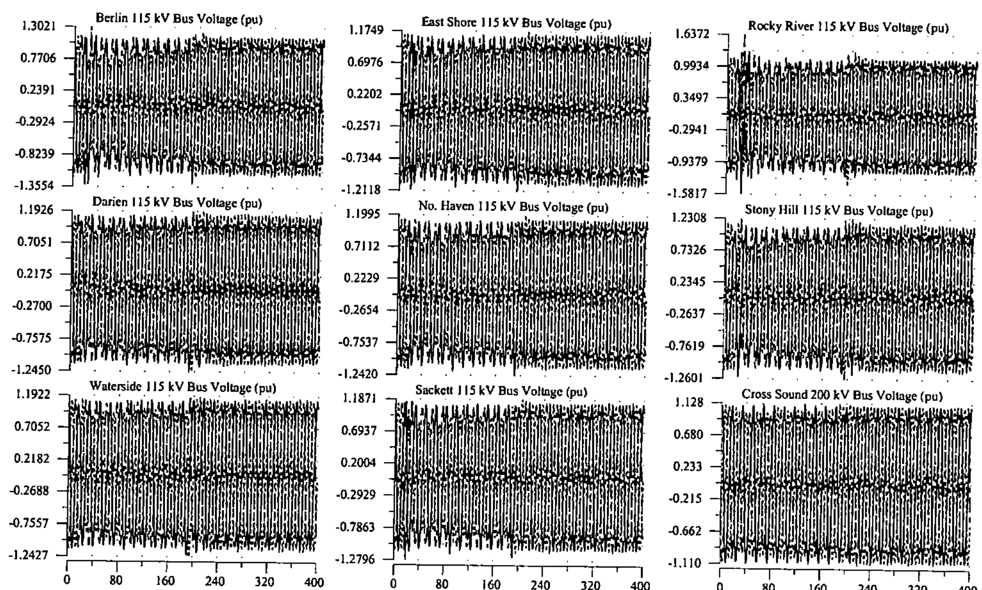
11A5 kV Bus Voltages and Capacitor Bank Locations



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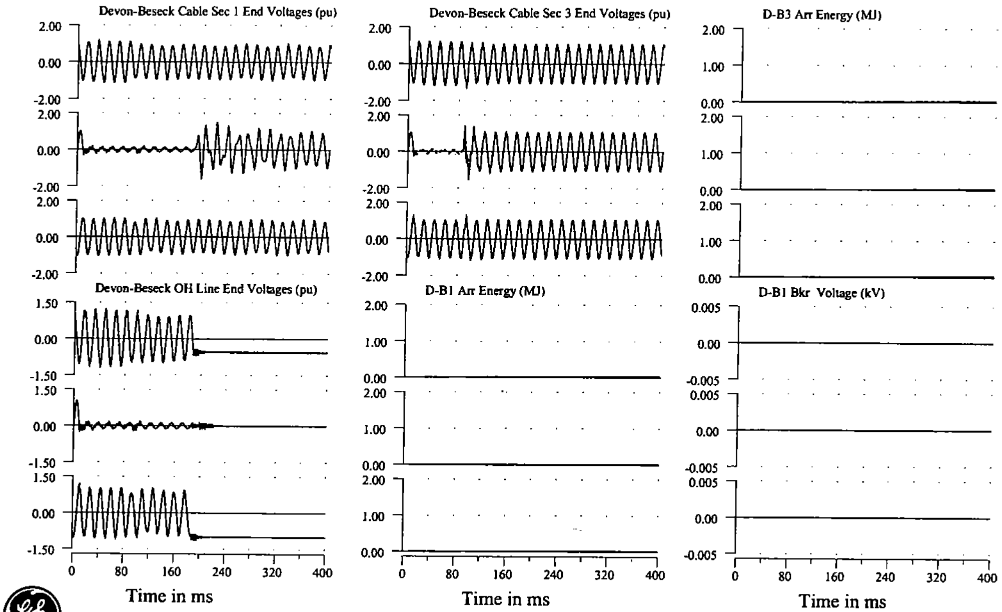
DBF_03_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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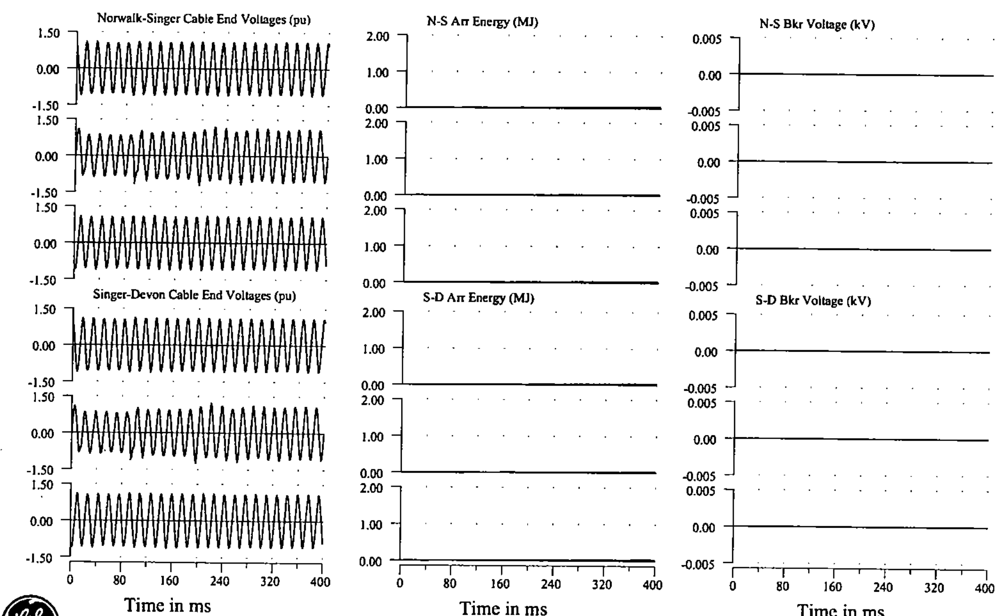

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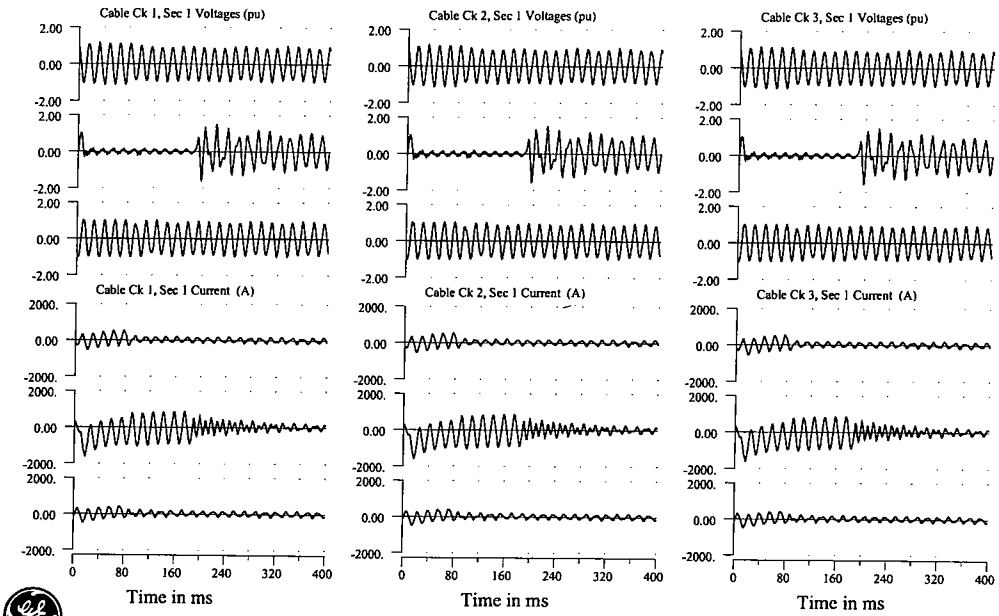
Devon-Beseck 345 kV Cables



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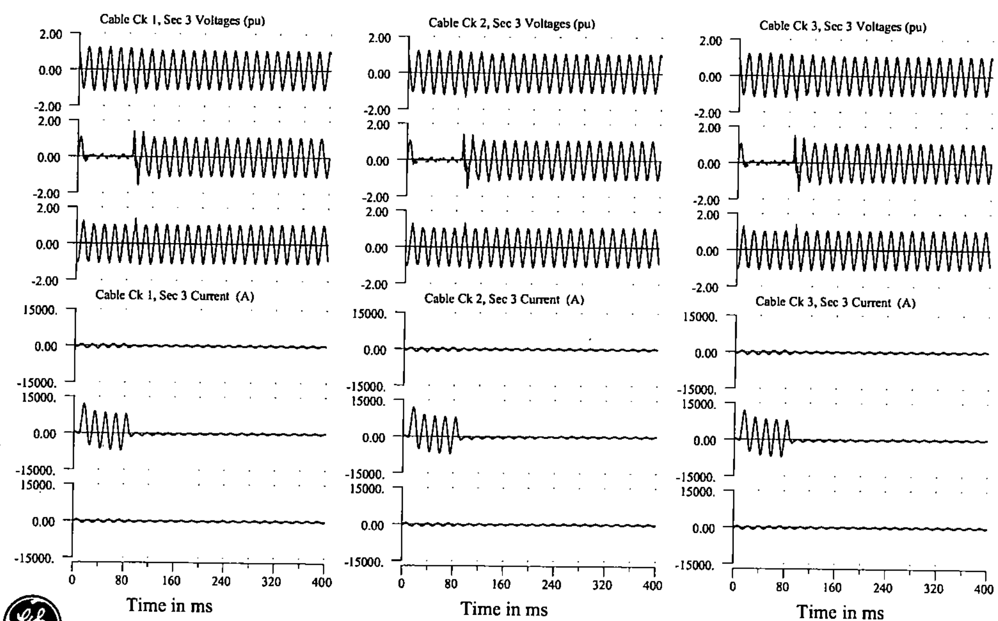
Devon-Beseck 345 kV Cables



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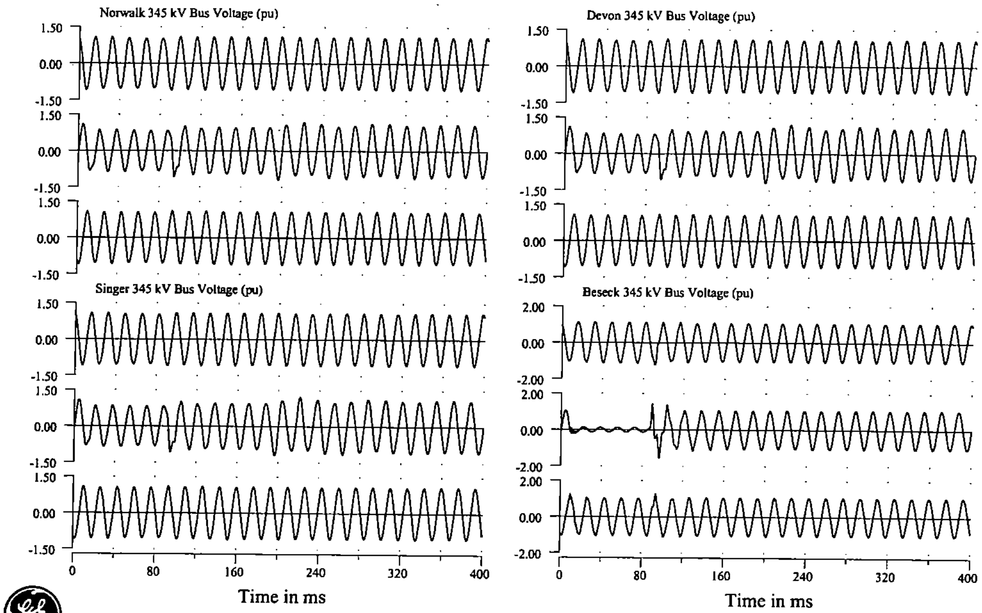
345 kV Bus Voltages



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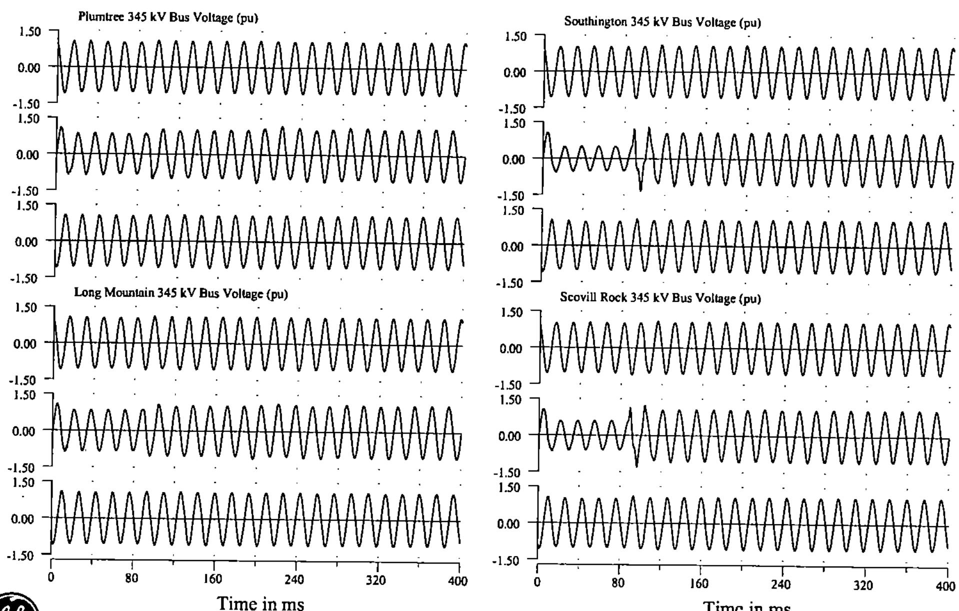

Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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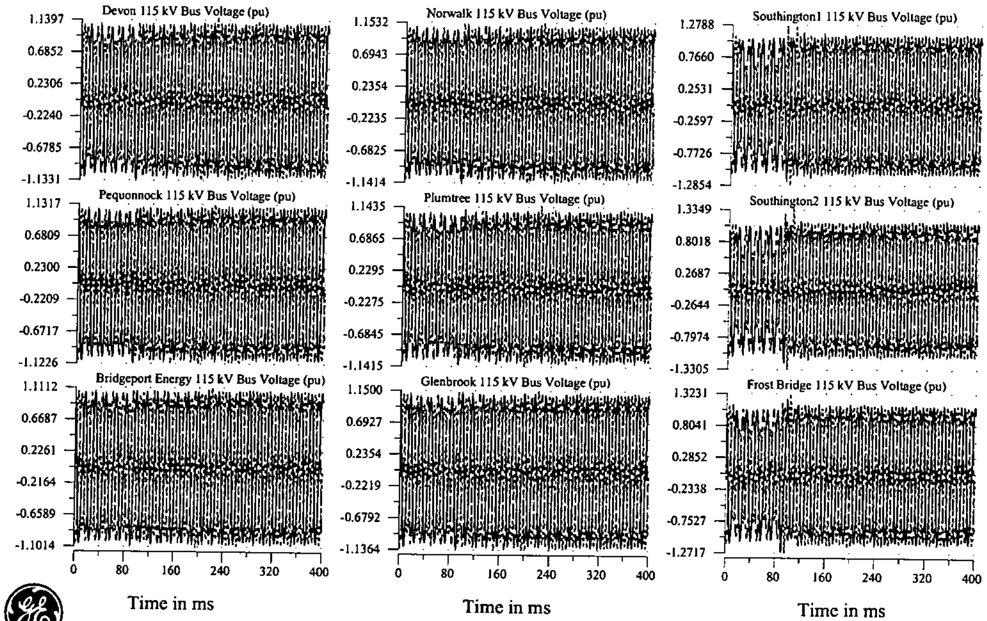
115 kV Bus Voltages and Capacitor Bank Locations



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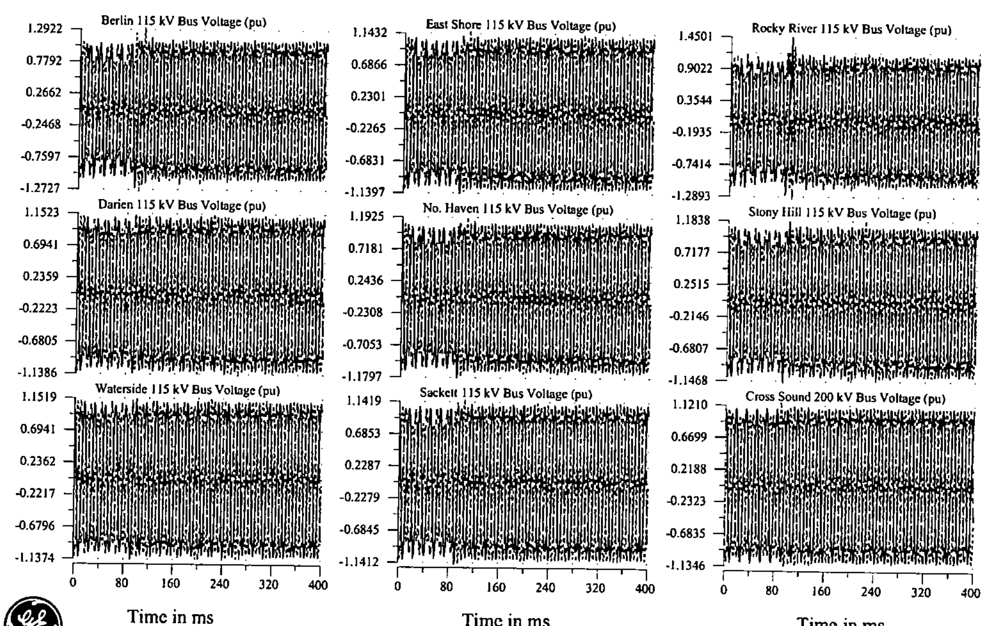
115 kV Bus Voltages and Capacitor Bank Locations



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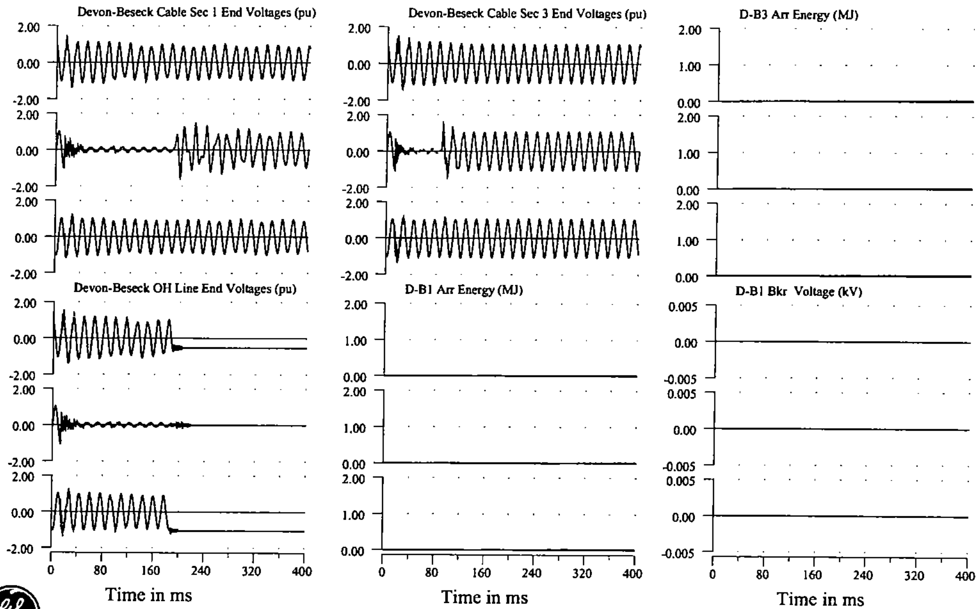
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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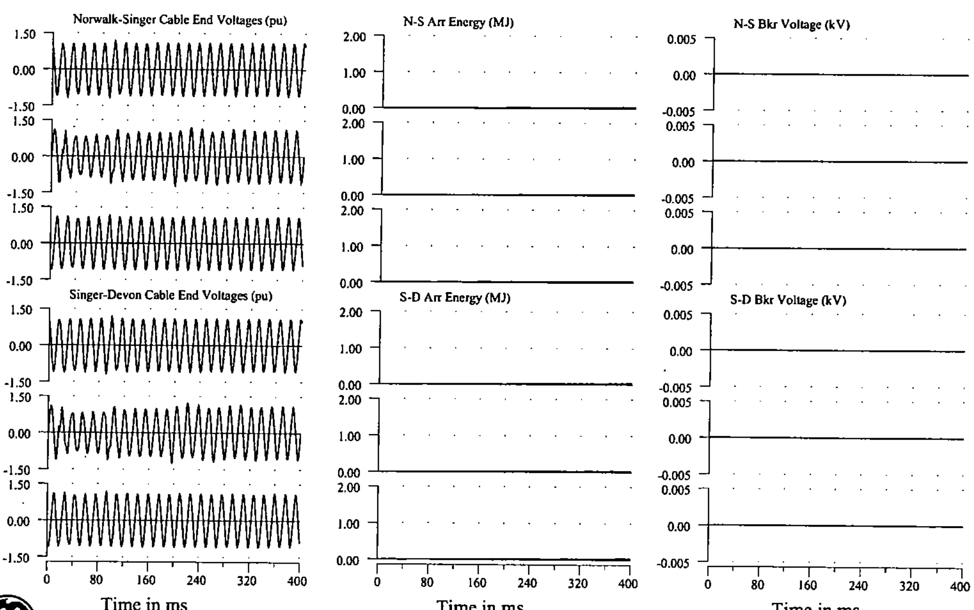
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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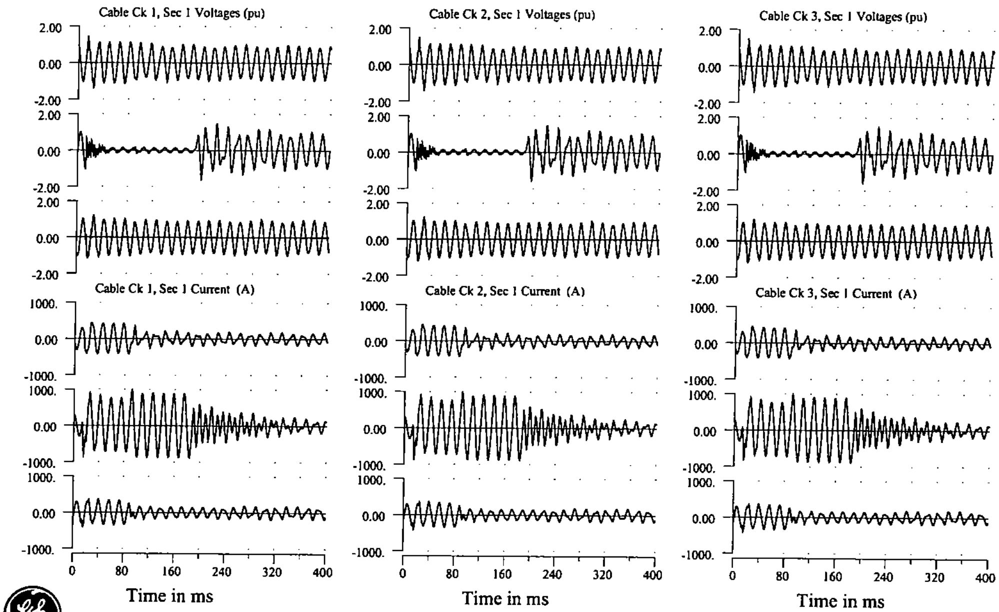
Devon-Beseck 345 kV Cables



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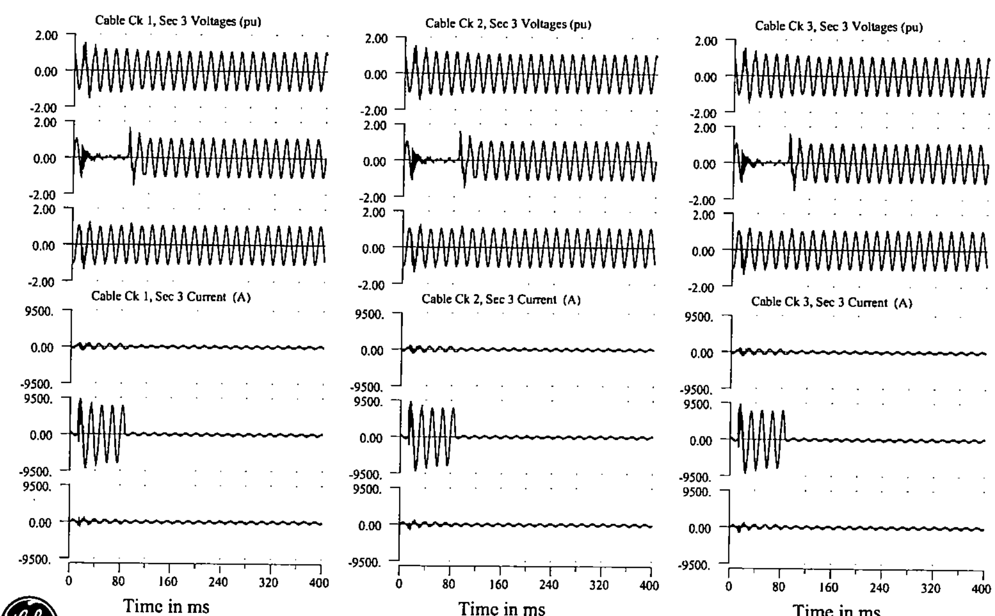
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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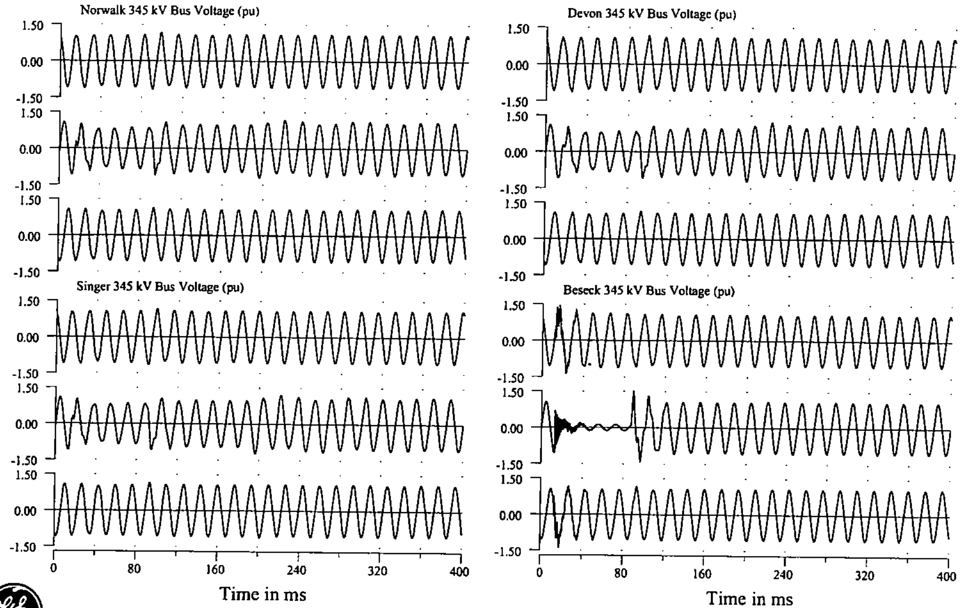
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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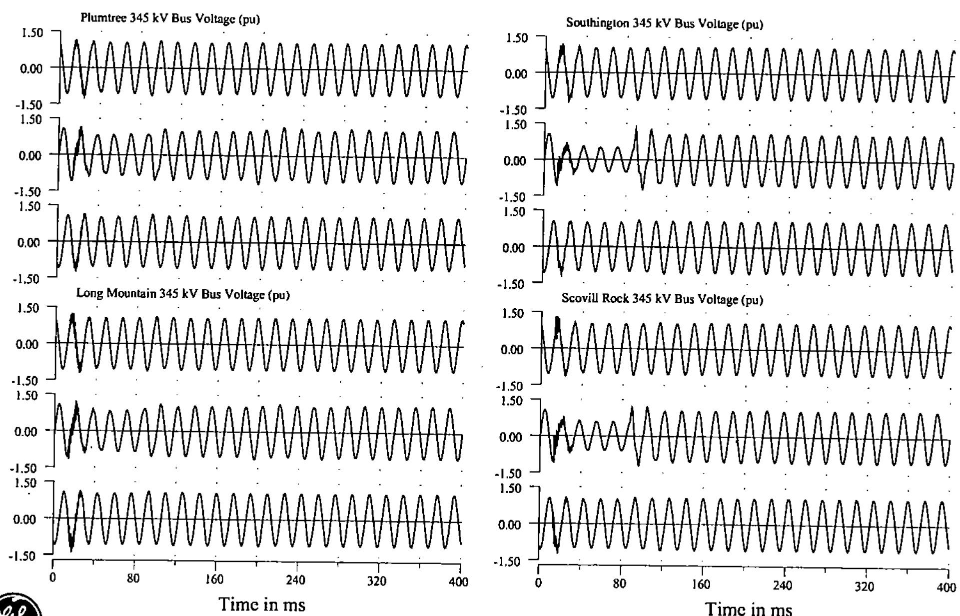
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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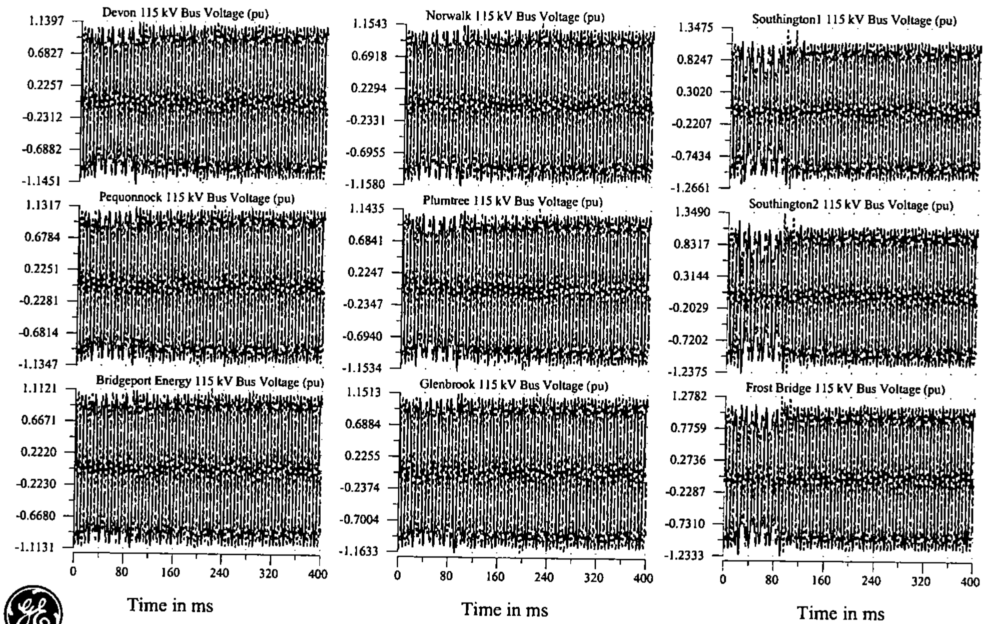
115 kV Bus Voltages and Capacitor Bank Locations



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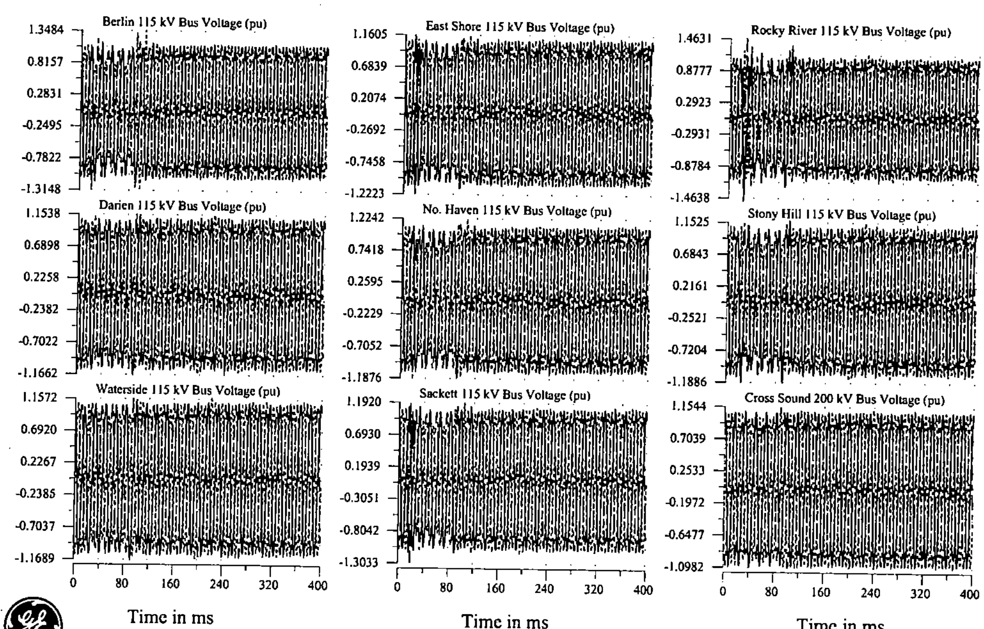
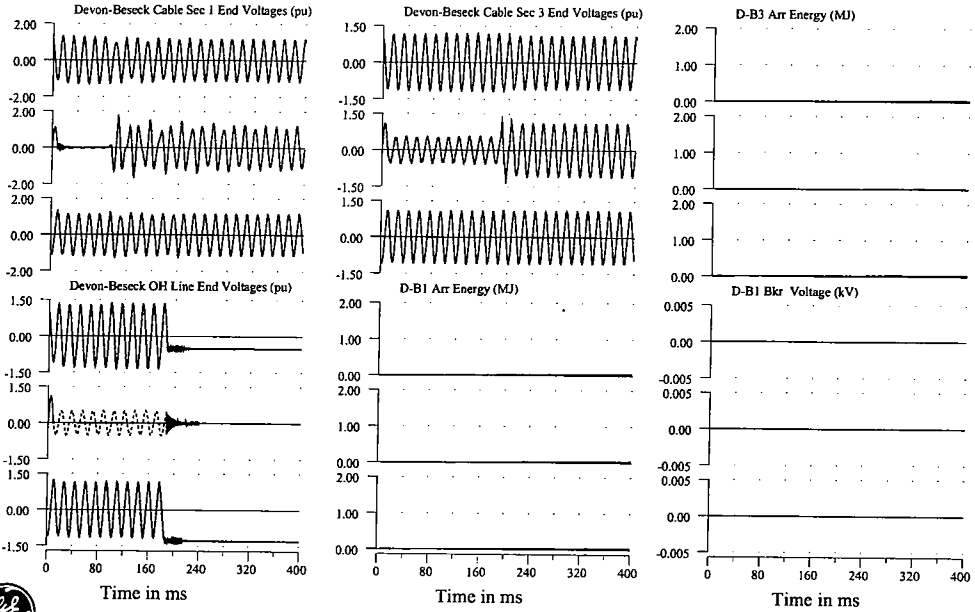
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_04_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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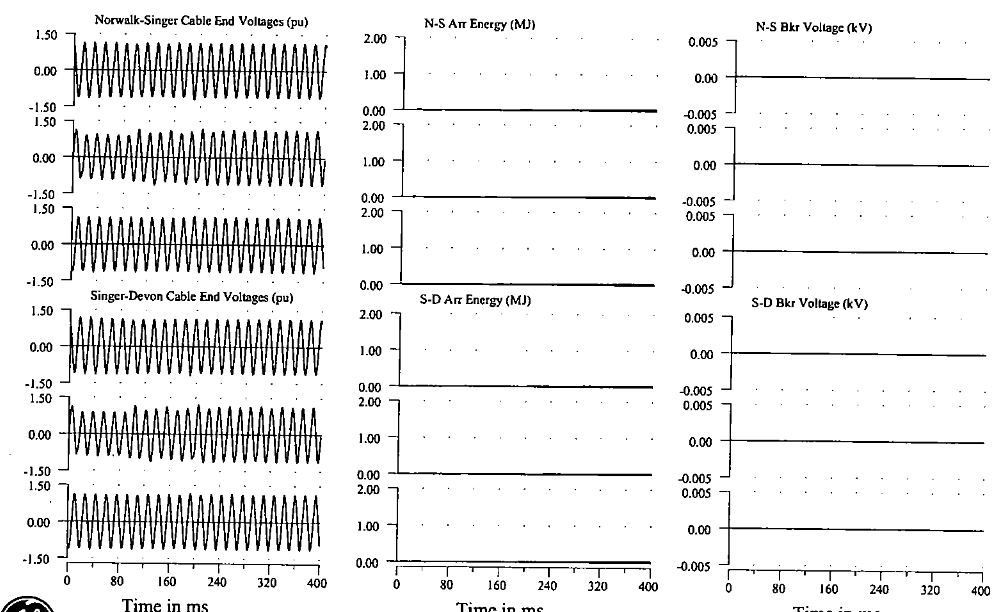
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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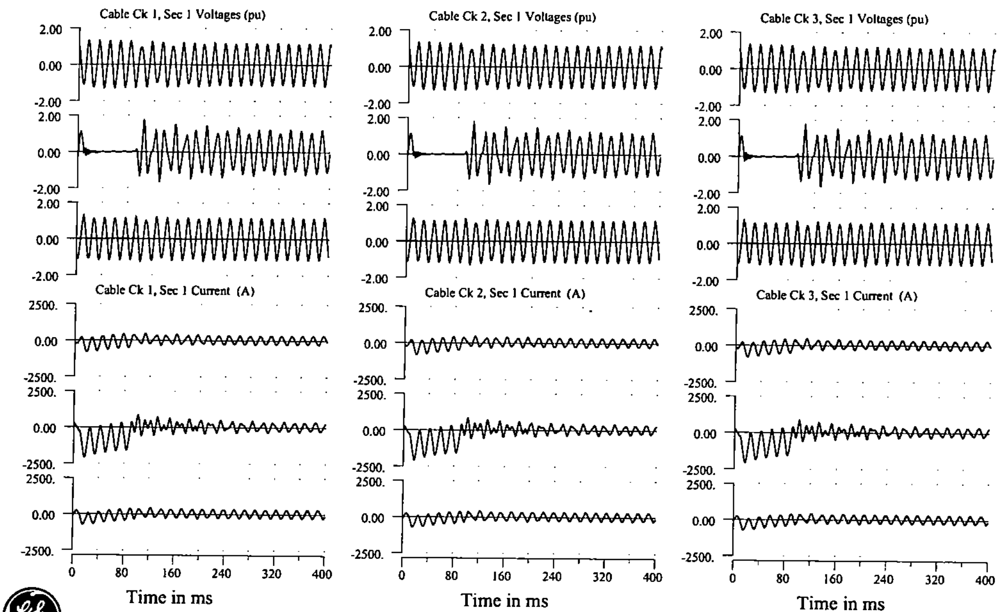
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_04_0
Devon-Beseck 345 kV Cables



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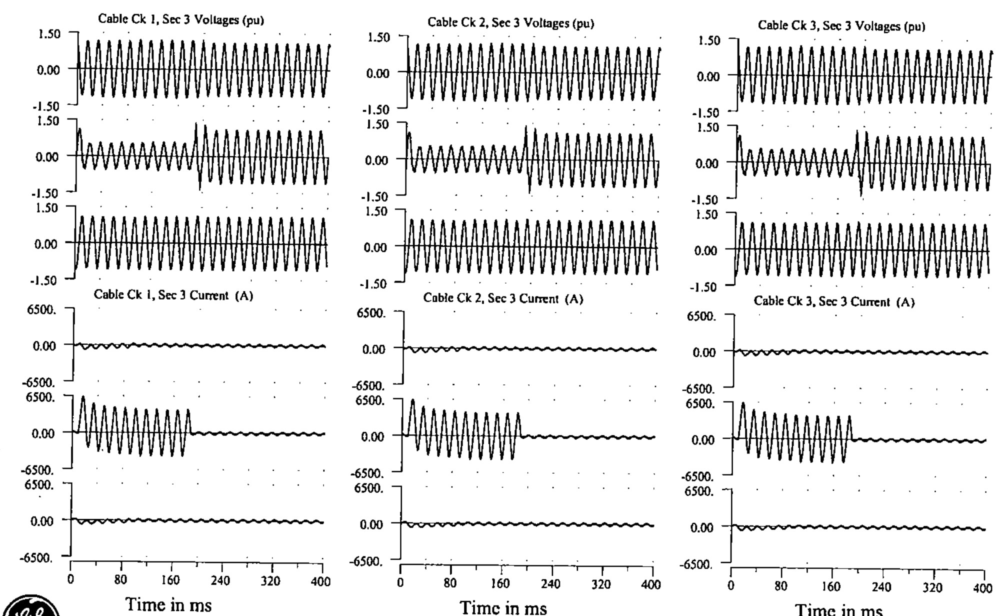
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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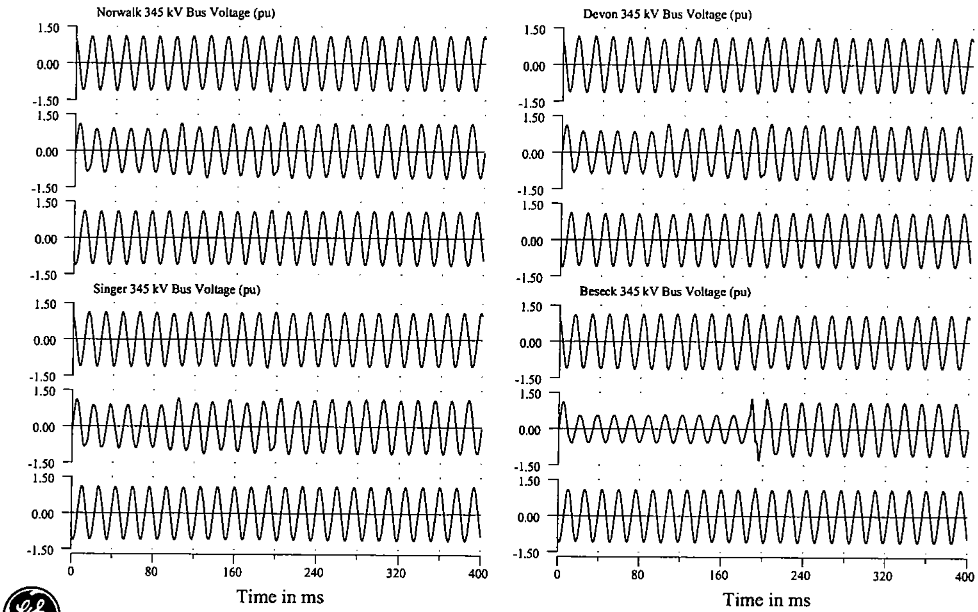
345 kV Bus Voltages



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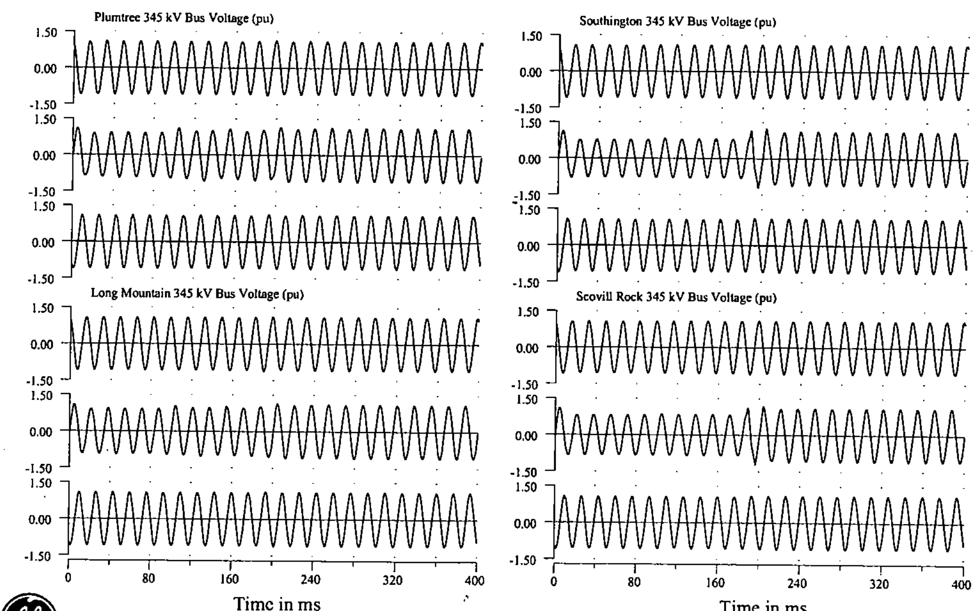
DBF_04_0
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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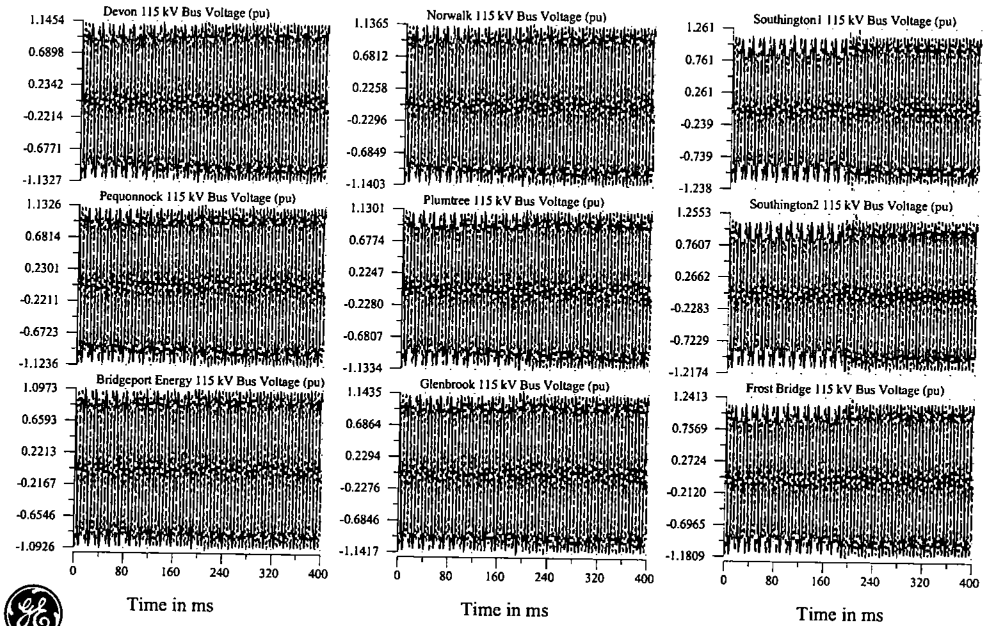
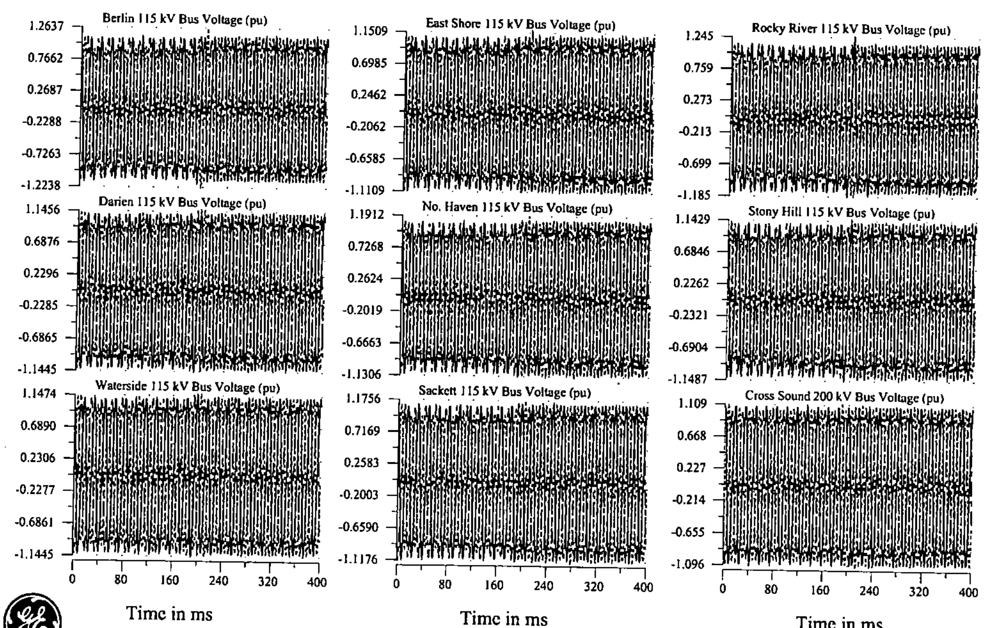
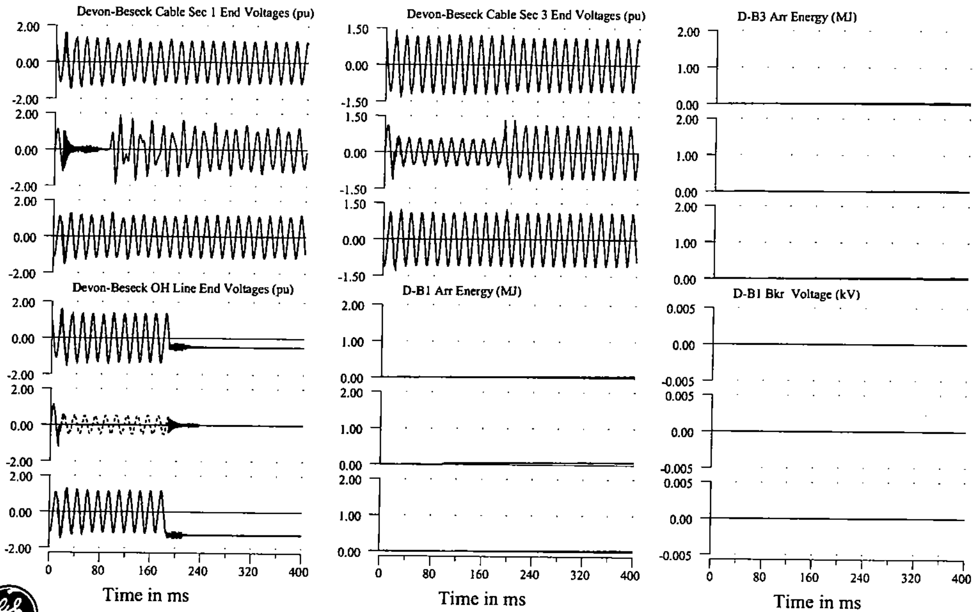
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_04_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_04_90
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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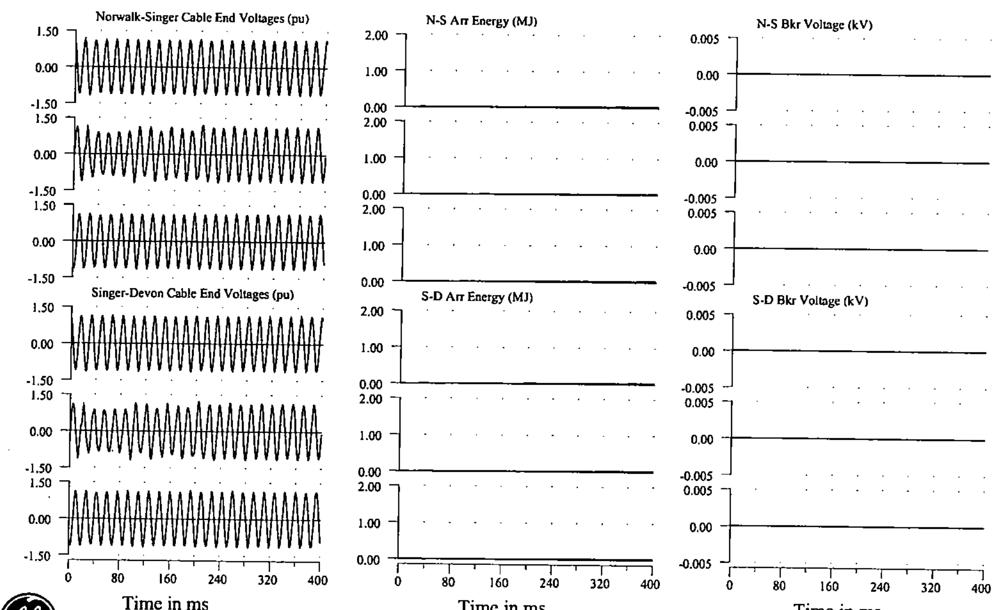
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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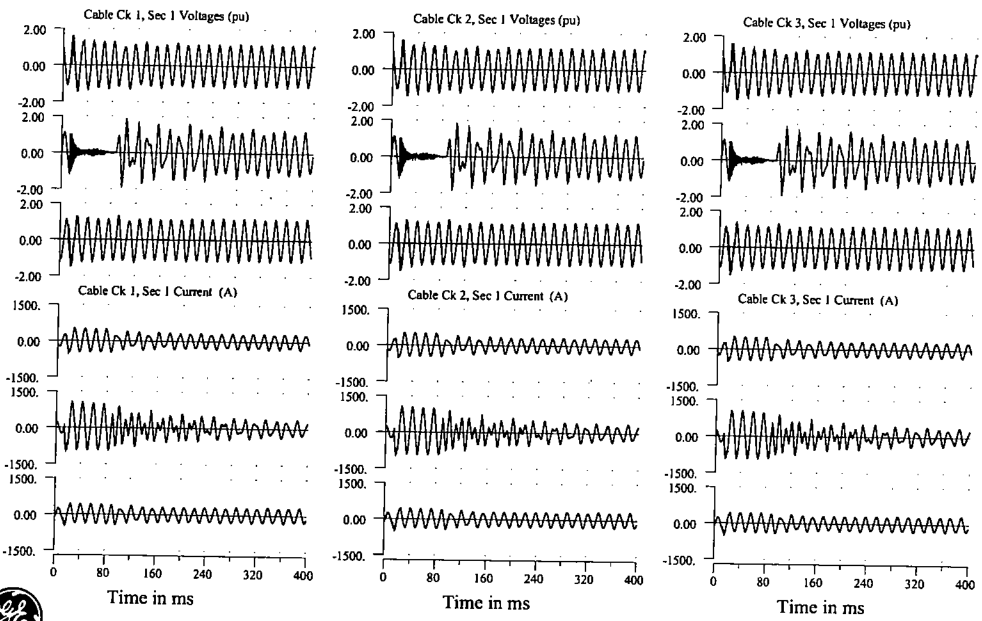
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_04_90
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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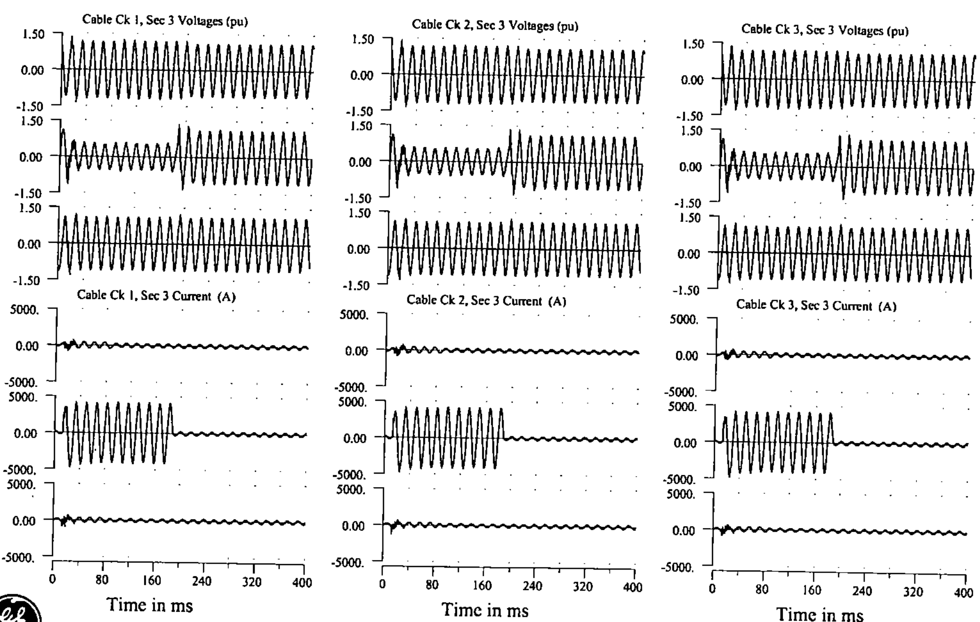
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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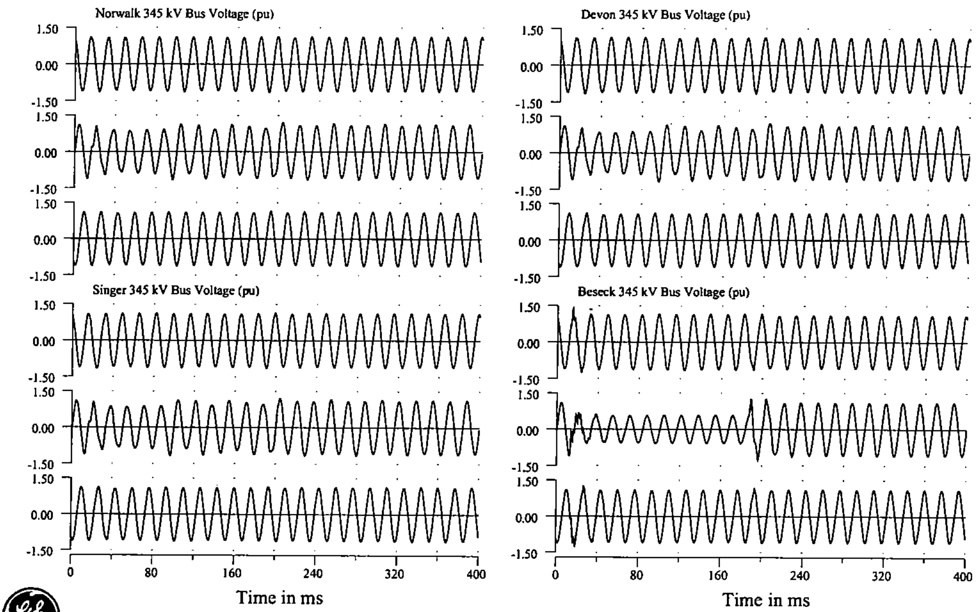
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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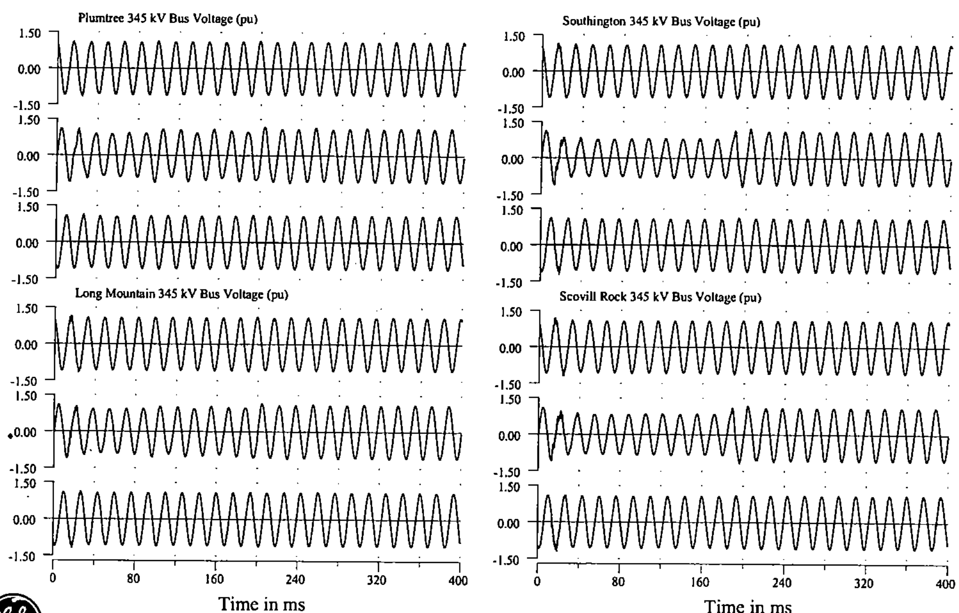
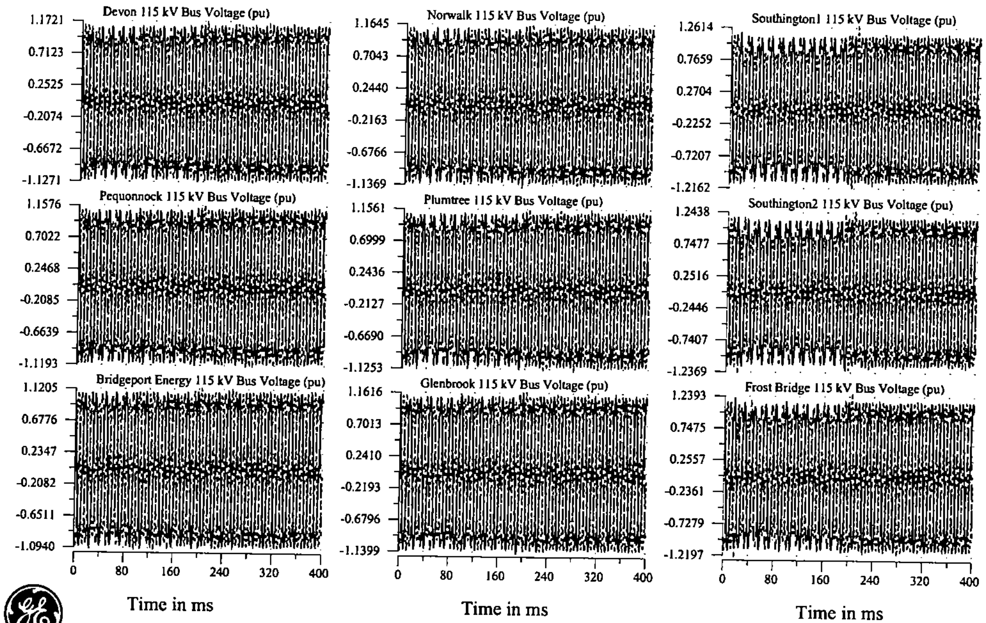
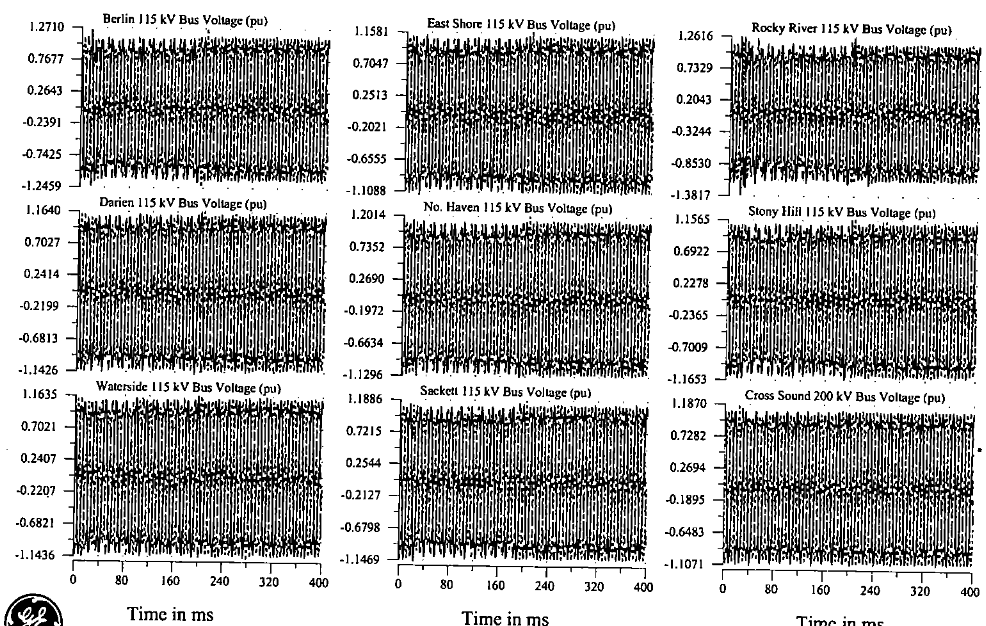
345 kV Bus Voltages



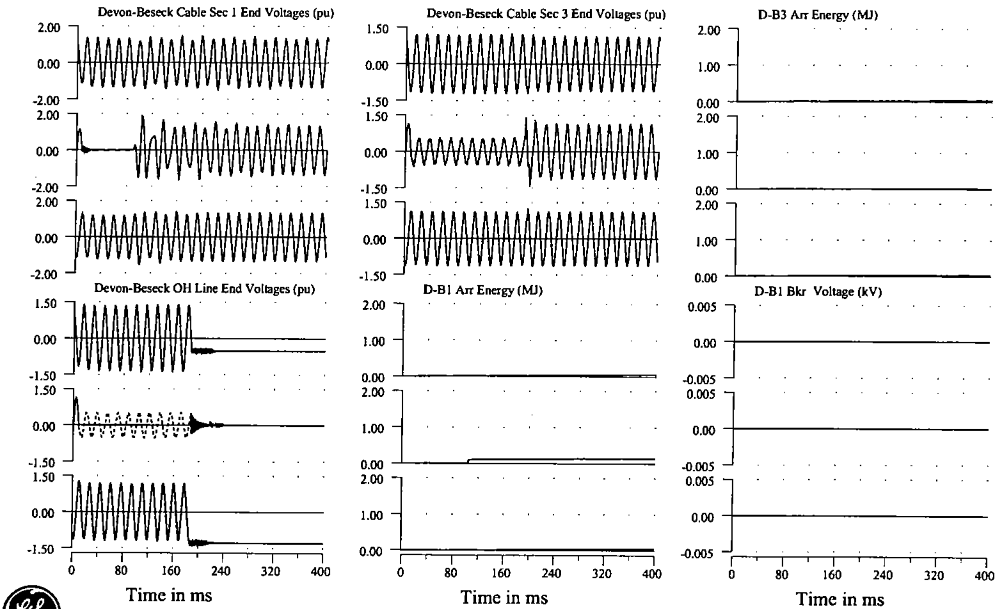
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_04_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_04_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_05_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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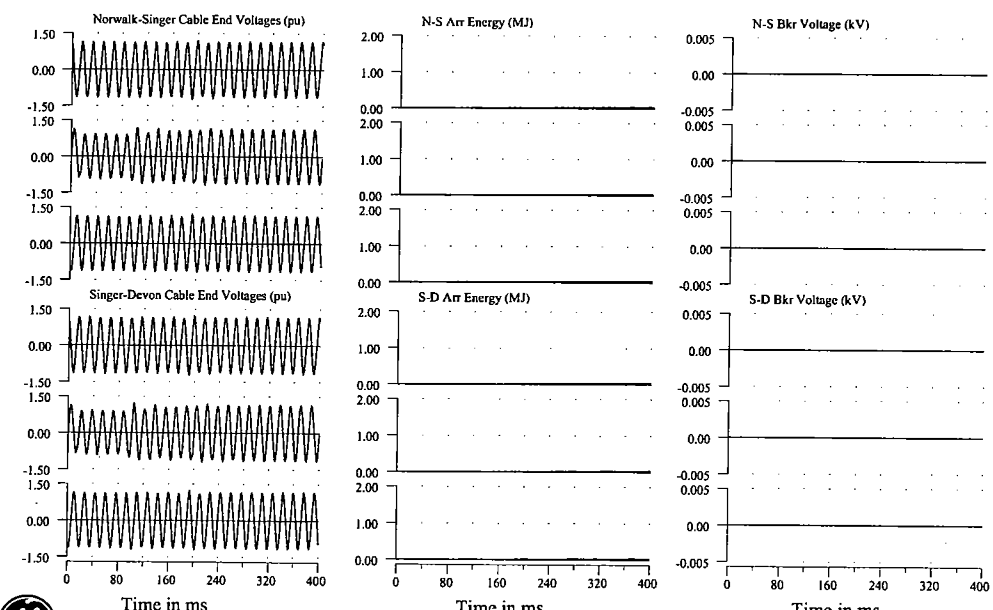
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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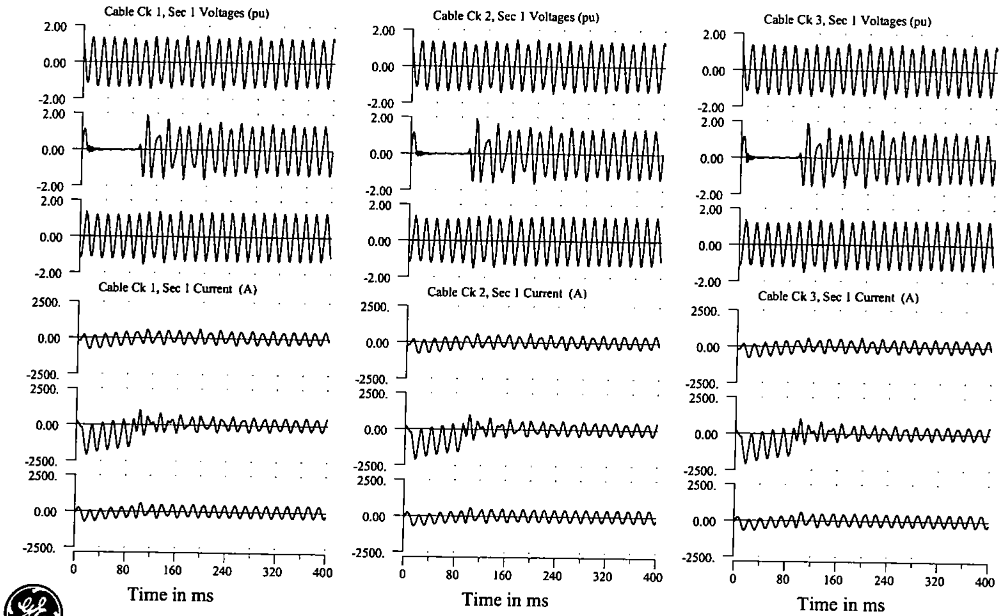
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_05_0
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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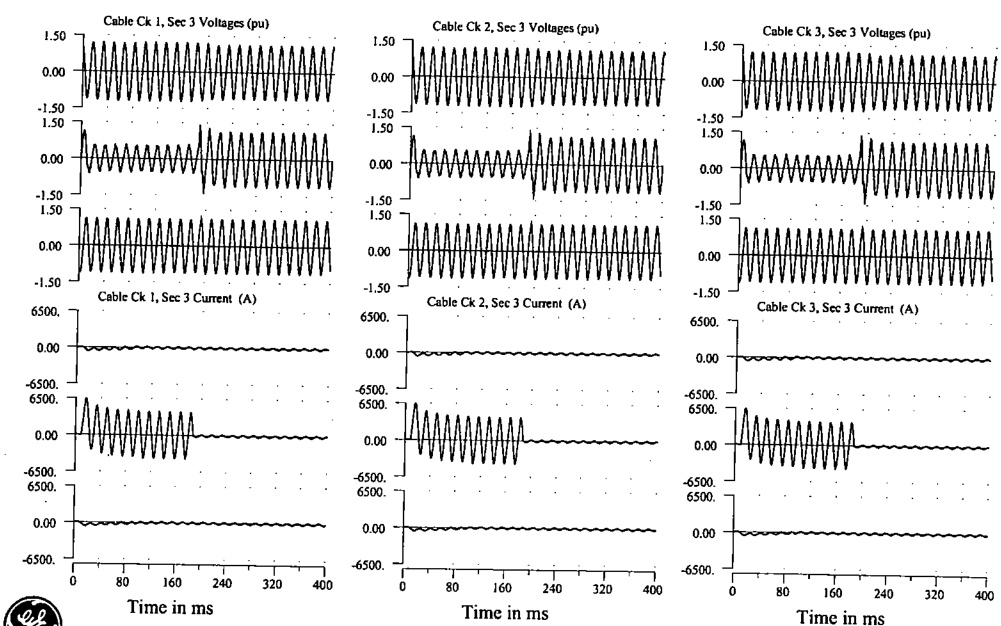
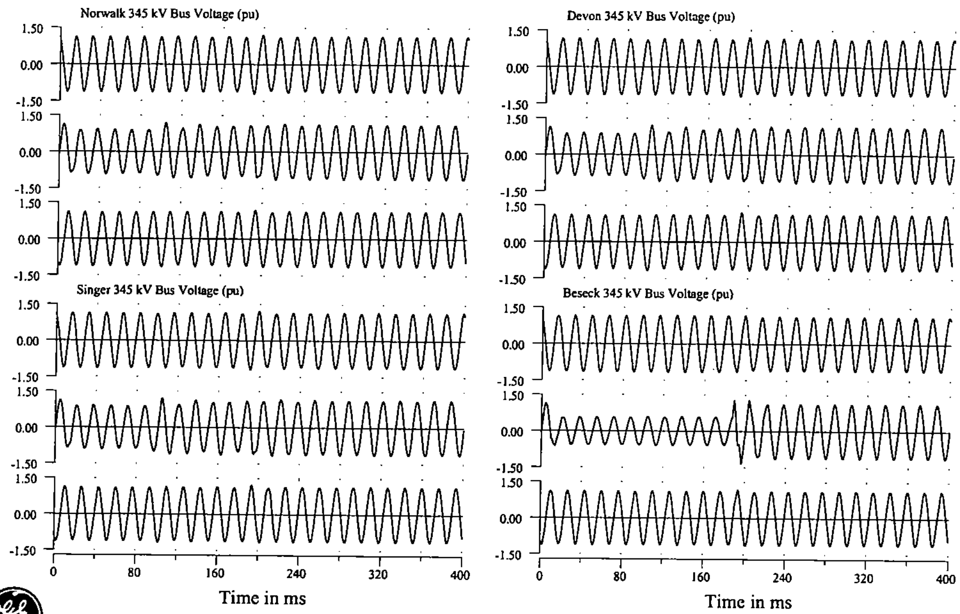
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_05_0

345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

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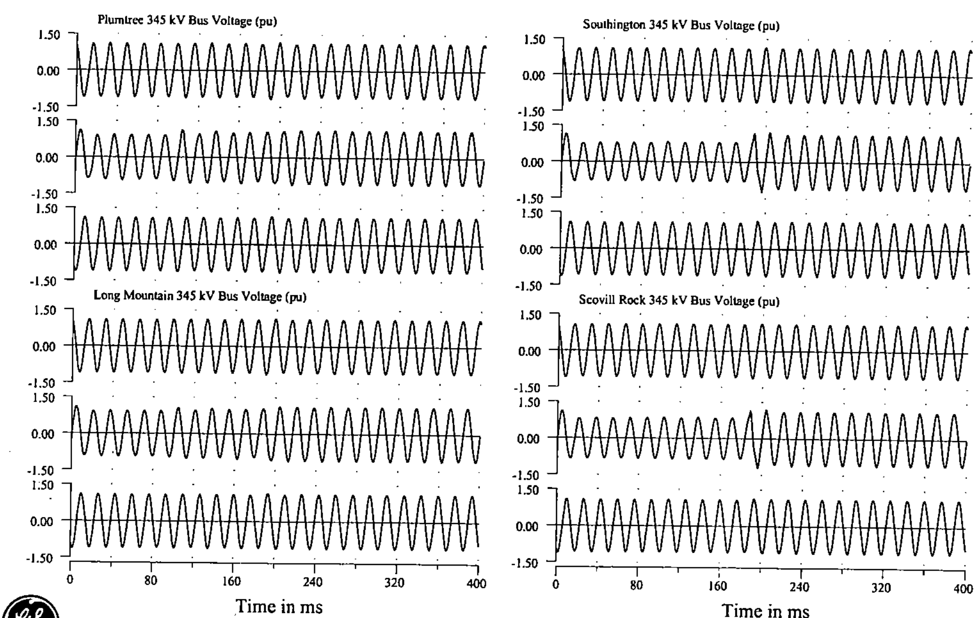
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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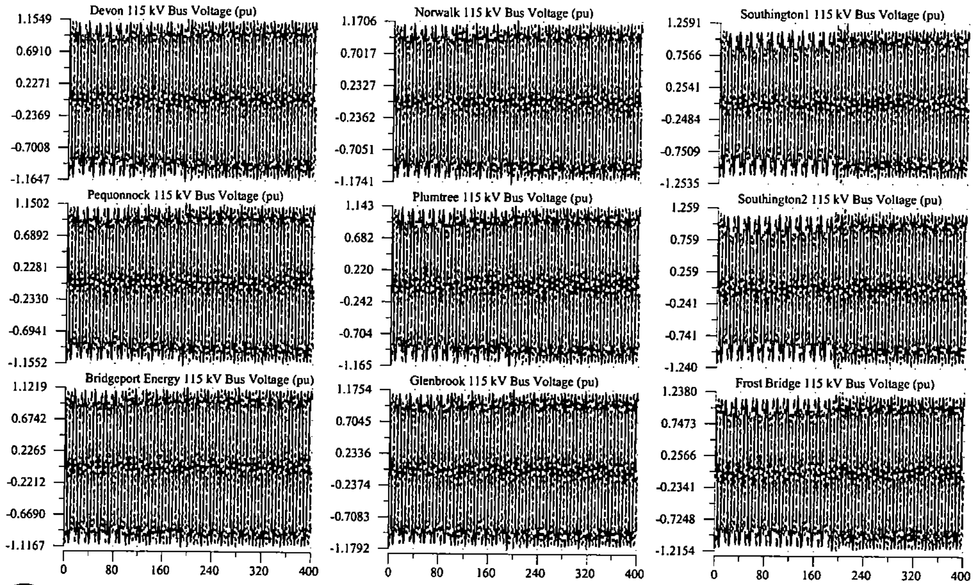
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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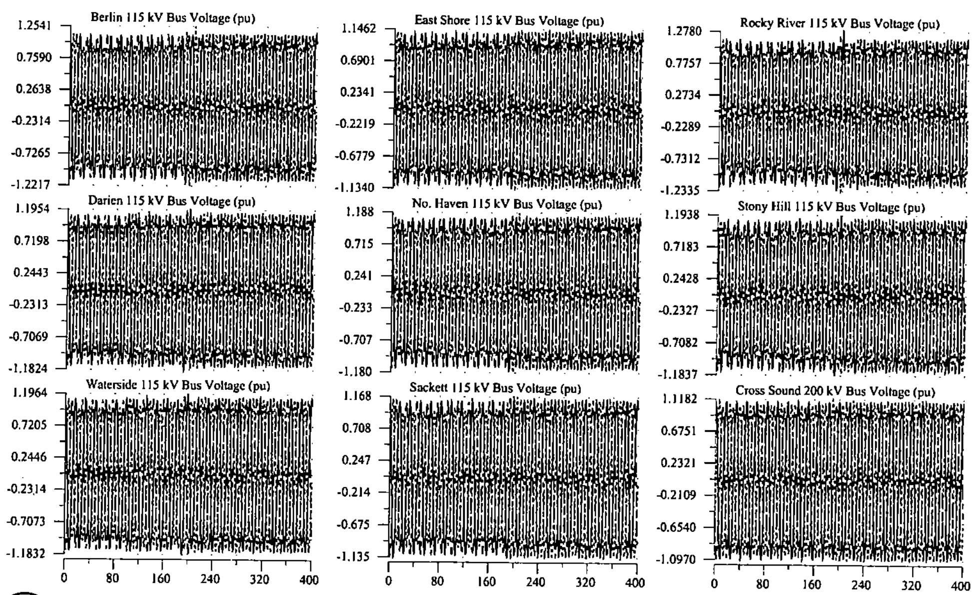
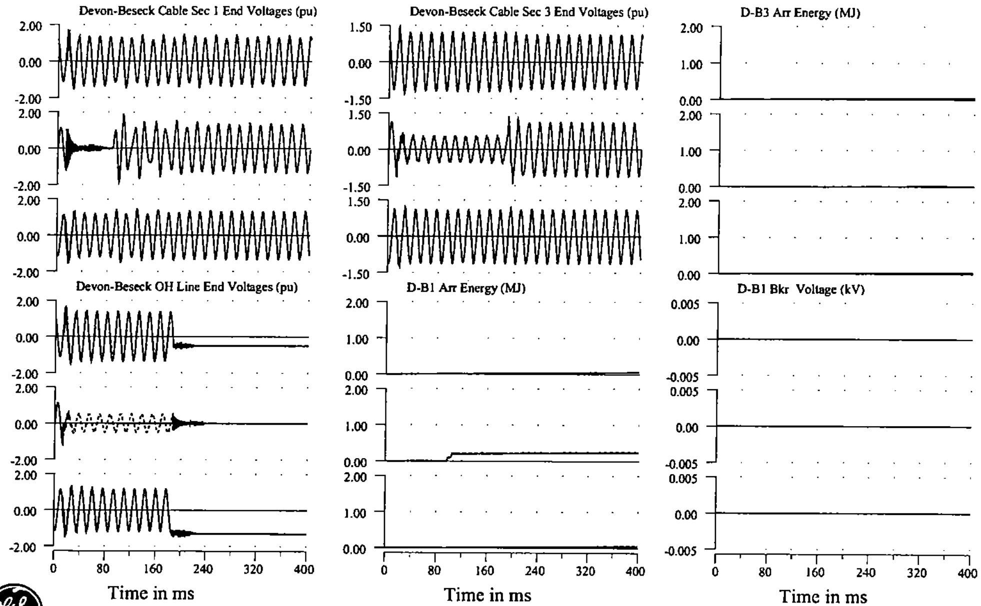
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_05_90

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

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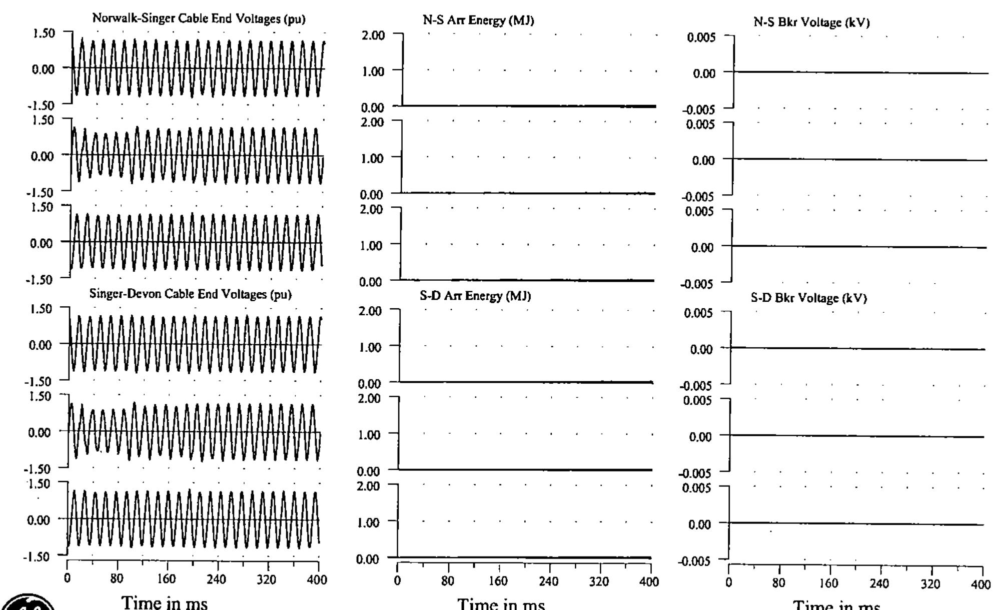
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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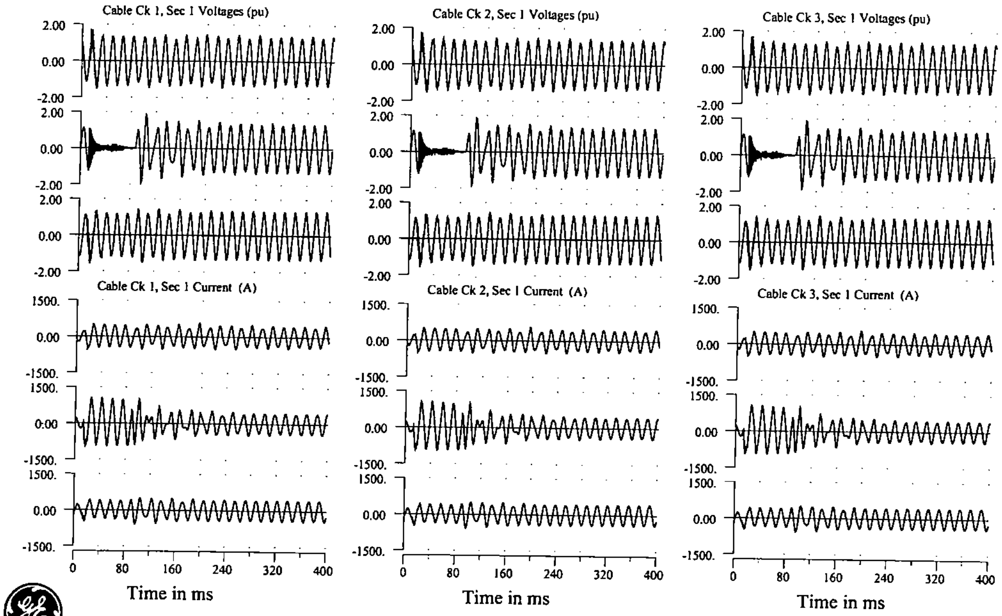
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_05_90
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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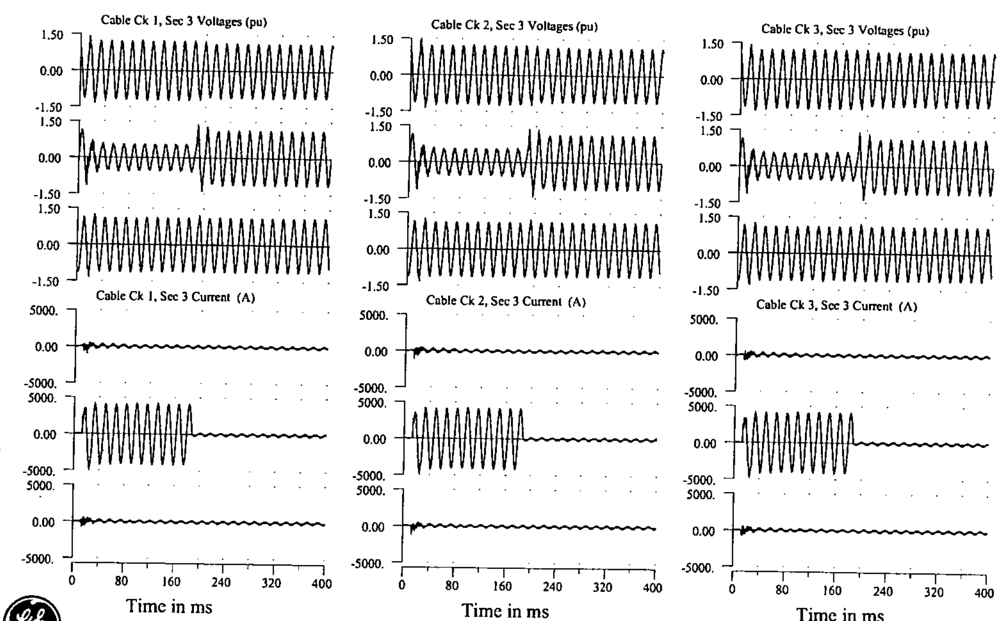
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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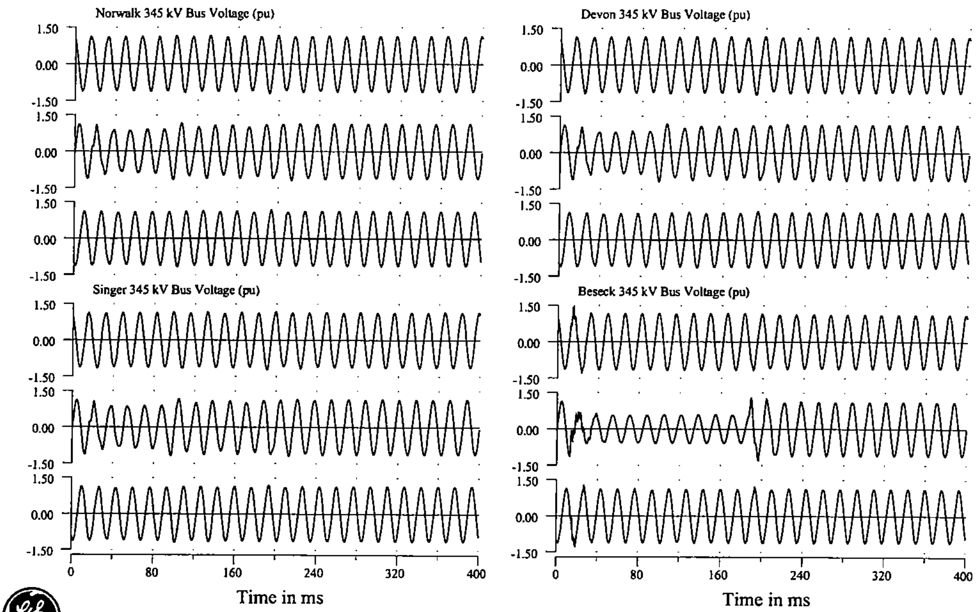
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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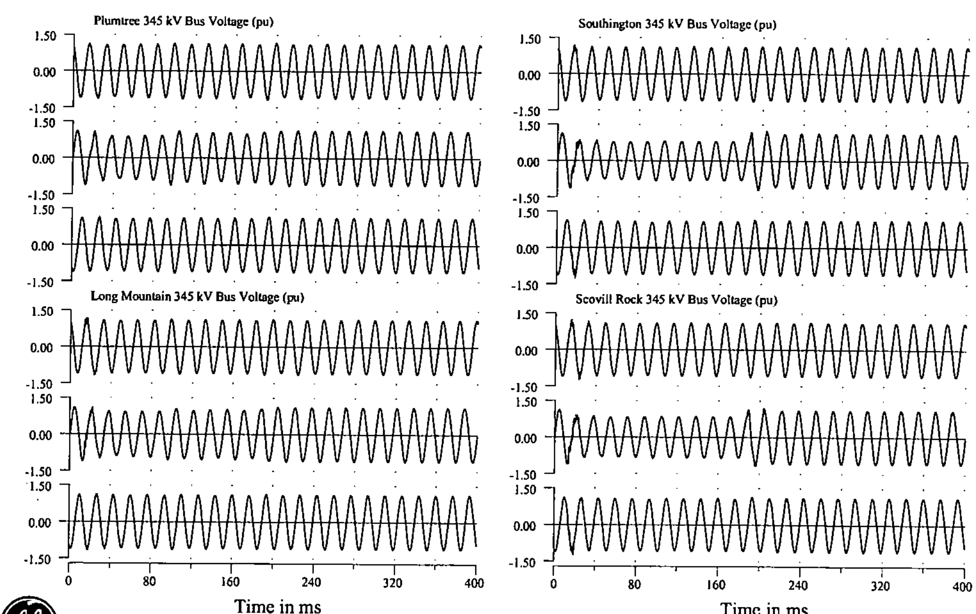
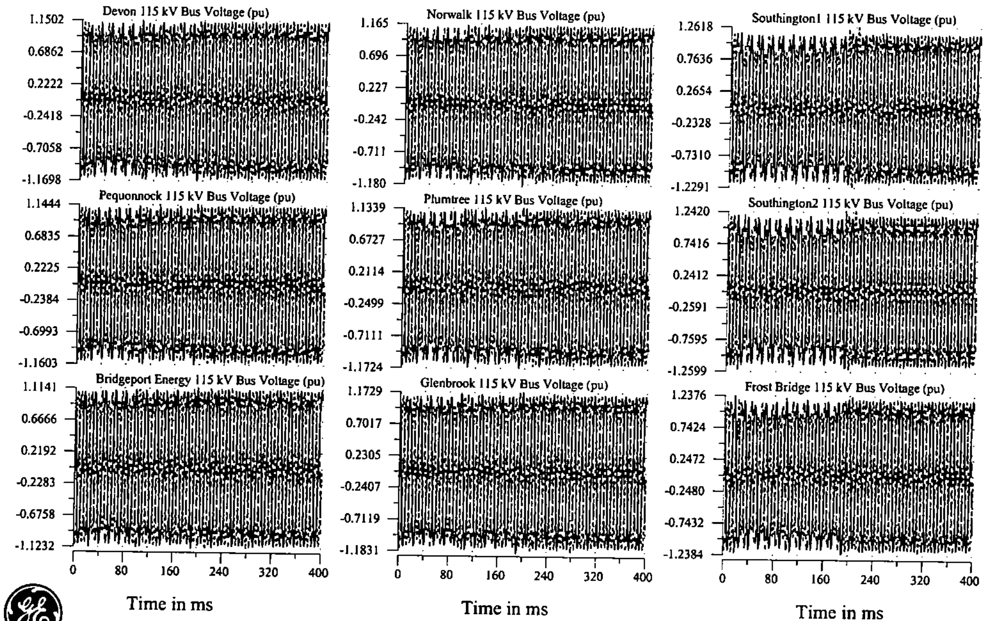
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_05_90
115 kV Bus Voltages and Capacitor Bank Locations



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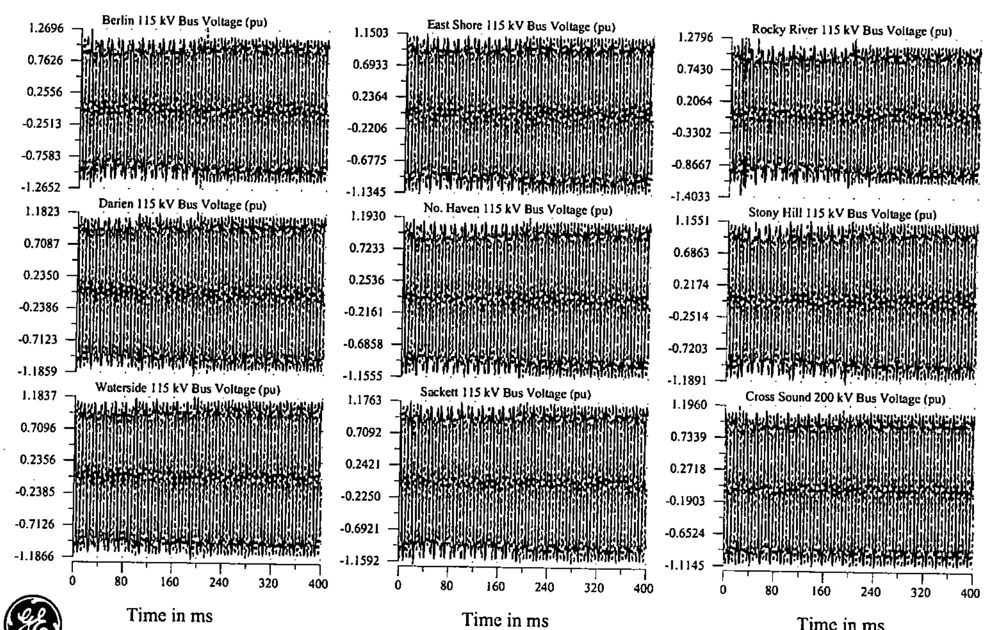
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_05_90
115 kV Bus Voltages and Capacitor Bank Locations



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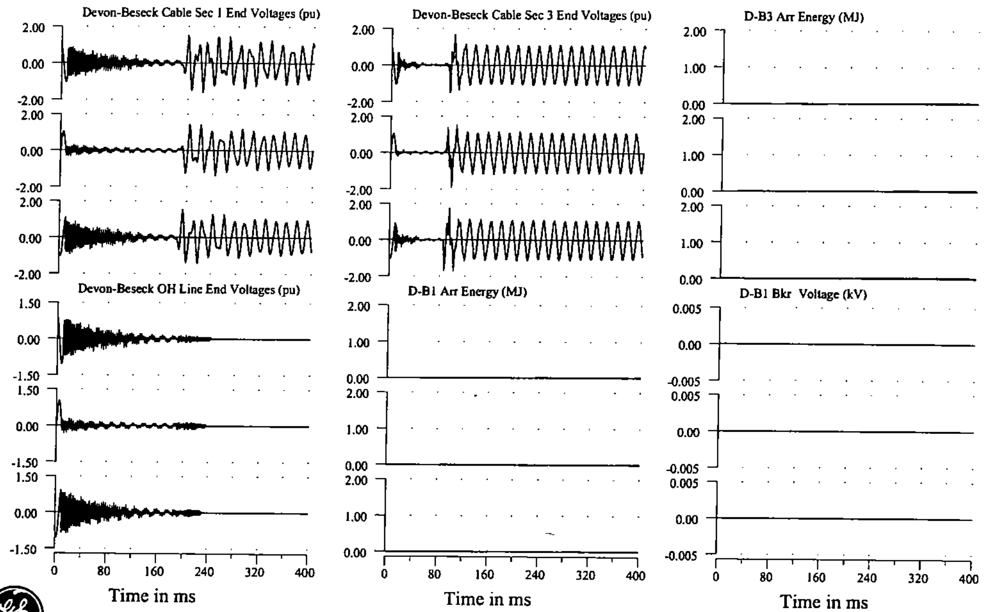
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_06_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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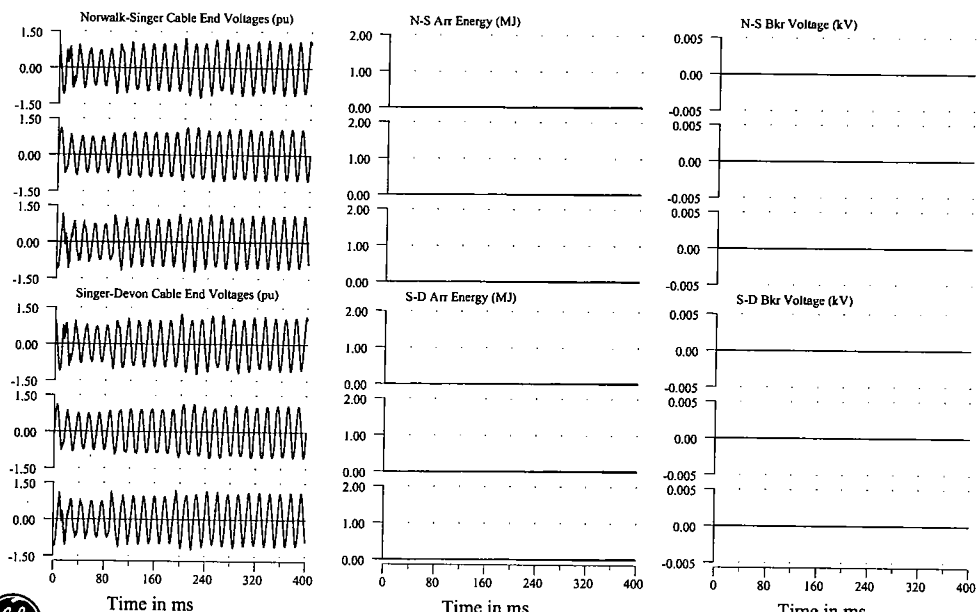
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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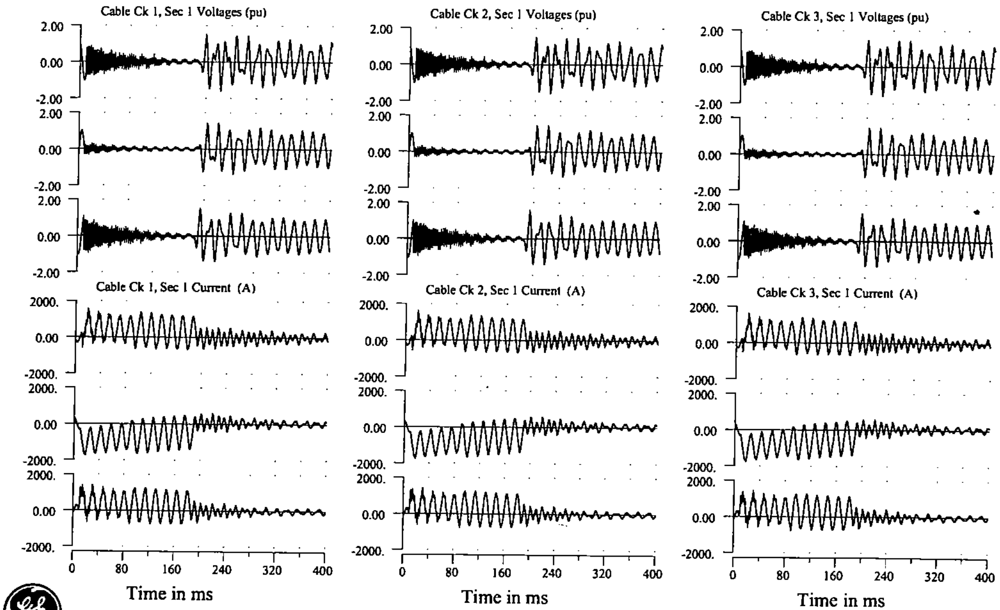
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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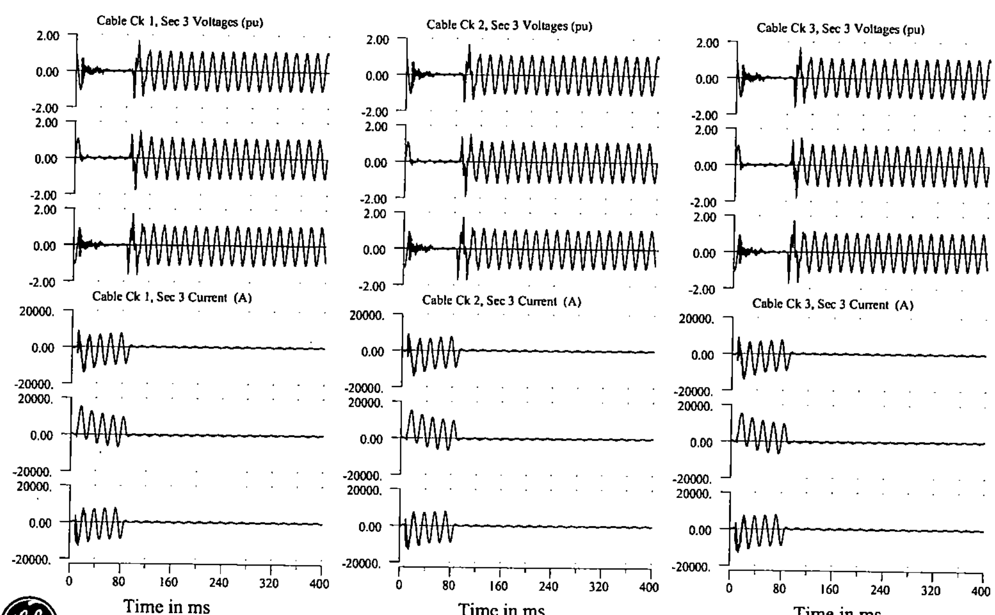
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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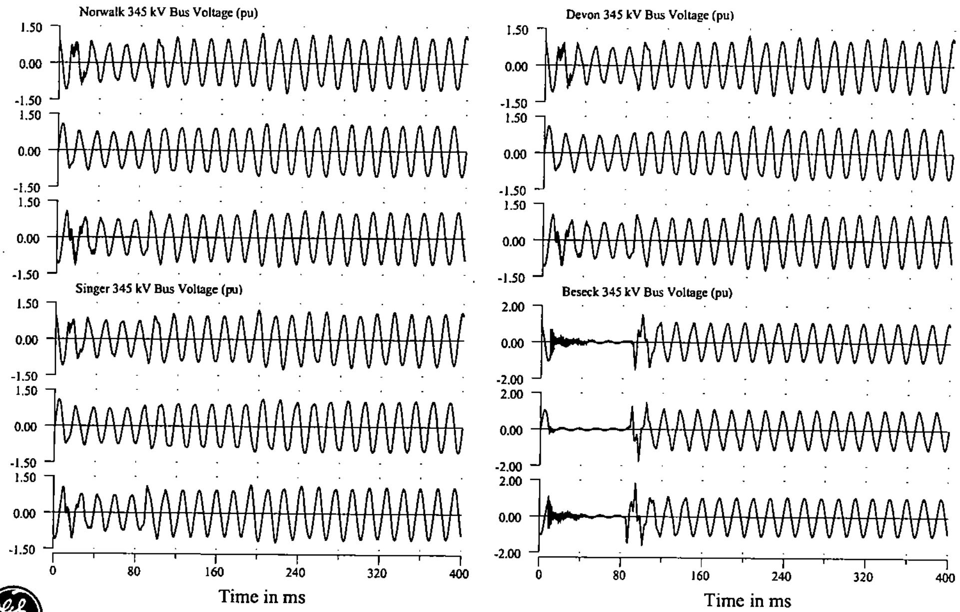
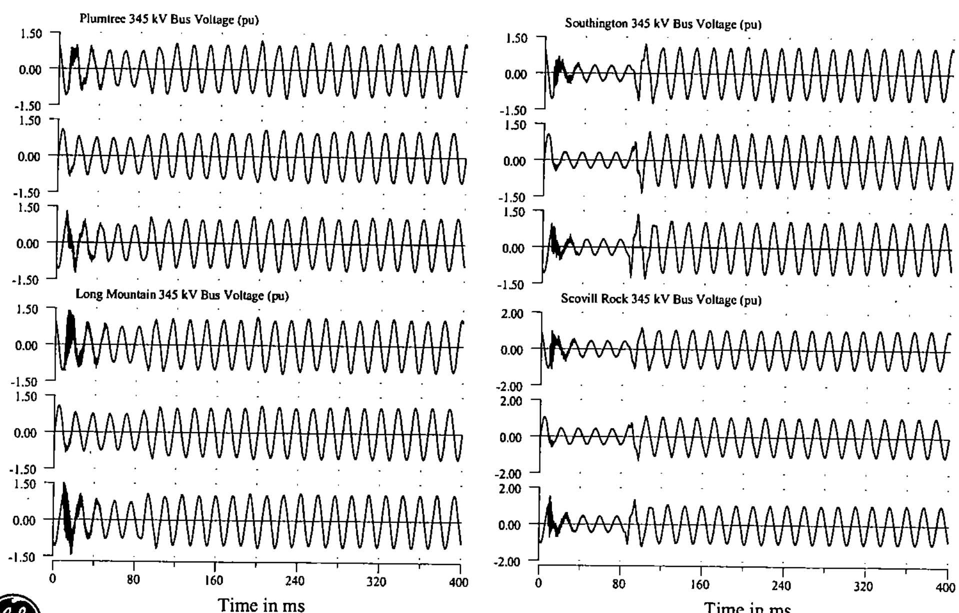
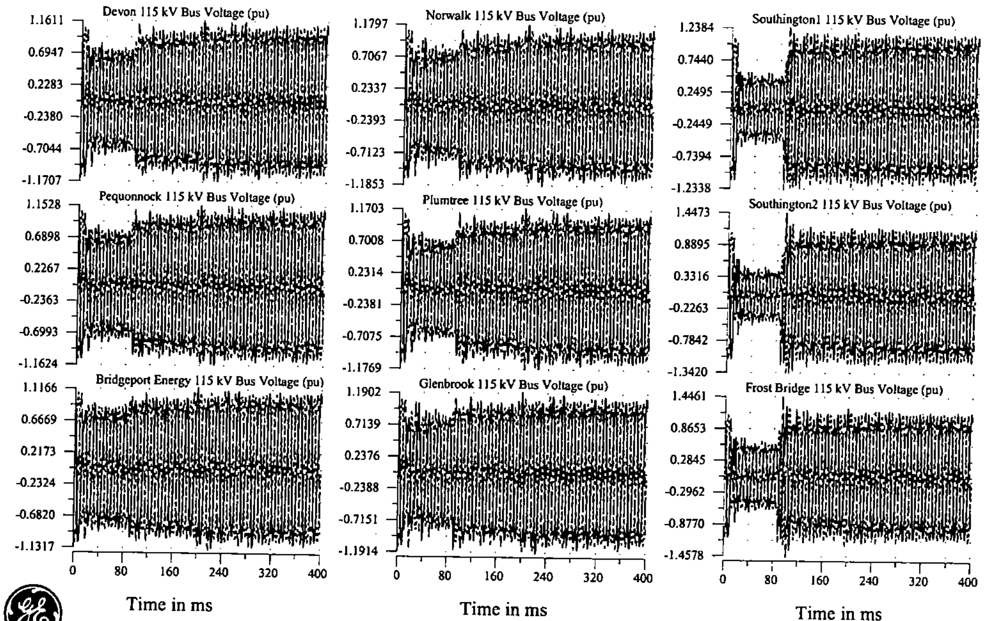
345 kV Bus Voltages



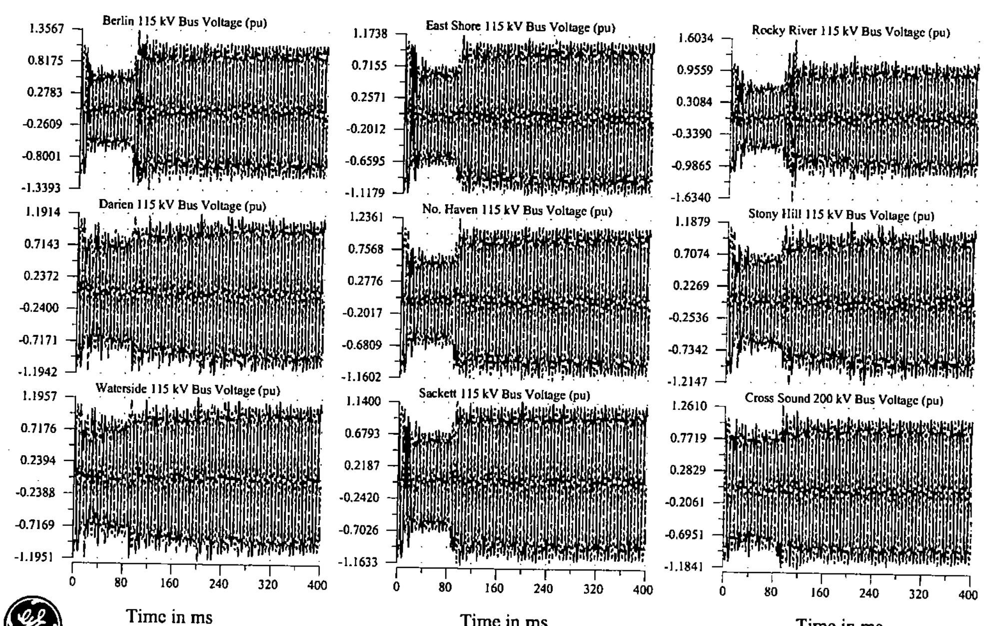
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_06_0
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_06_0
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_06_0
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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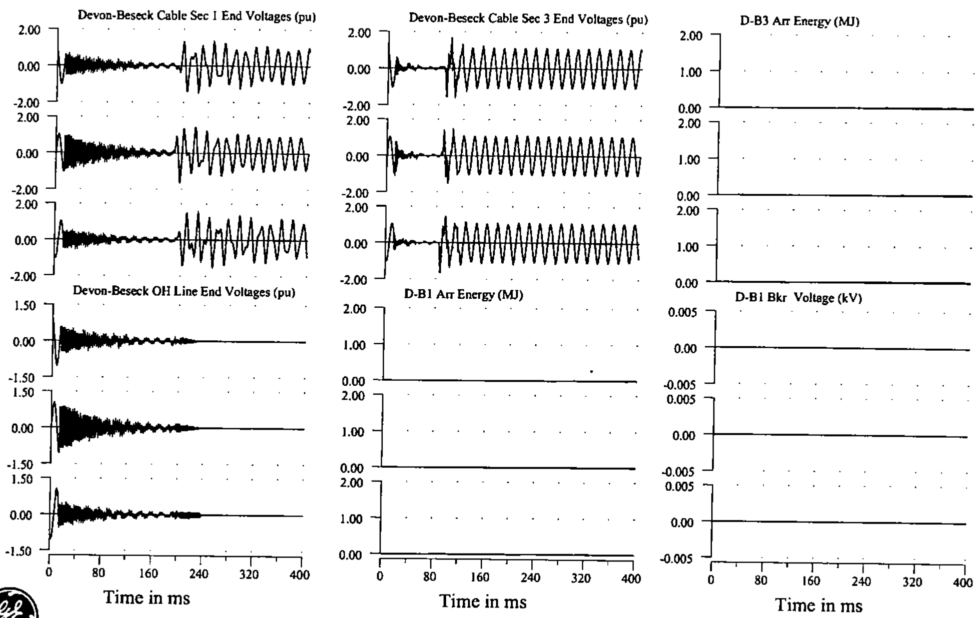
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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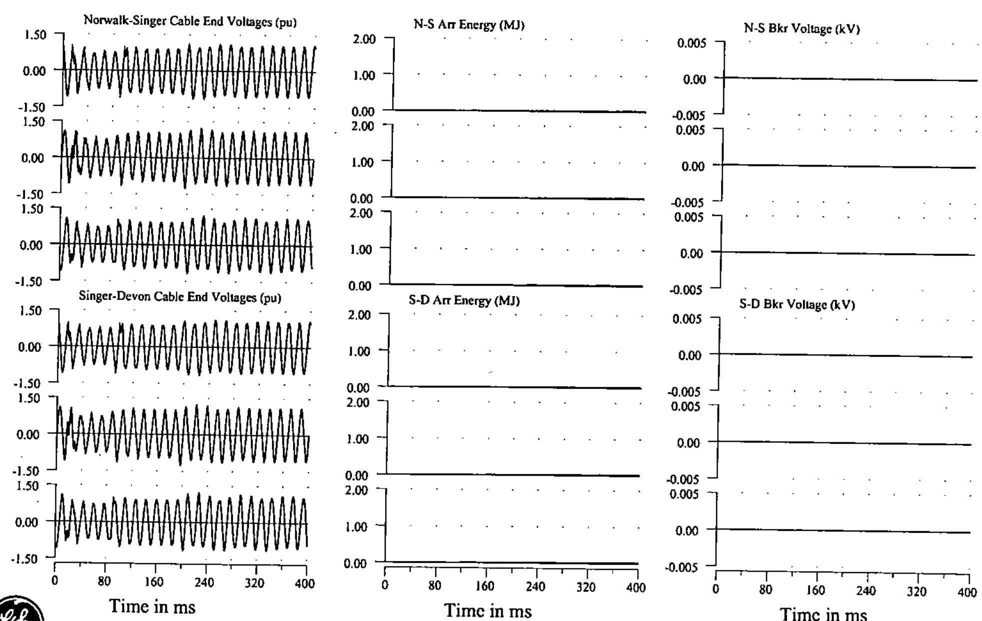
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_06_90
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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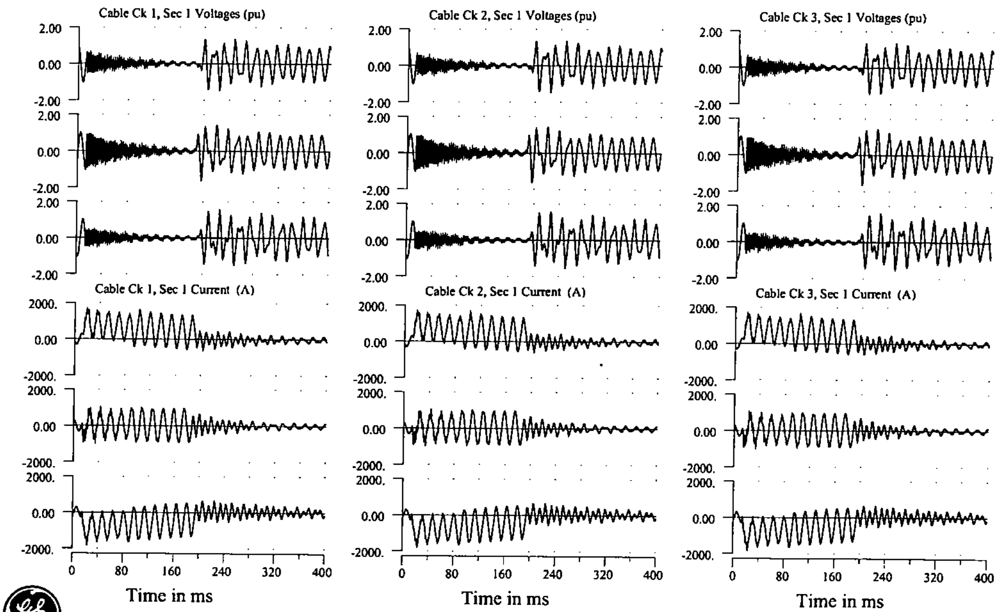
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_06_90
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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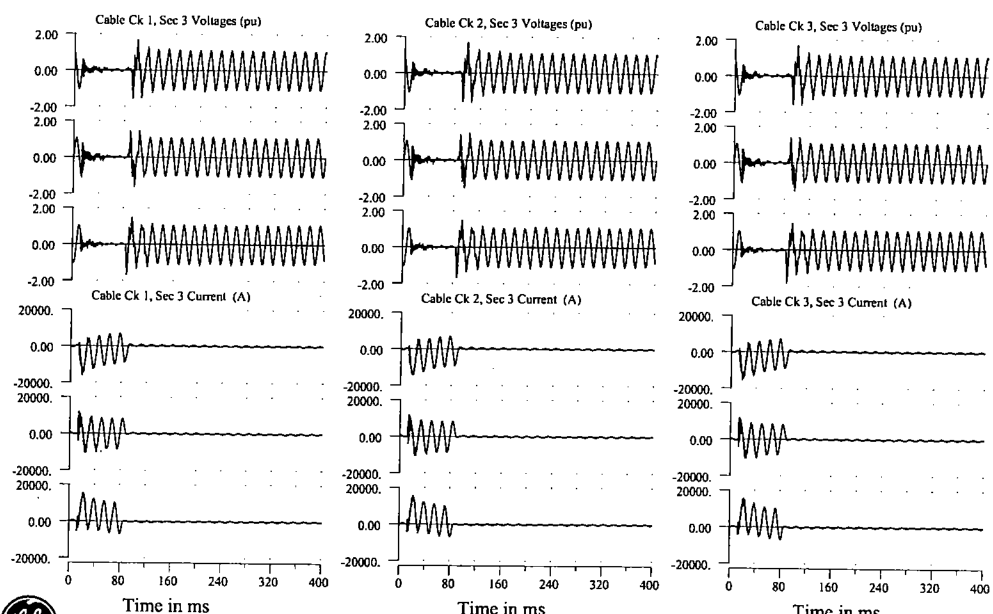
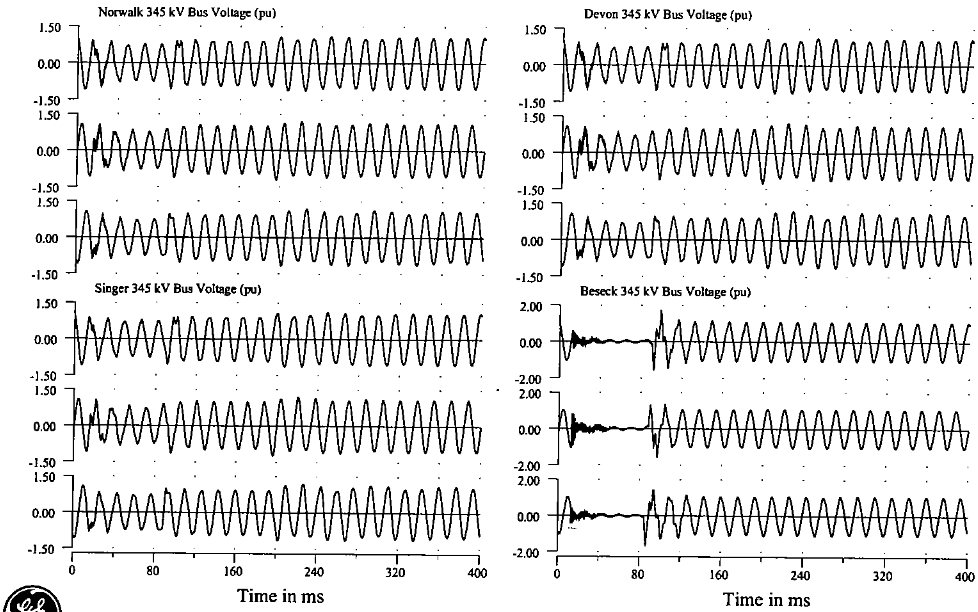
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_06_90
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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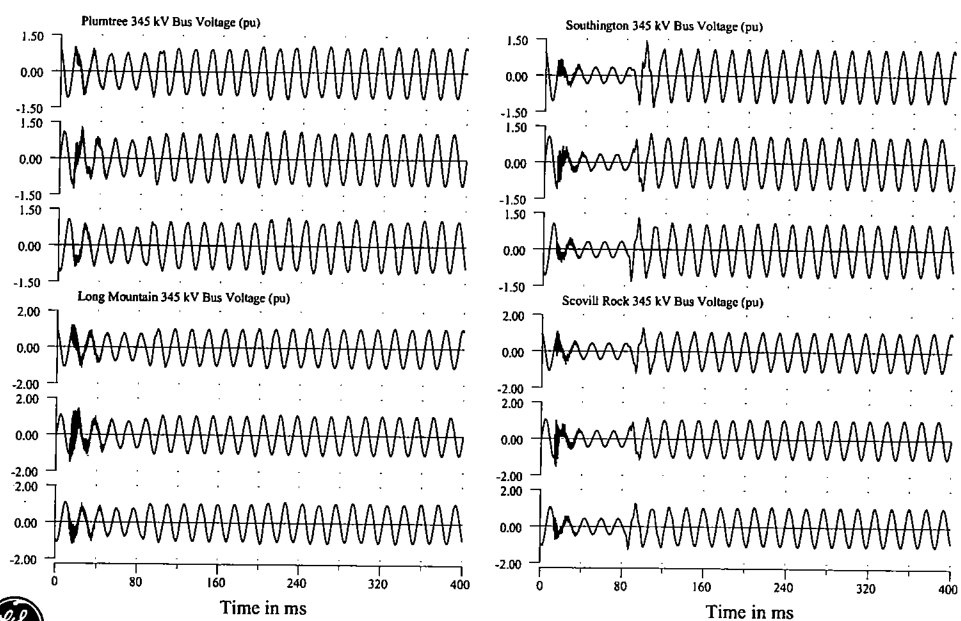
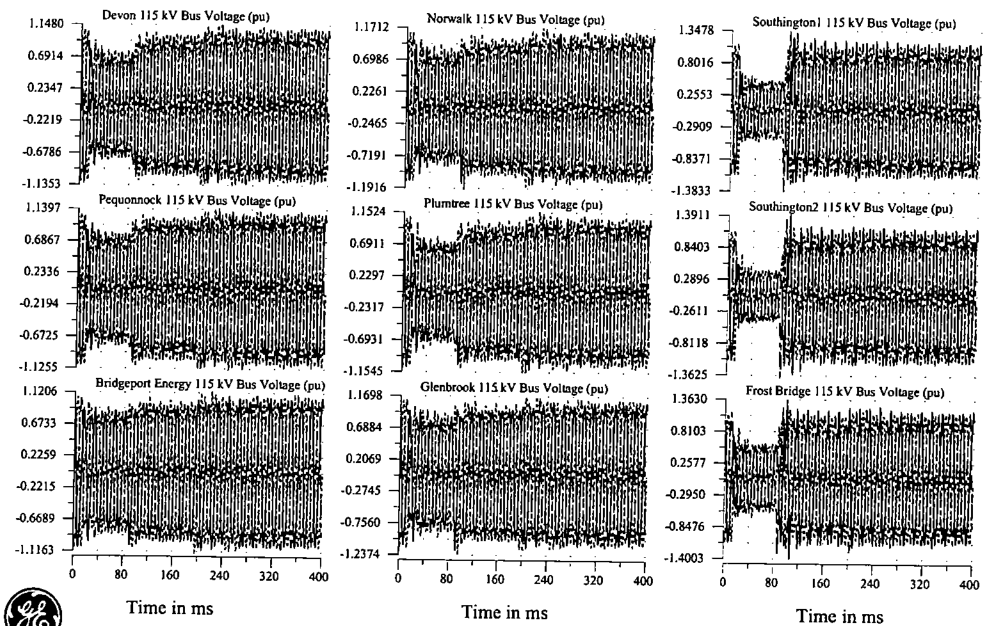
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_06_90

11A5 kV Bus Voltages and Capacitor Bank Locations



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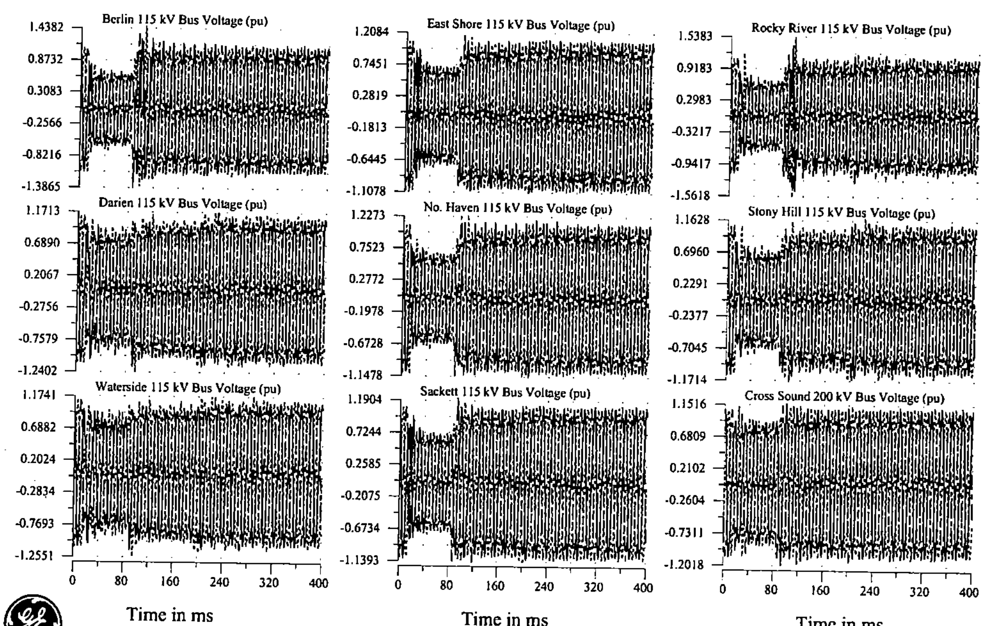
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_06_90

11A5 kV Bus Voltages and Capacitor Bank Locations



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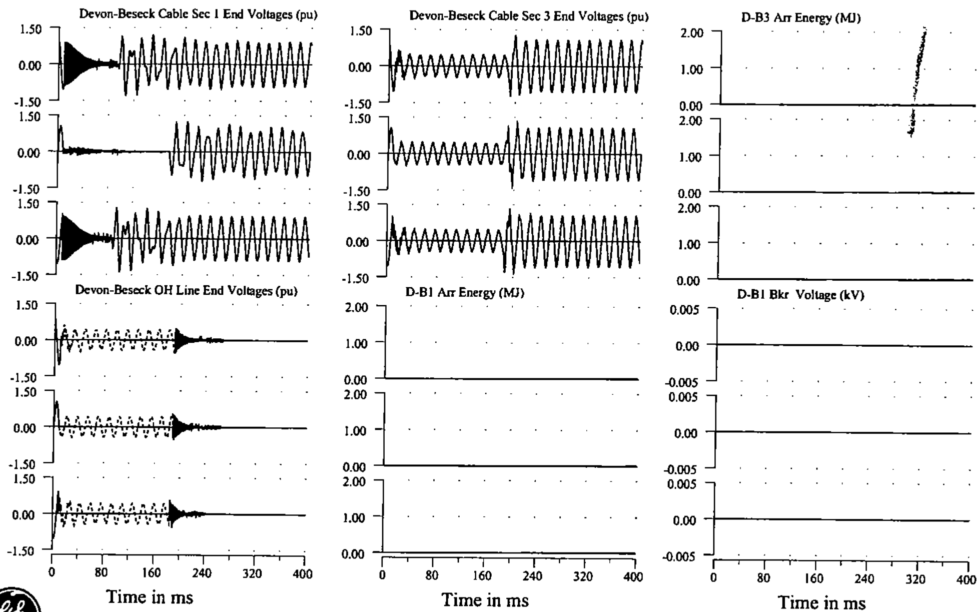
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_07_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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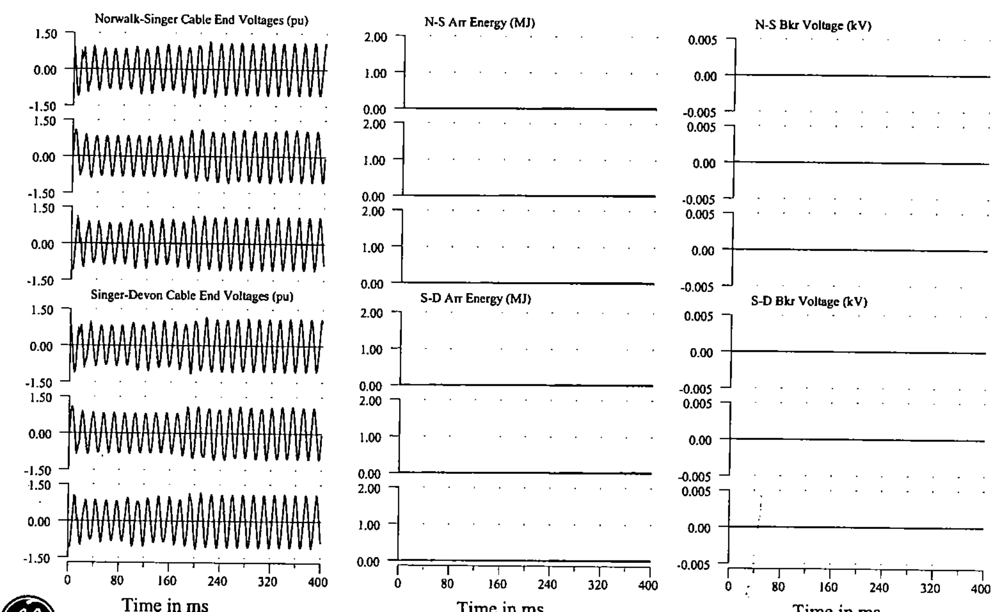
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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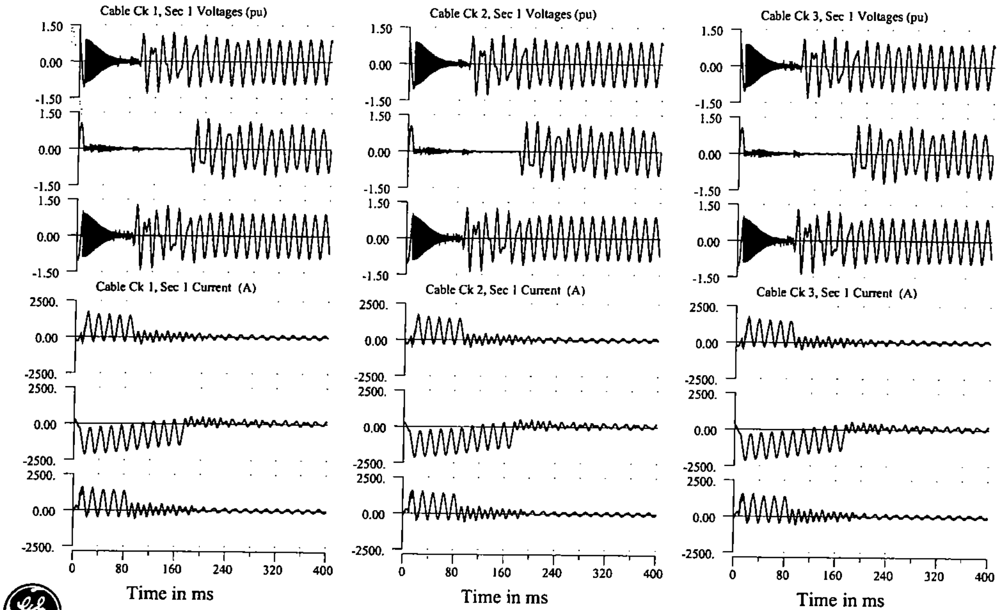
Devon-Beseck 345 kV Cables



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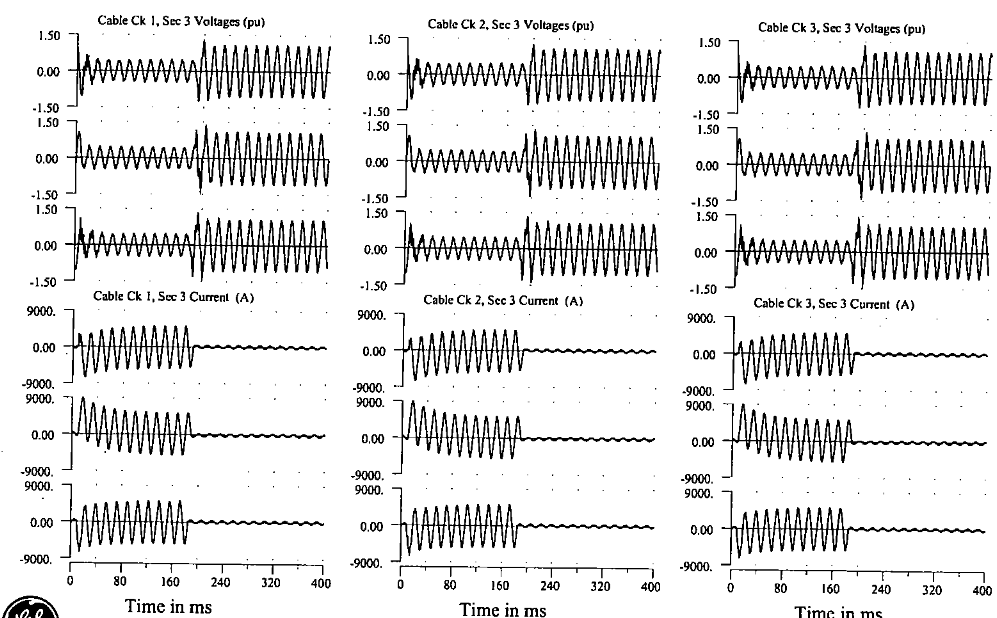
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_07_0
Devon-Beseck 345 kV Cables



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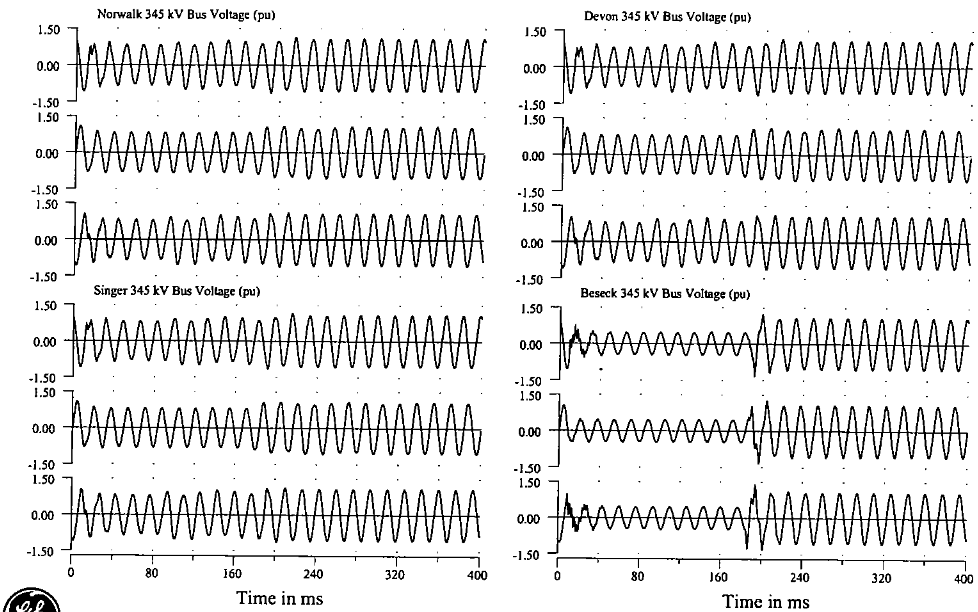
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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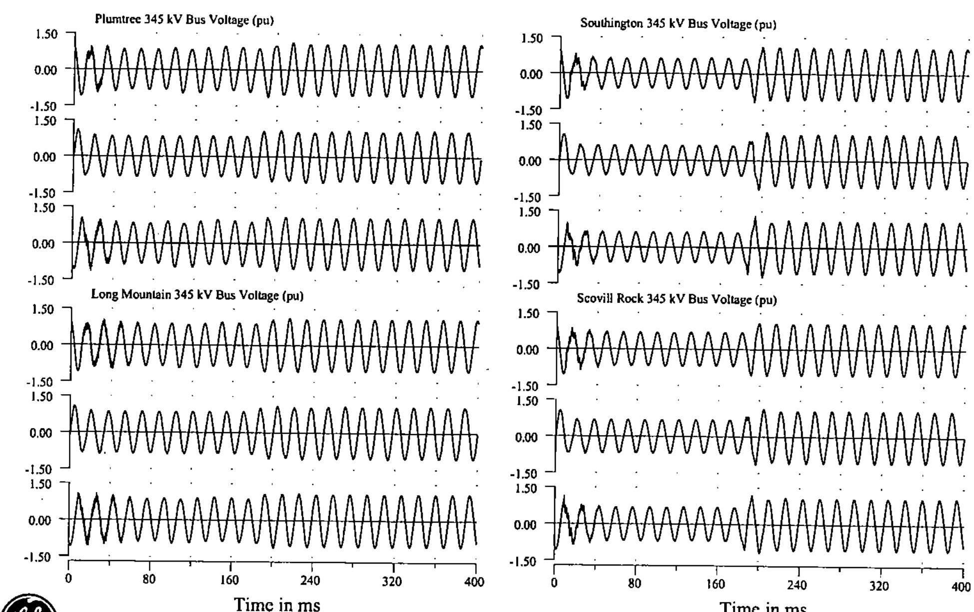
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

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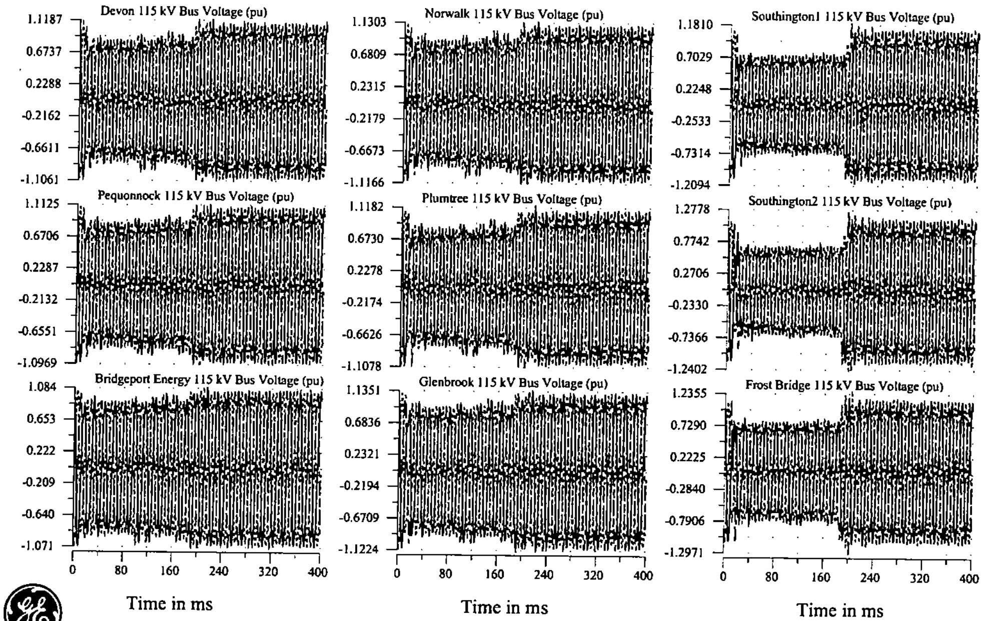
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

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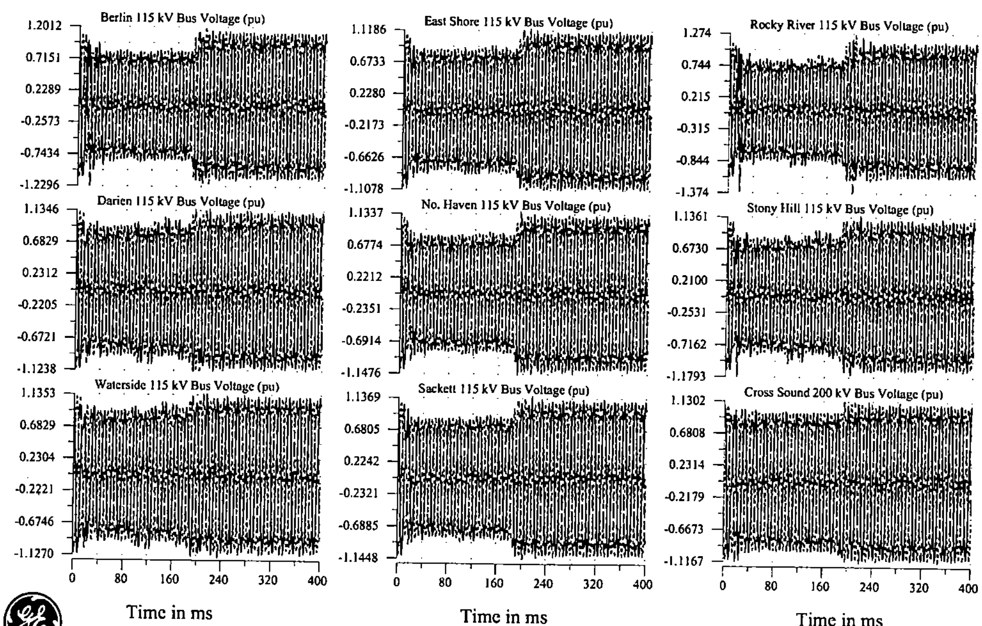
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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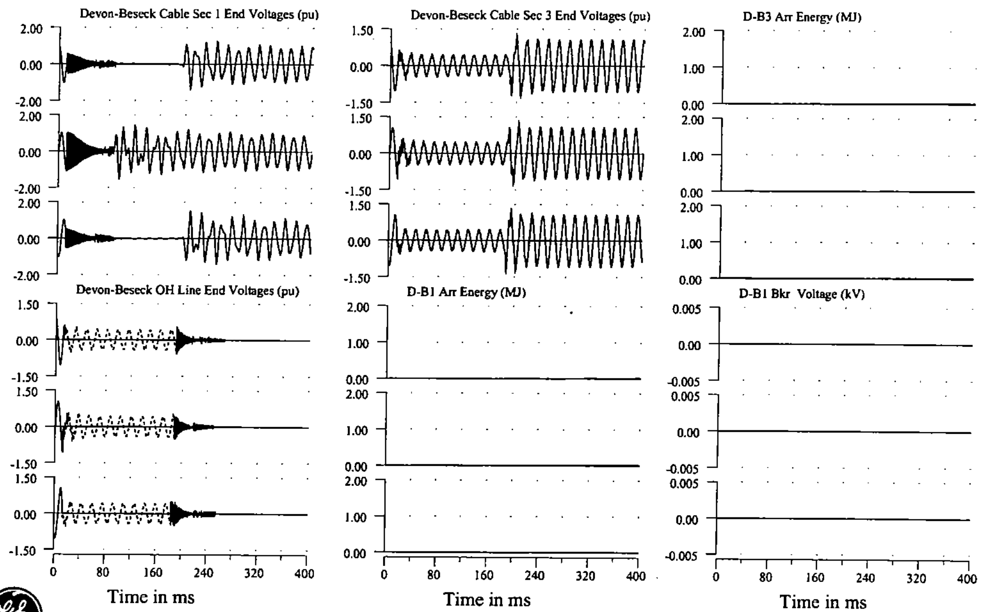
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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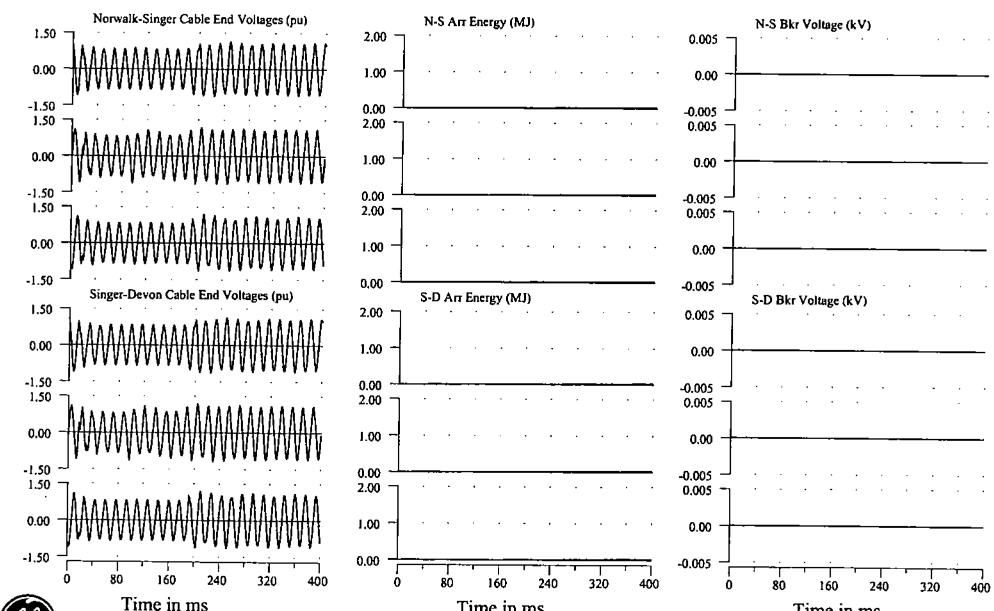
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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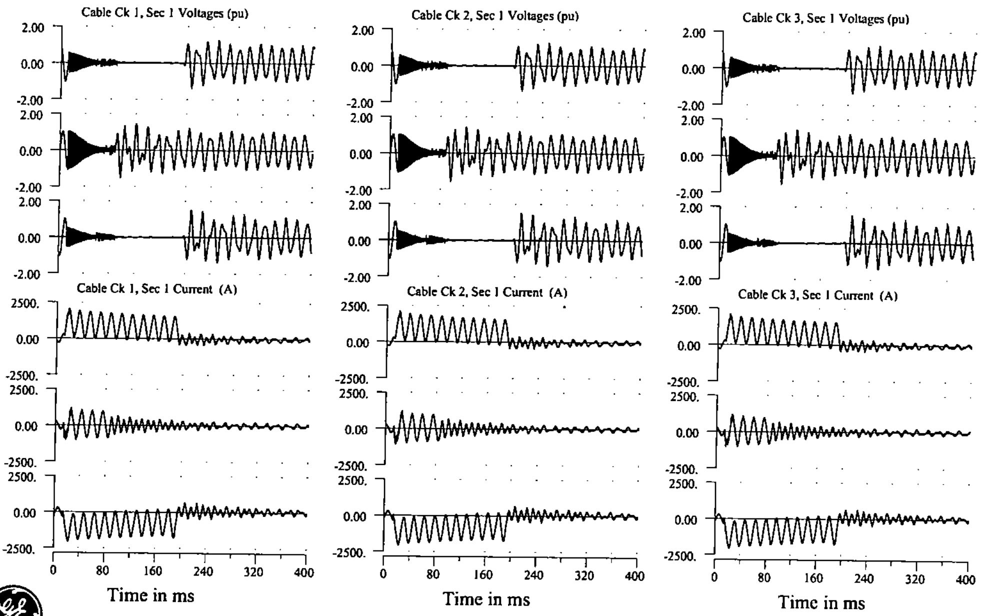
Devon-Beseck 345 kV Cables



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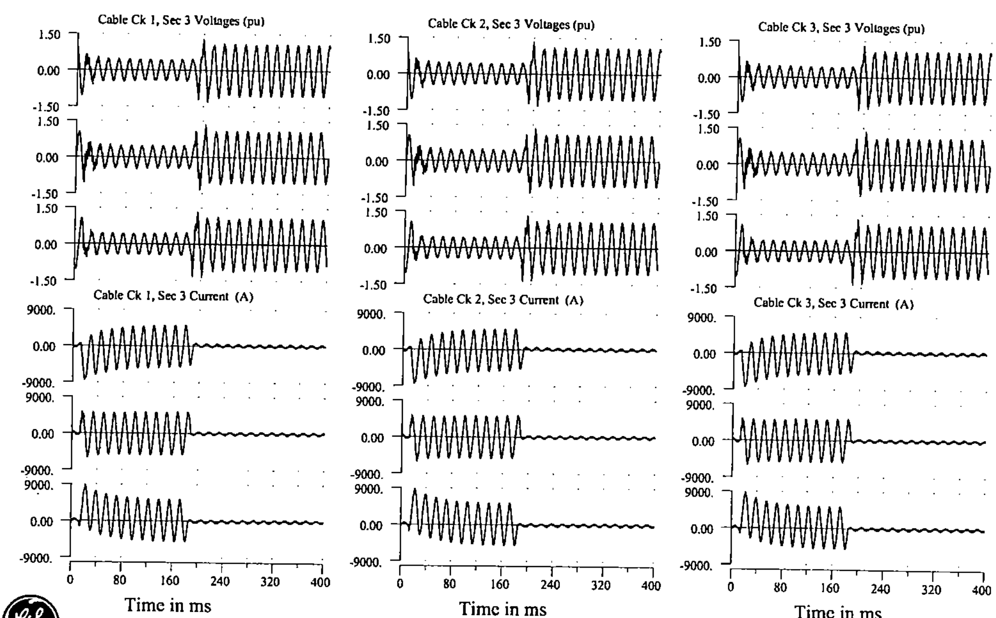
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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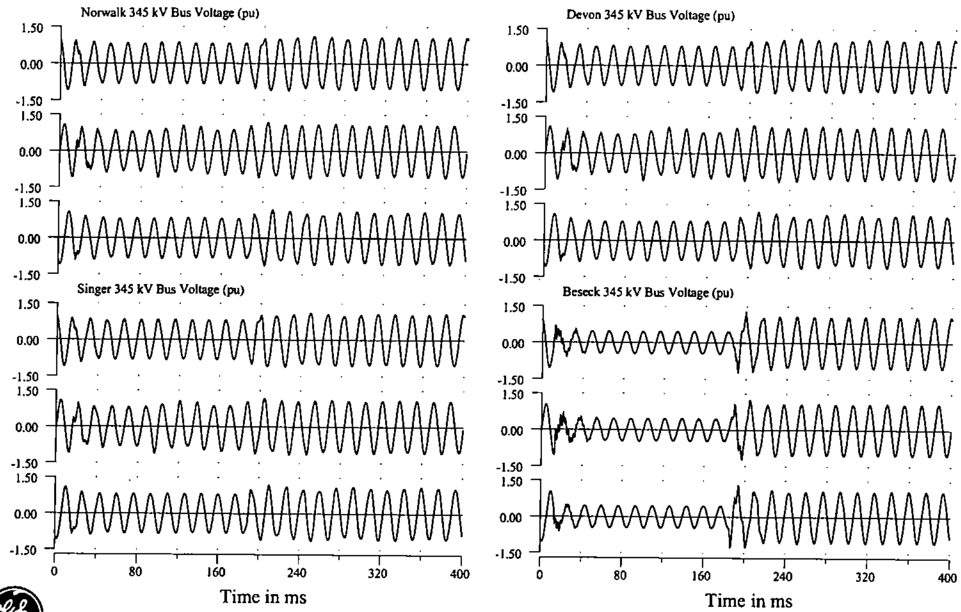
345 kV Bus Voltages



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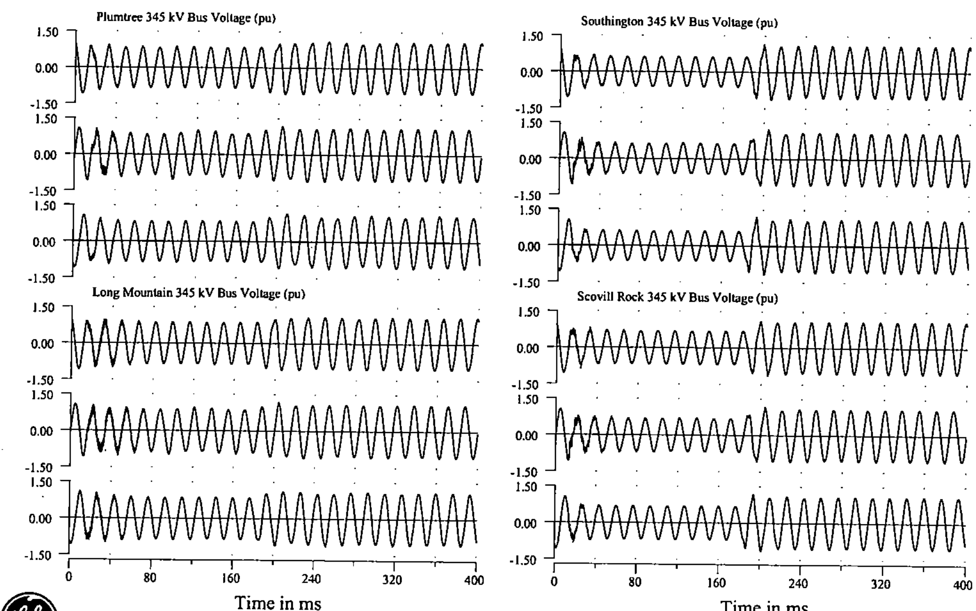
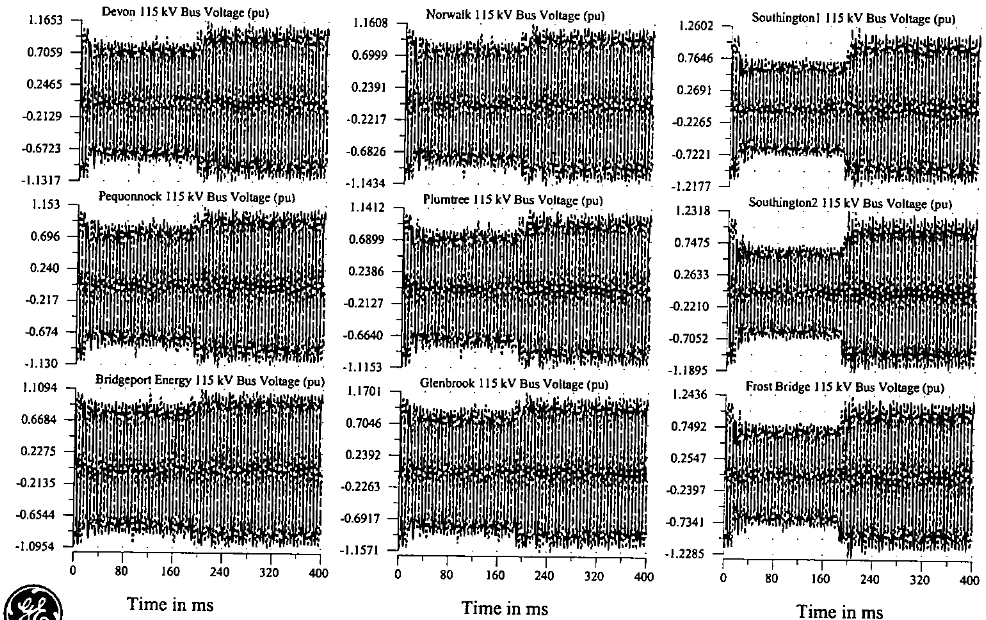
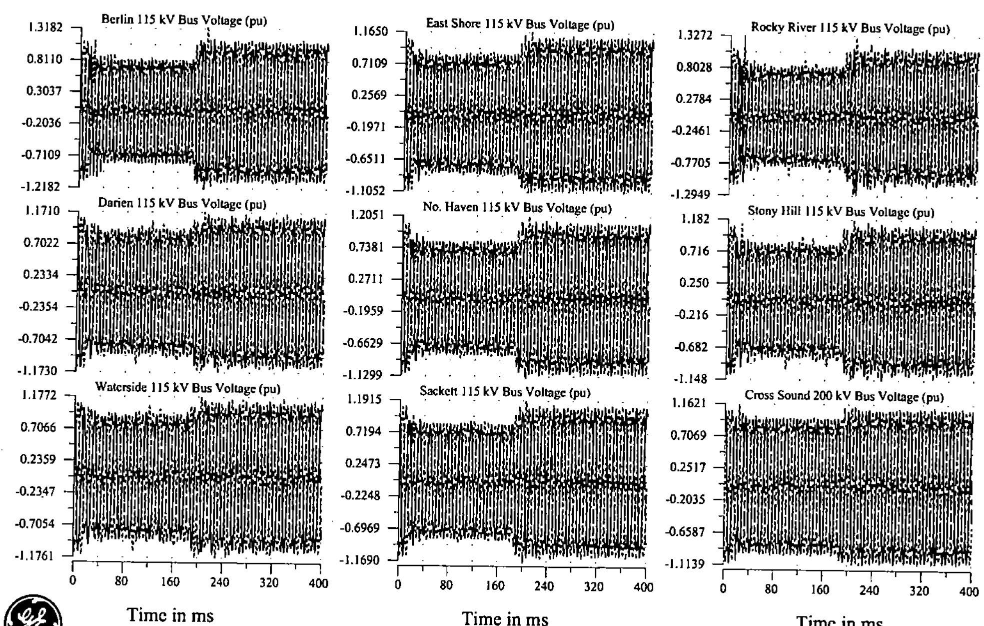
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_07_90
11A5 kV Bus Voltages and Capacitor Bank Locations



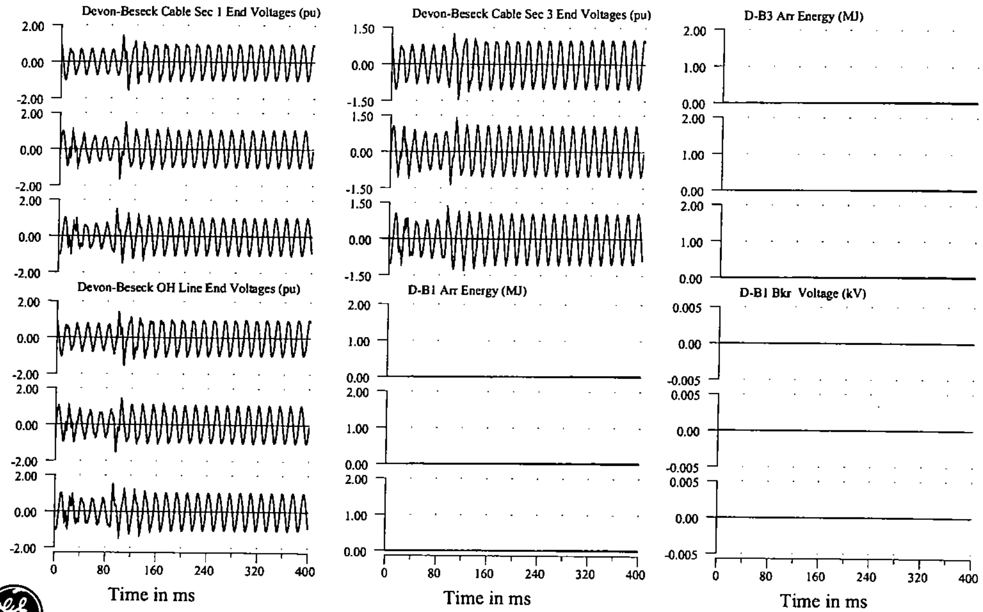
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_07_90
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_08_0

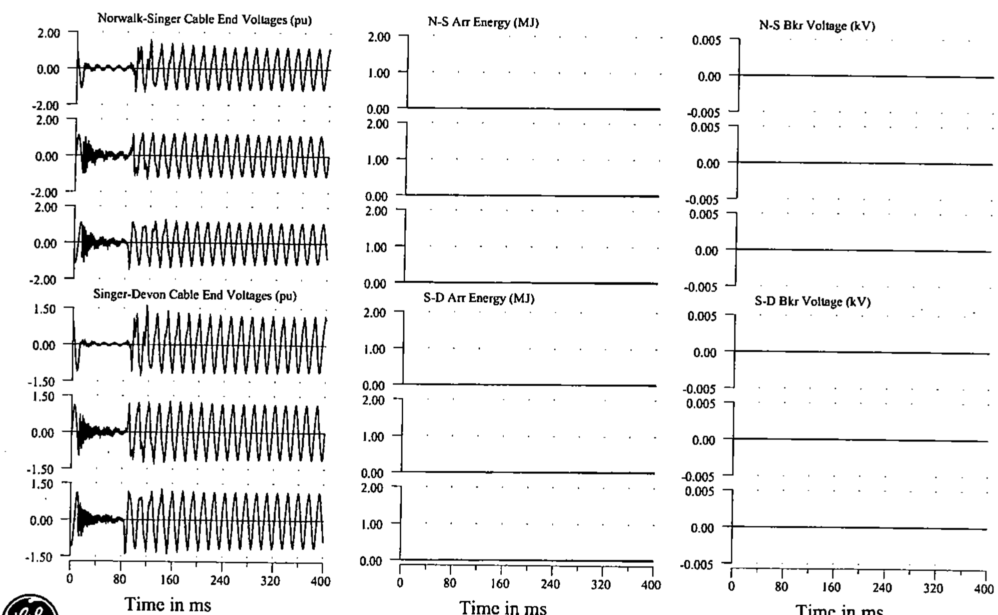
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



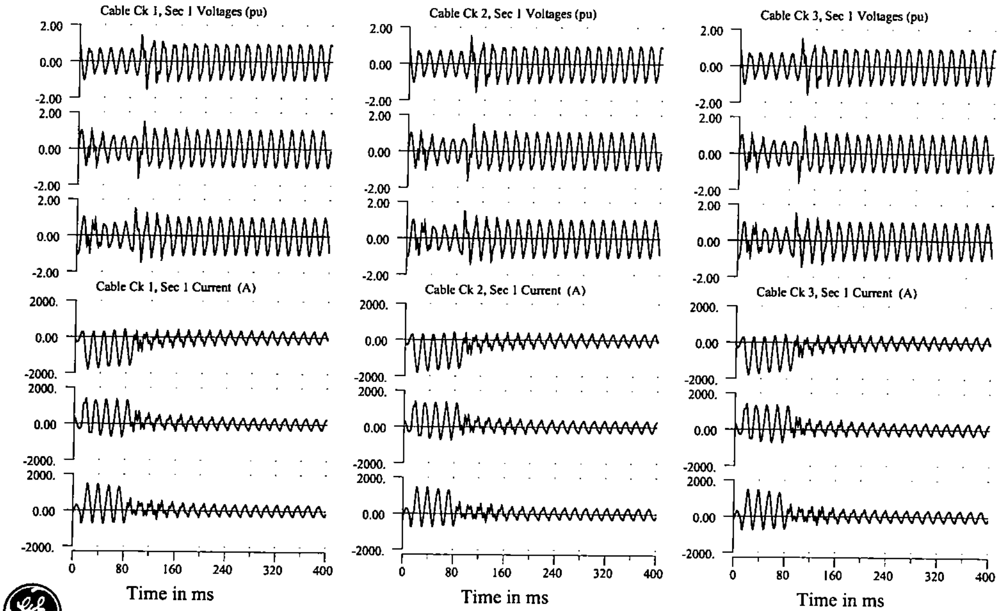
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_08_0

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_08_0
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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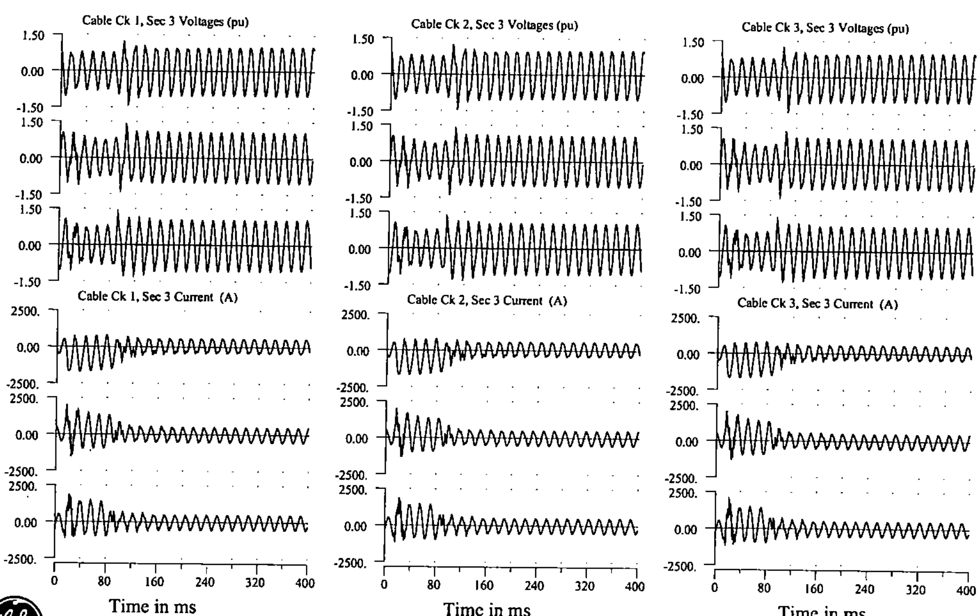
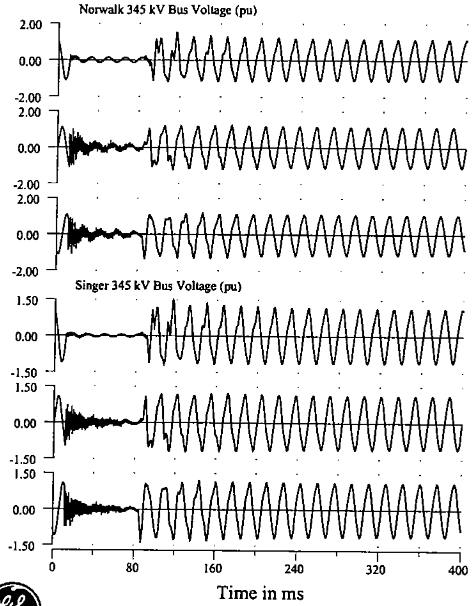
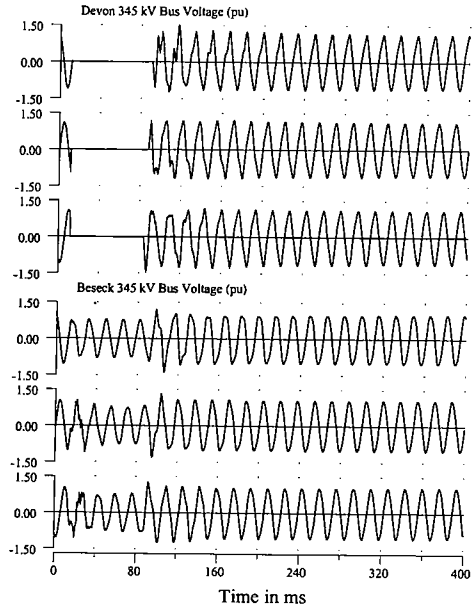
Devon-Beseck 345 kV Cables

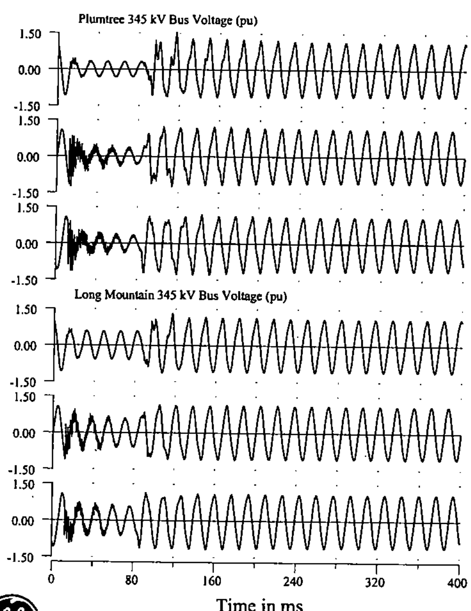


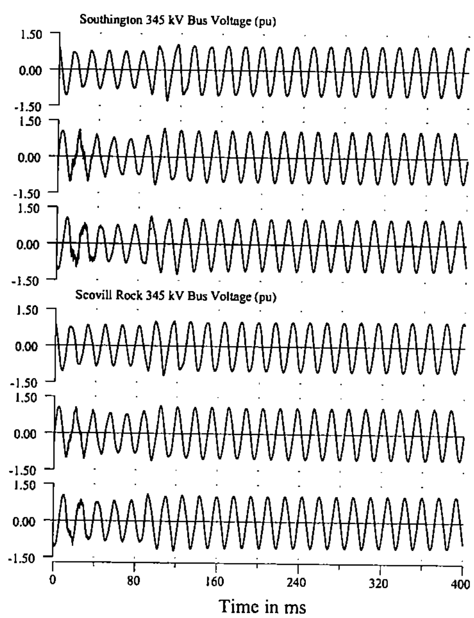
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_08_0
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_08_0
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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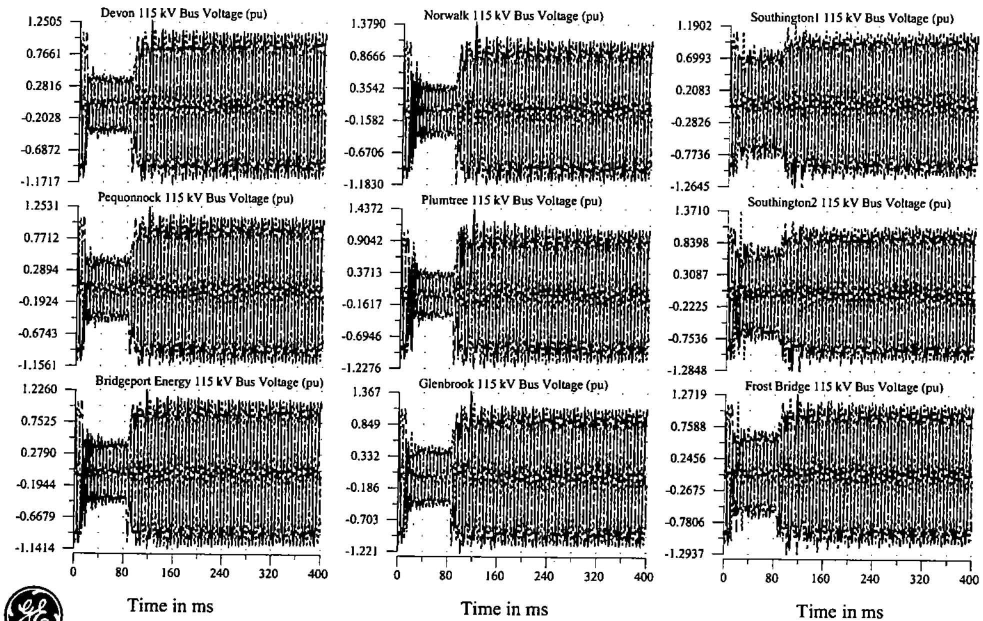
115 kV Bus Voltages and Capacitor Bank Locations



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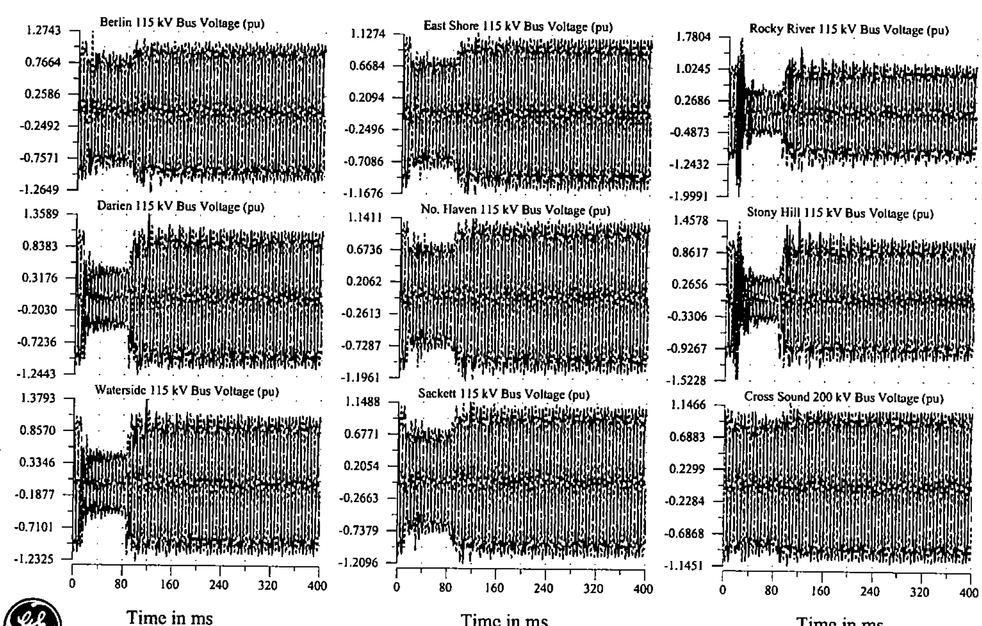
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_08_0
115 kV Bus Voltages and Capacitor Bank Locations



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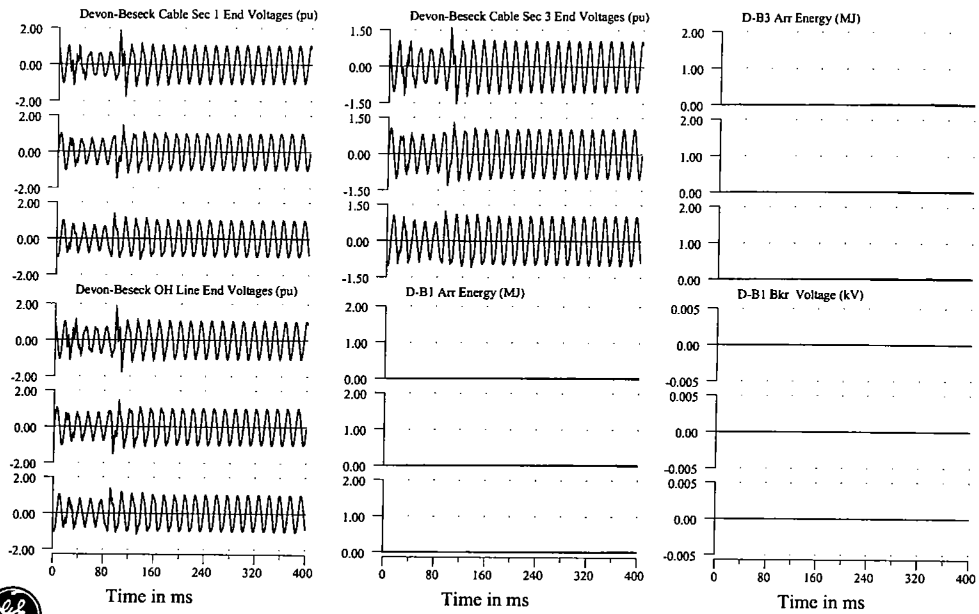
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_08_90
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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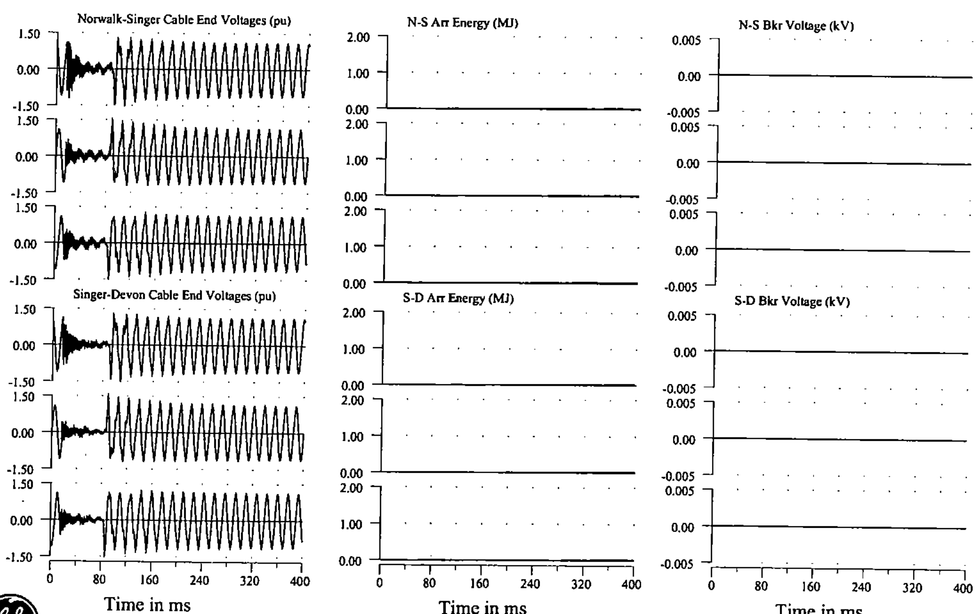
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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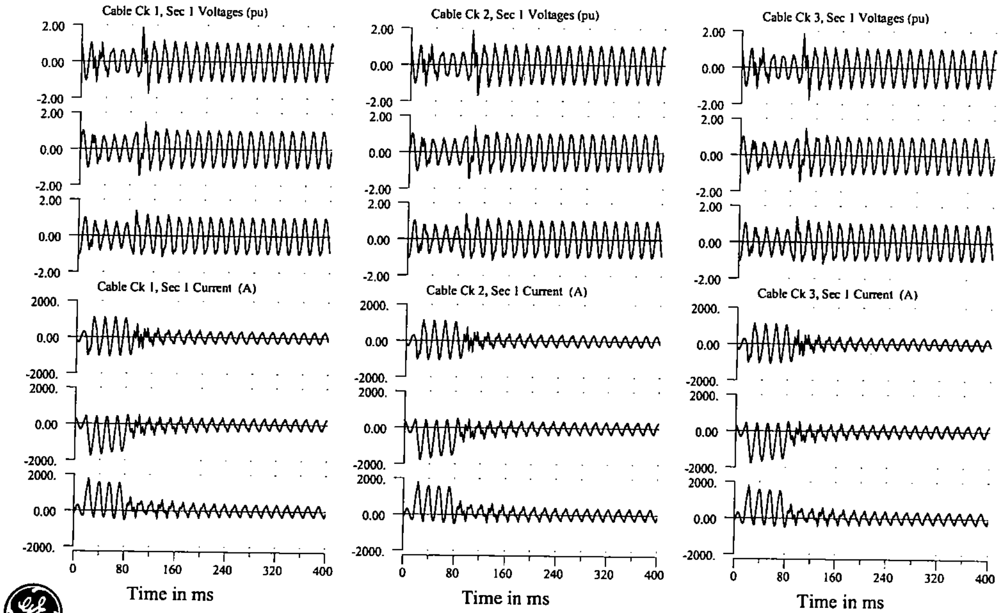
Devon-Beseck 345 kV Cables



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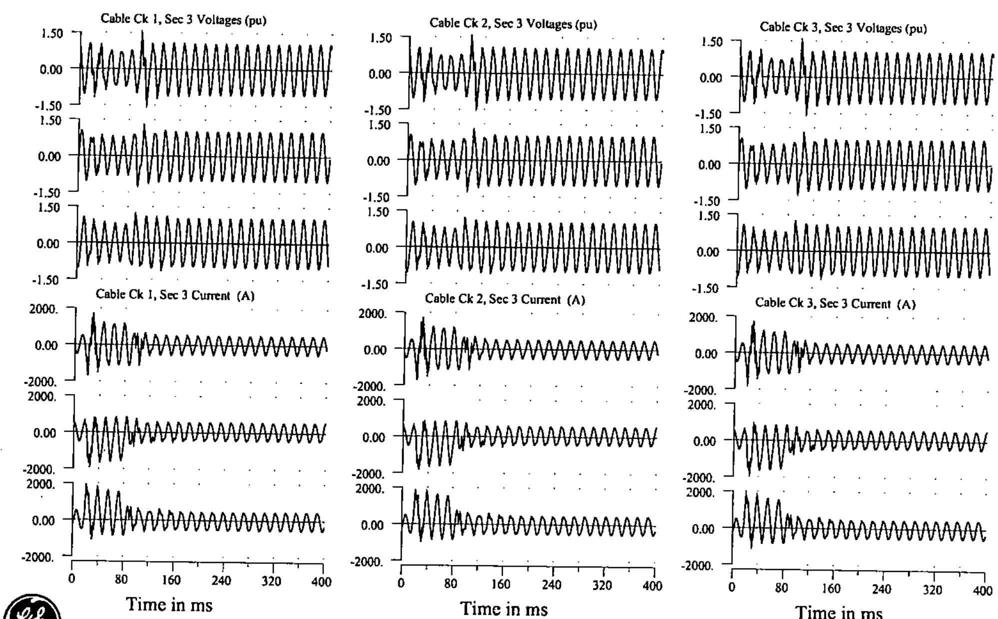
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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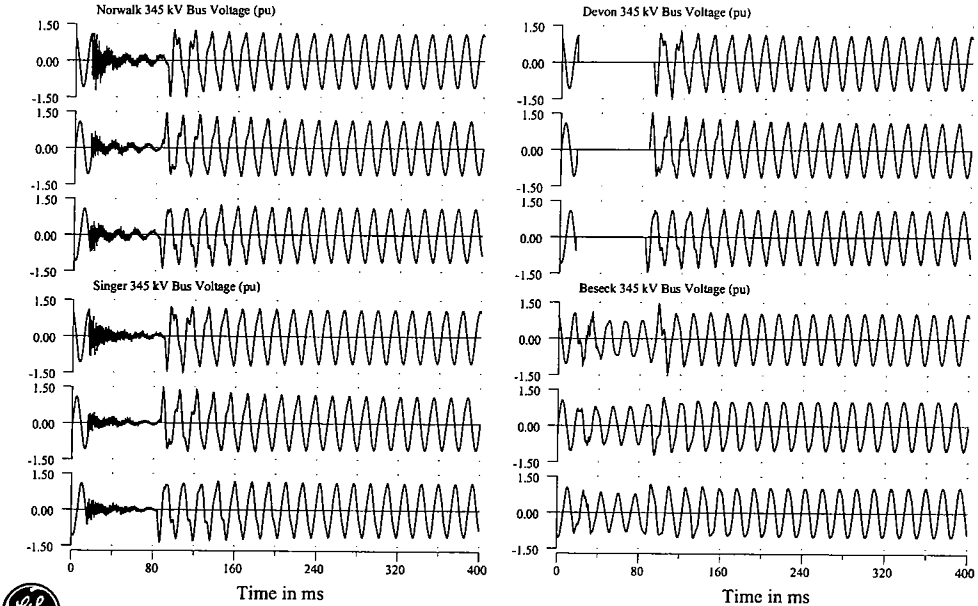
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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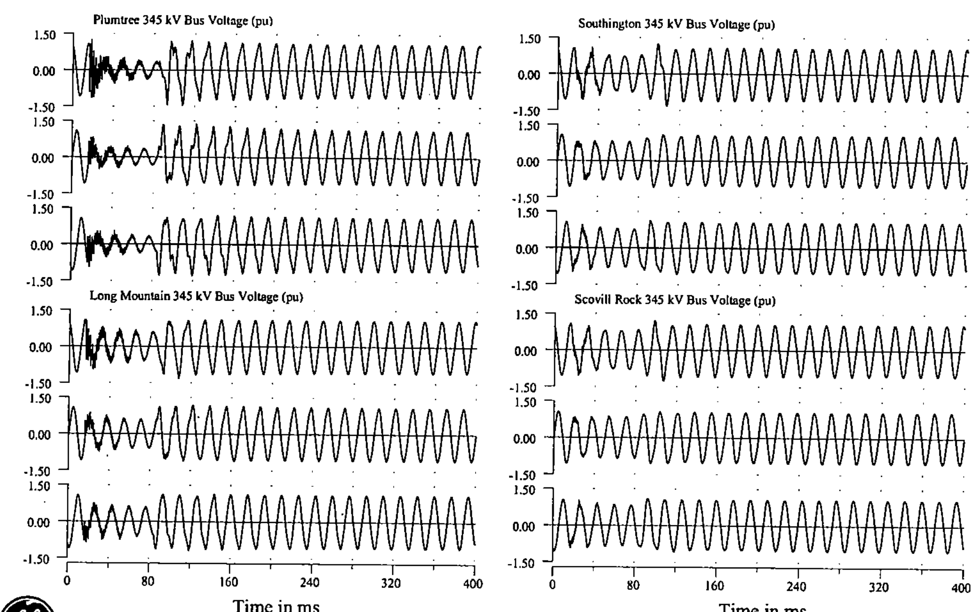
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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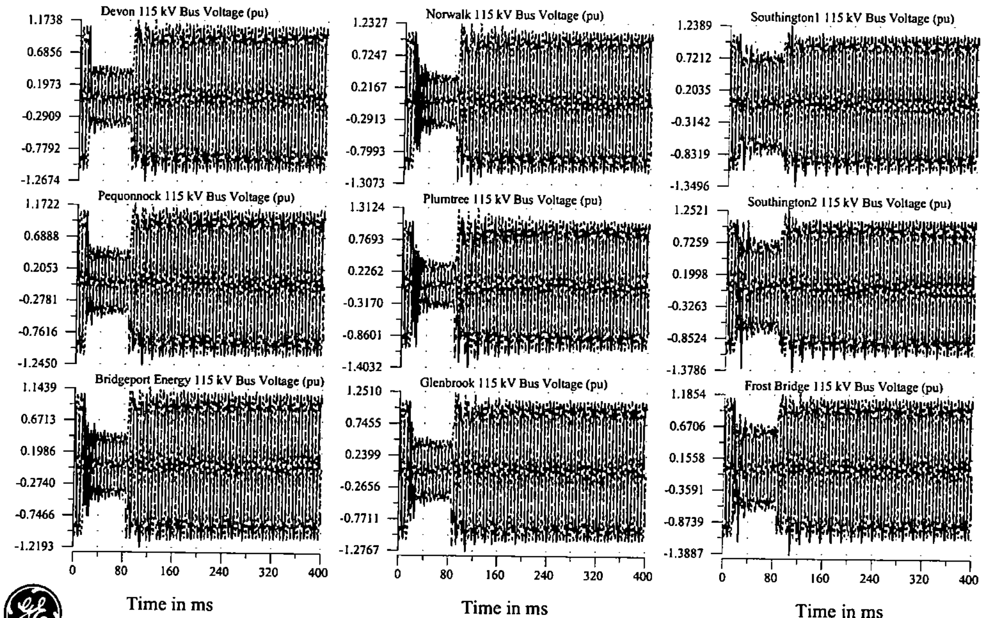
115 kV Bus Voltages and Capacitor Bank Locations



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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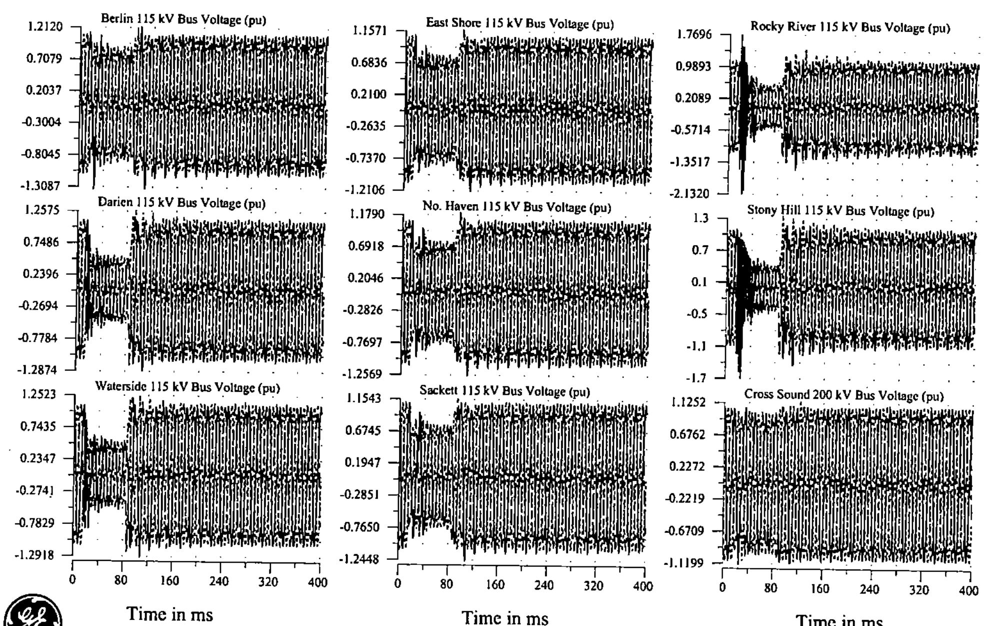
115 kV Bus Voltages and Capacitor Bank Locations



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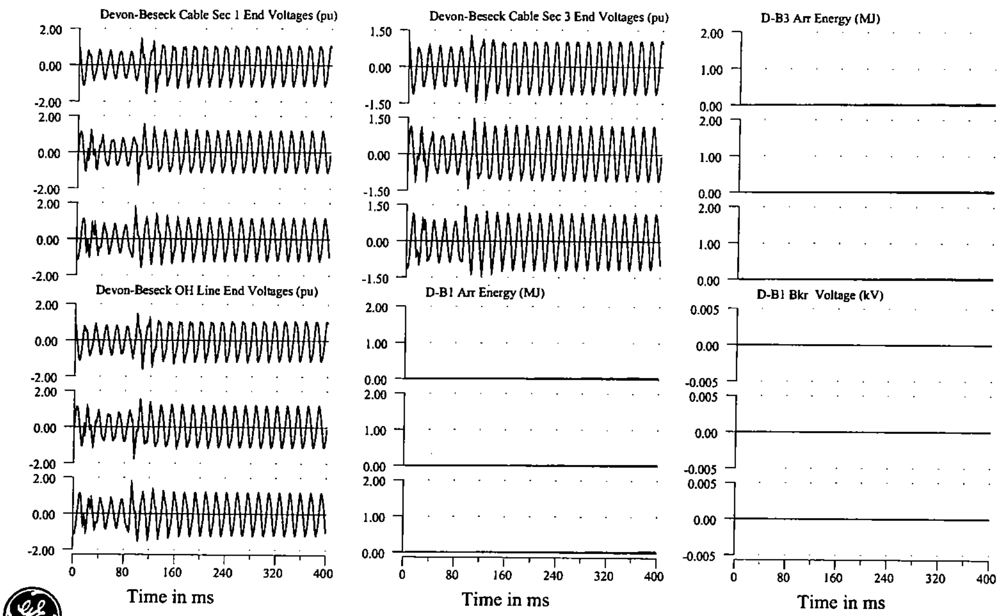
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_09_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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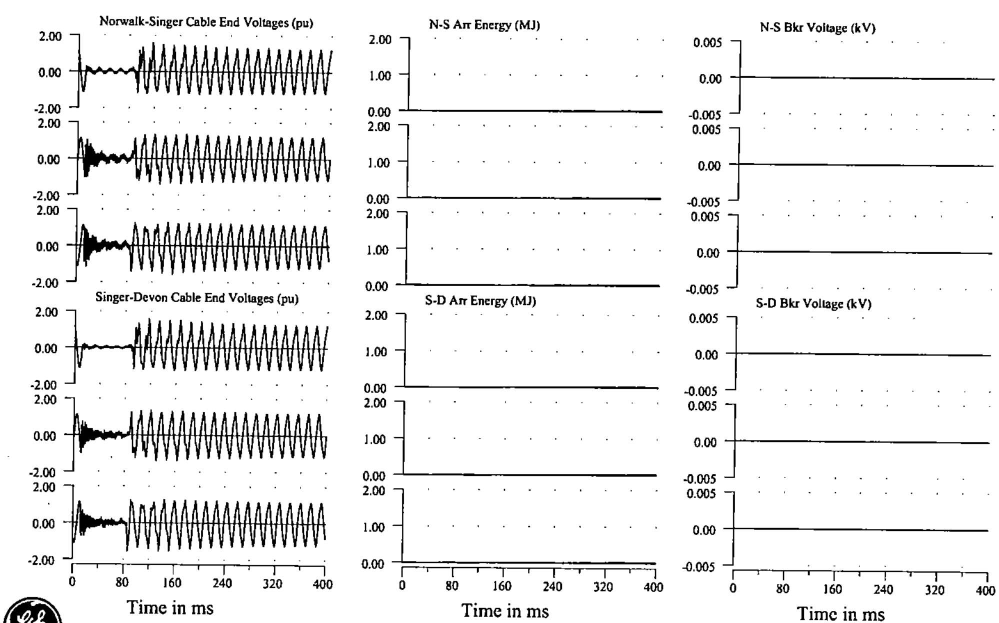
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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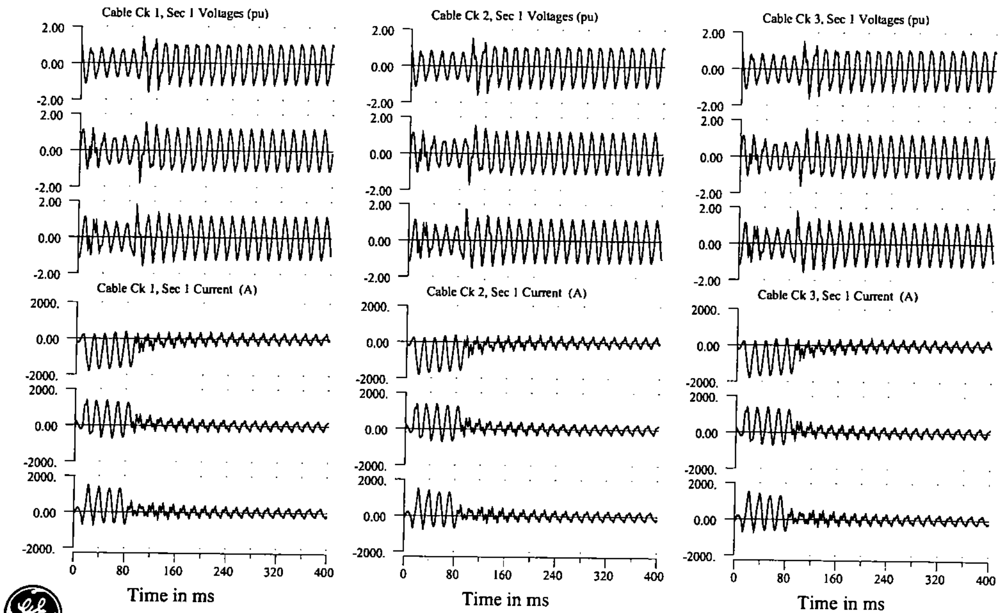
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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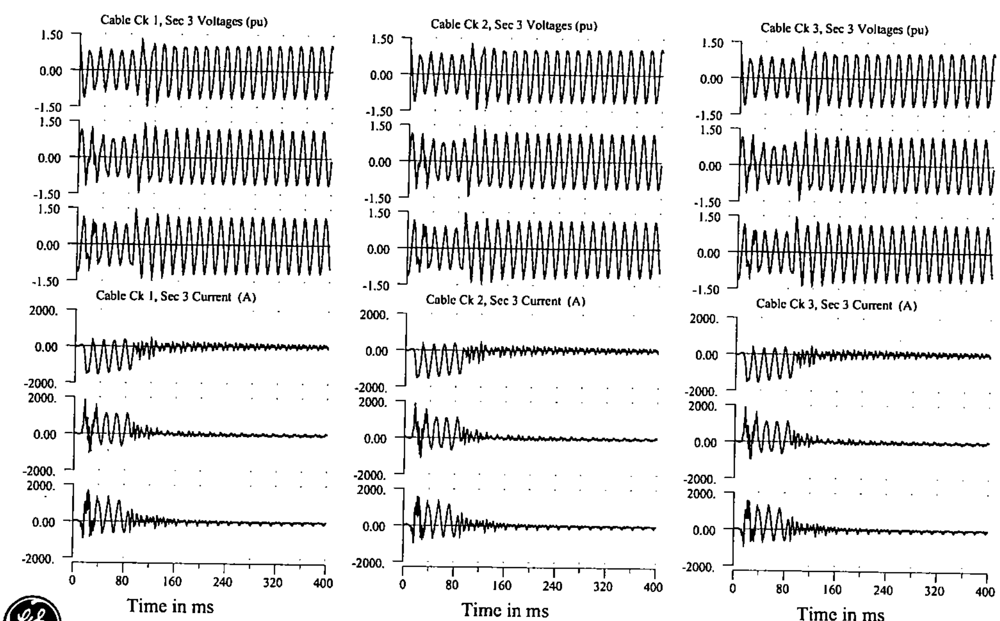
Devon-Beseck 345 kV Cables



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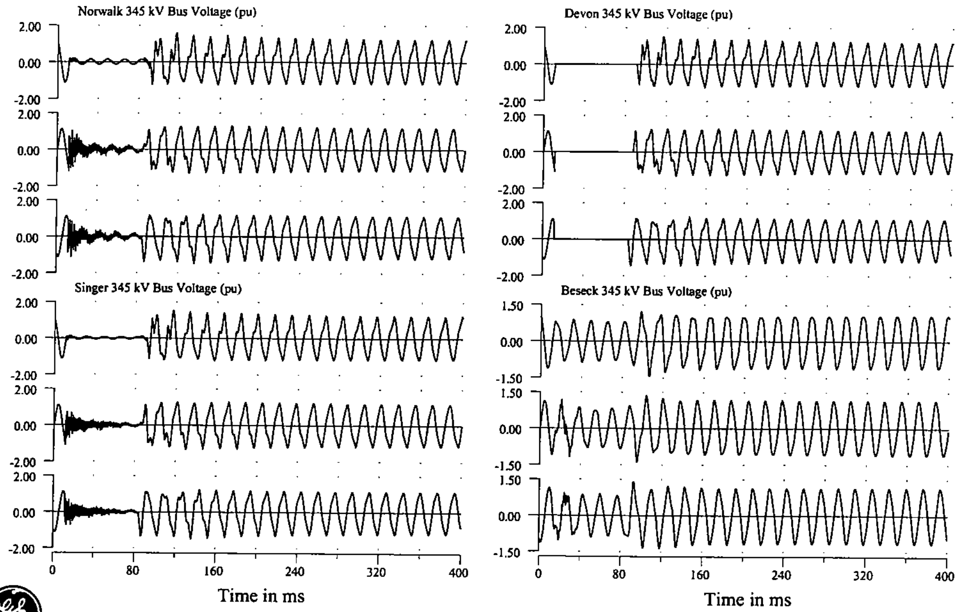
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_09_0
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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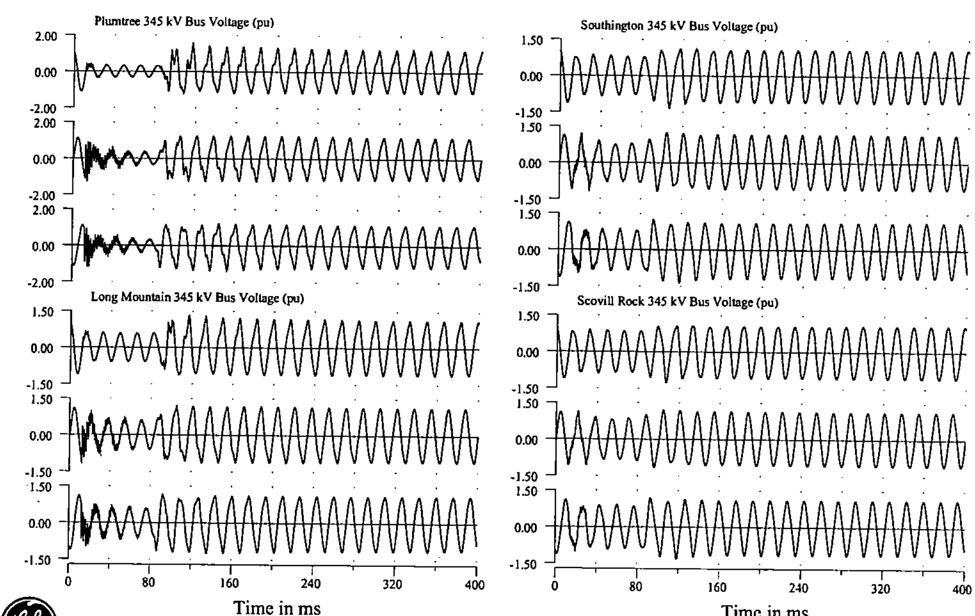
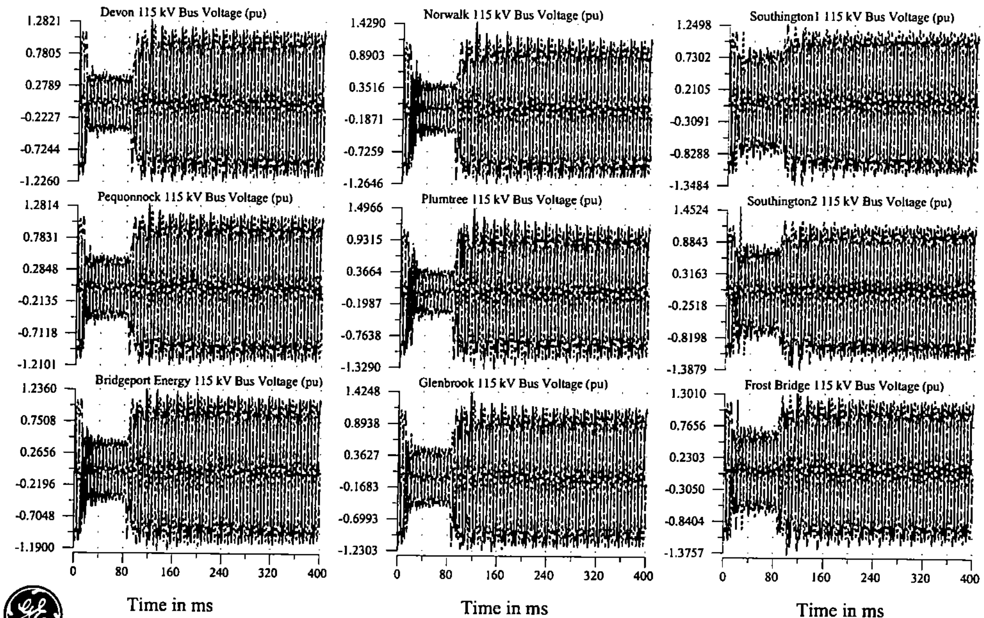
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_09_0
115 kV Bus Voltages and Capacitor Bank Locations



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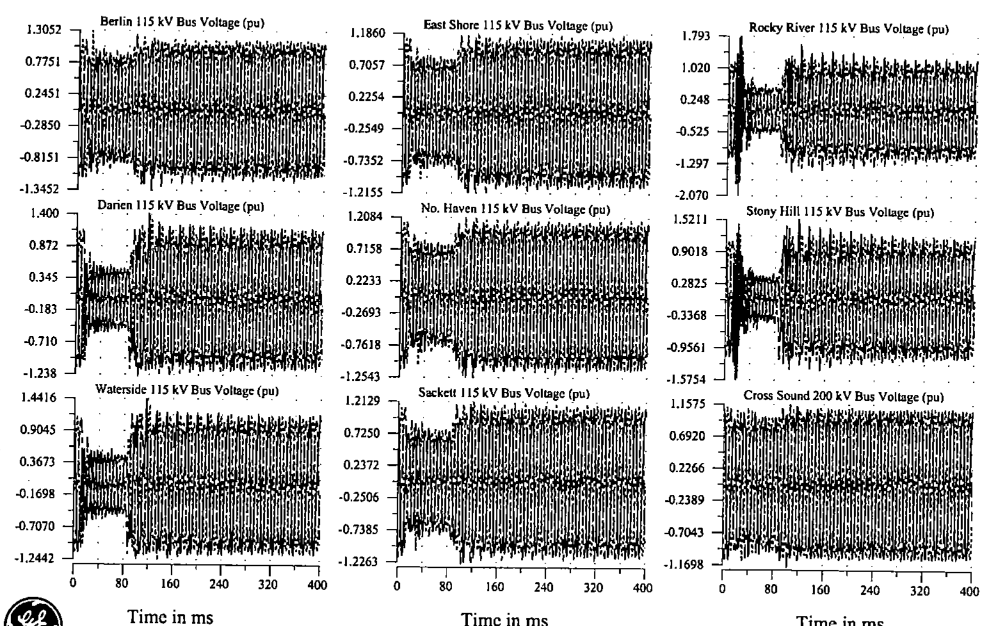
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_09_0
115 kV Bus Voltages and Capacitor Bank Locations



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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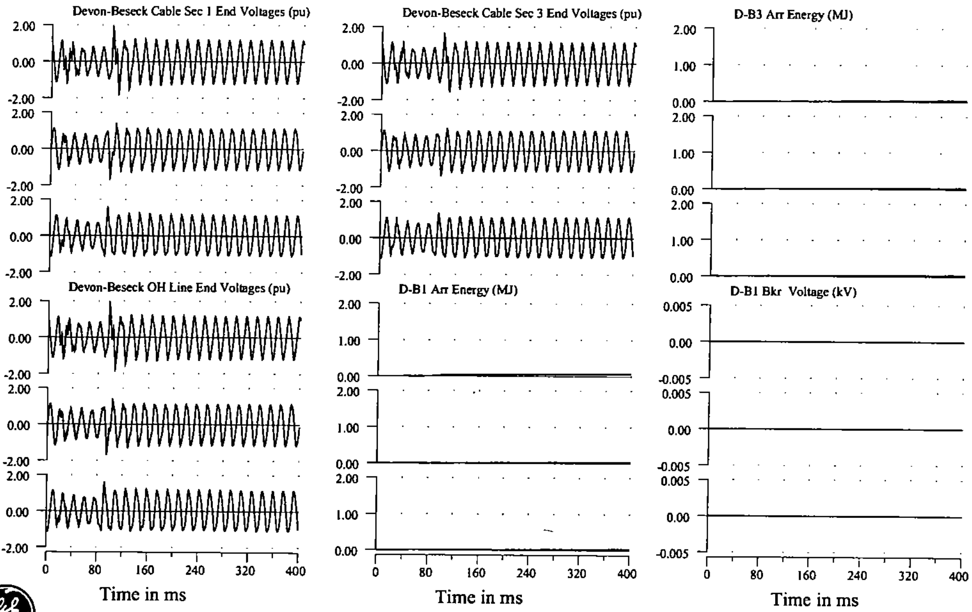
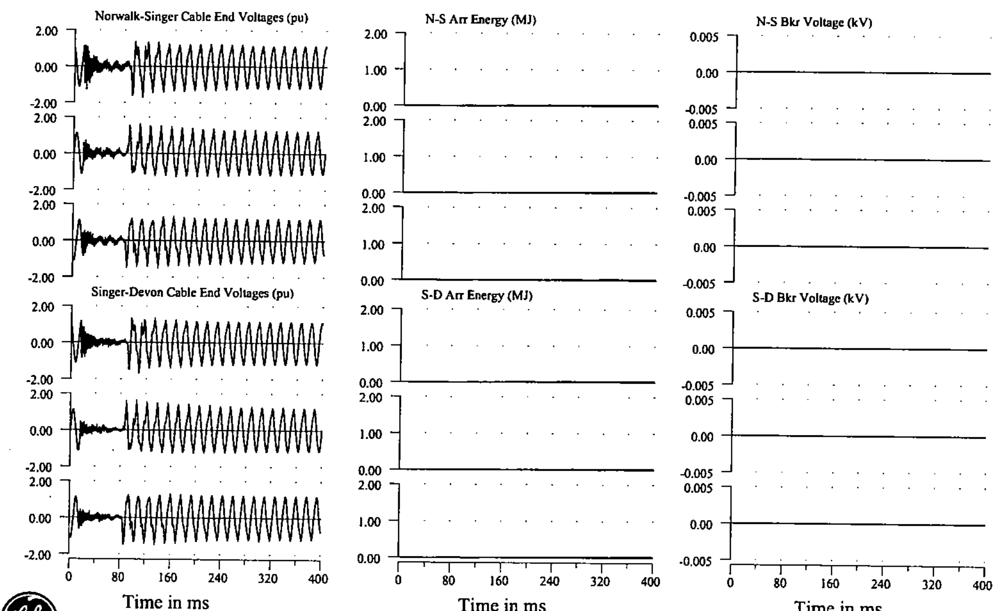
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_09_90
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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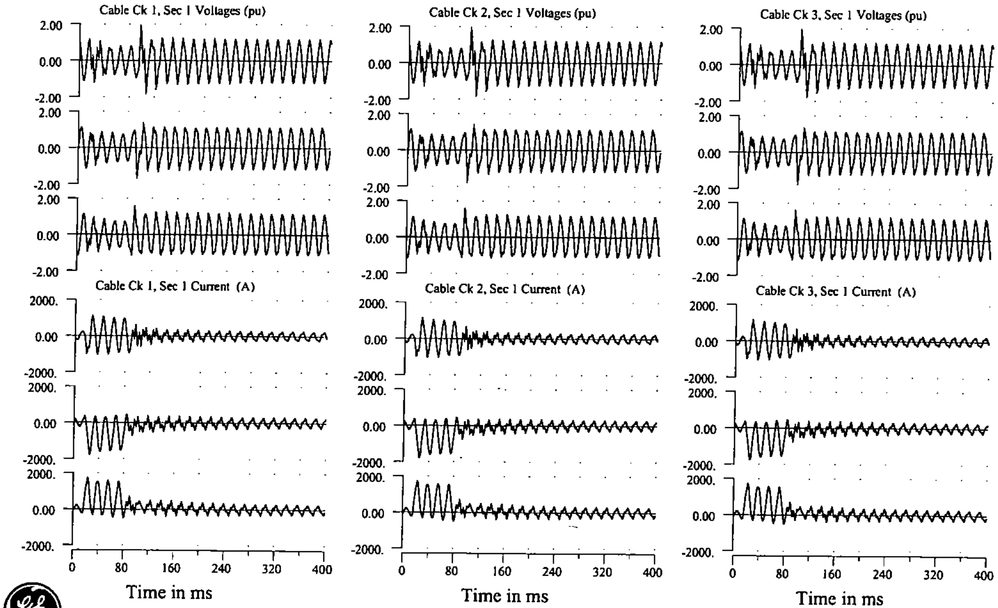
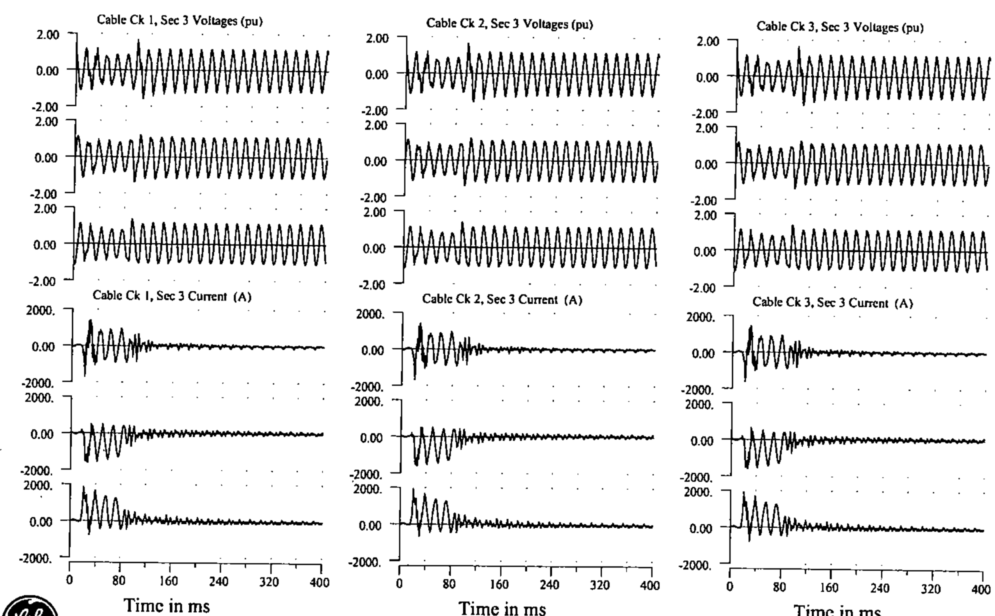
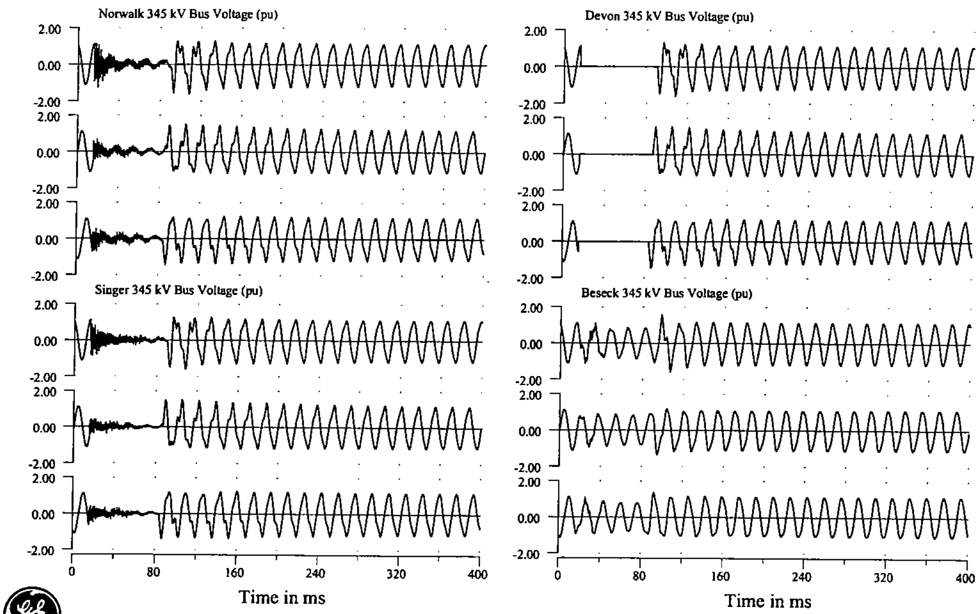
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_09_90
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_09_90
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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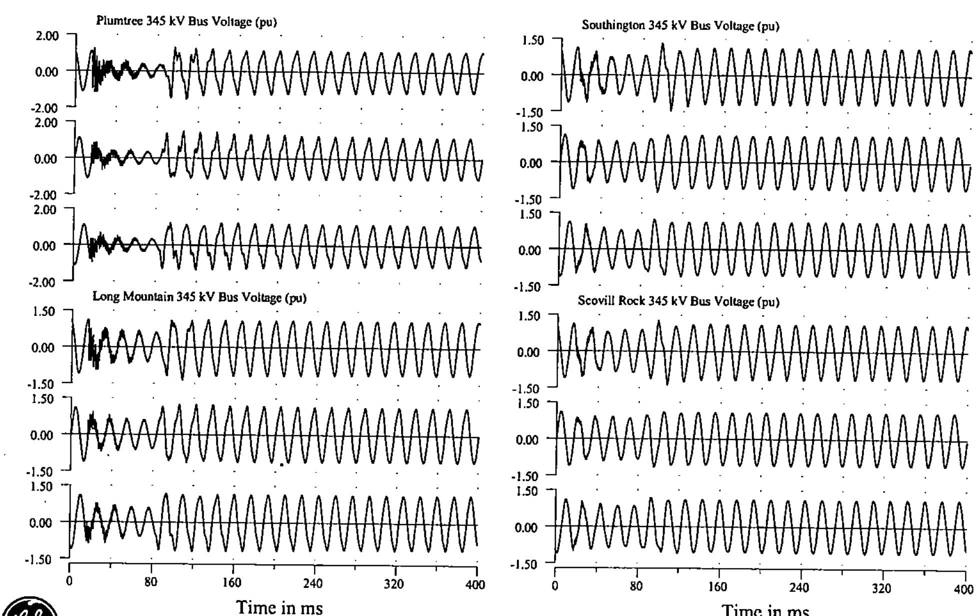
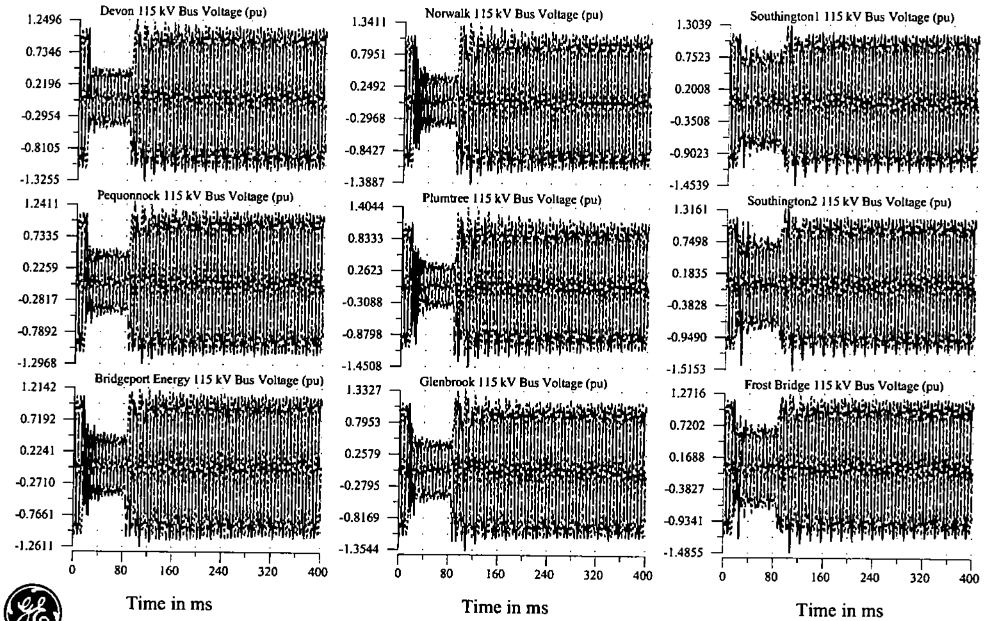
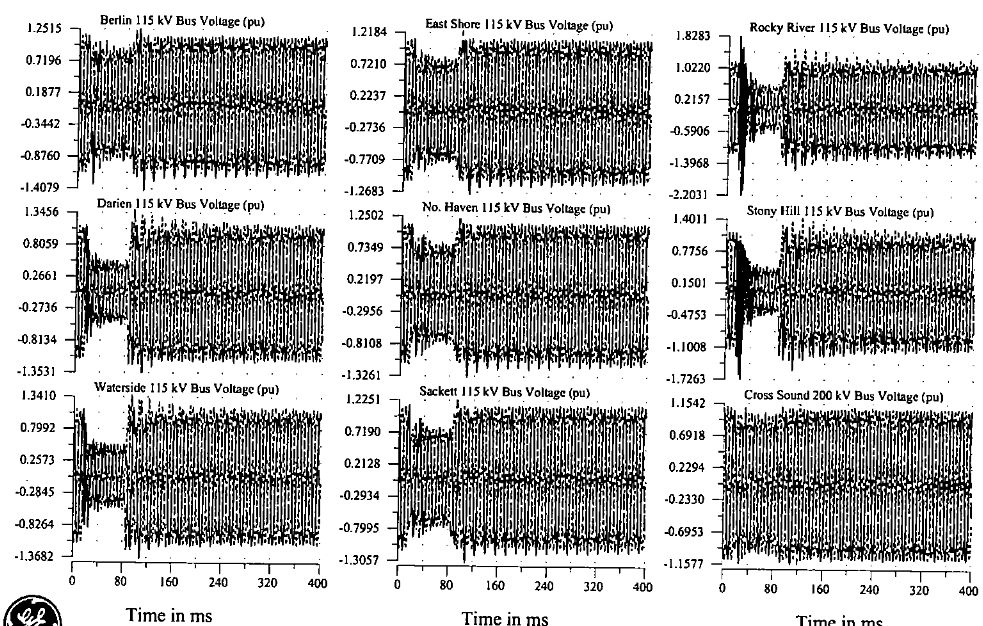
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_09_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_09_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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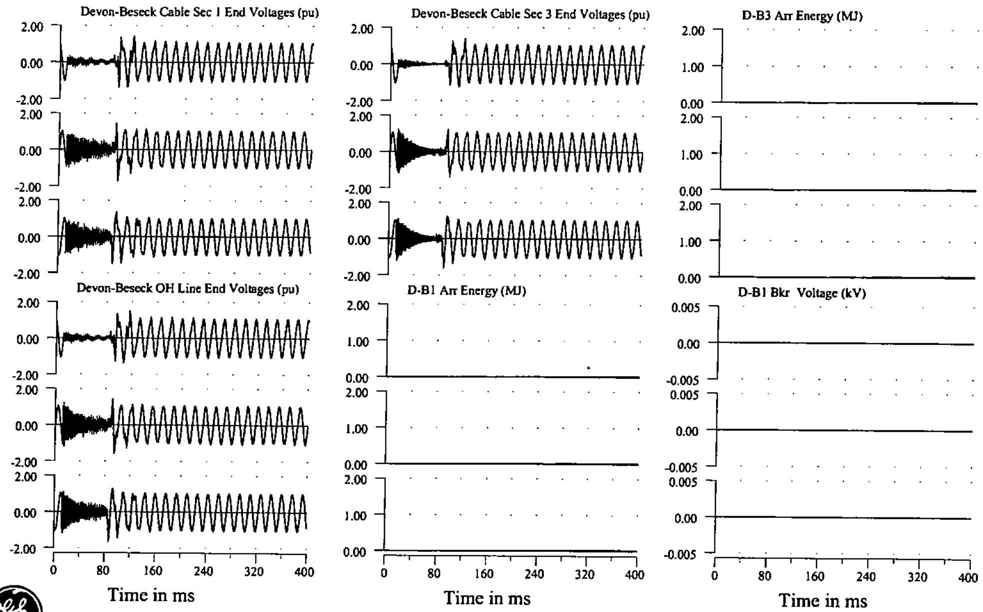

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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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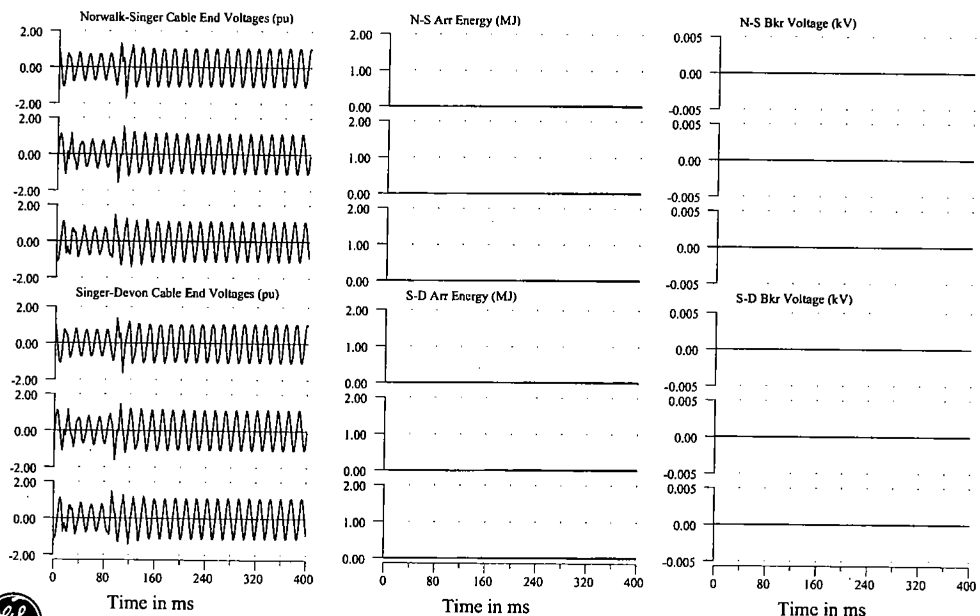

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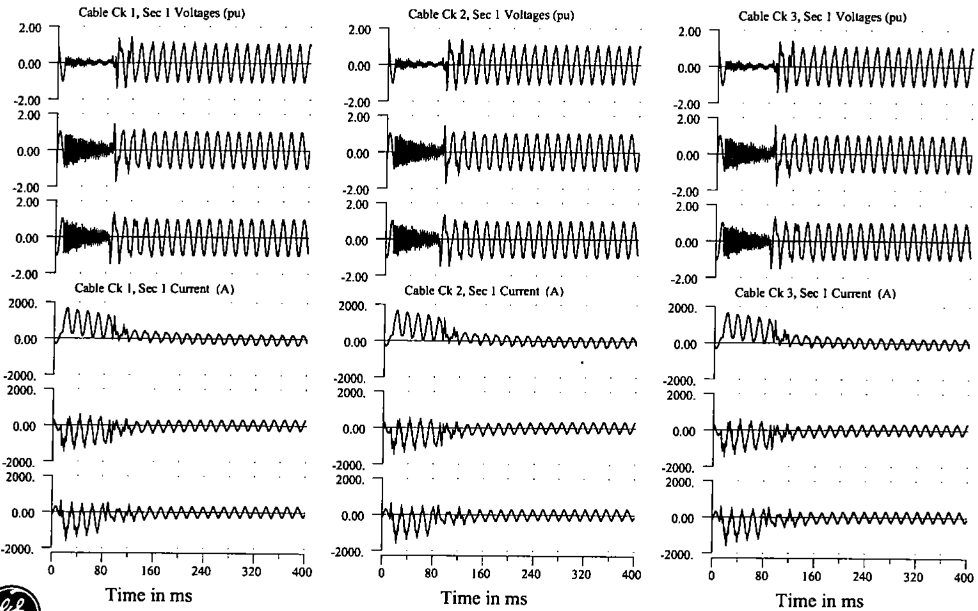
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_10_0

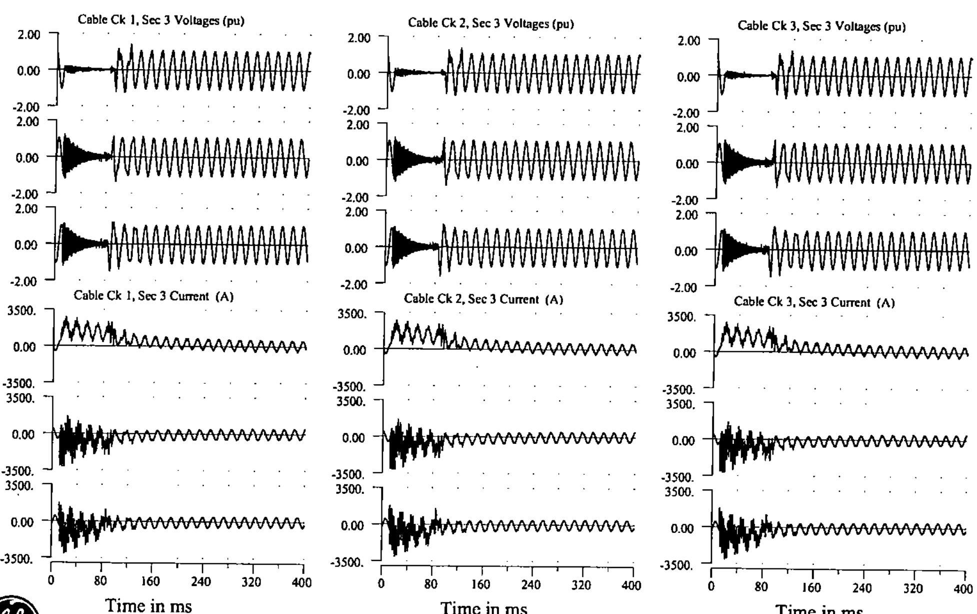
Devon-Beseck 345 kV Cables



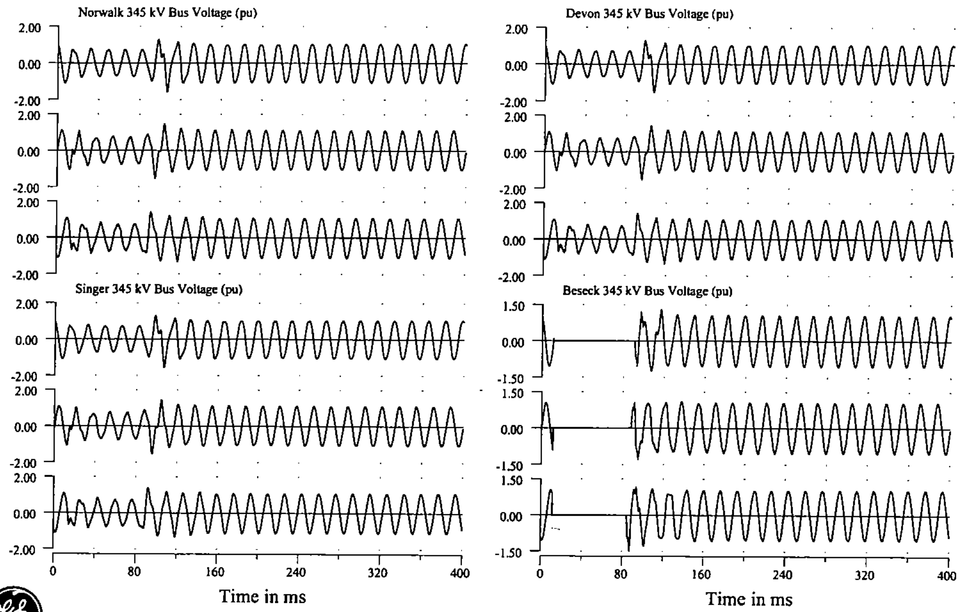
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_10_0

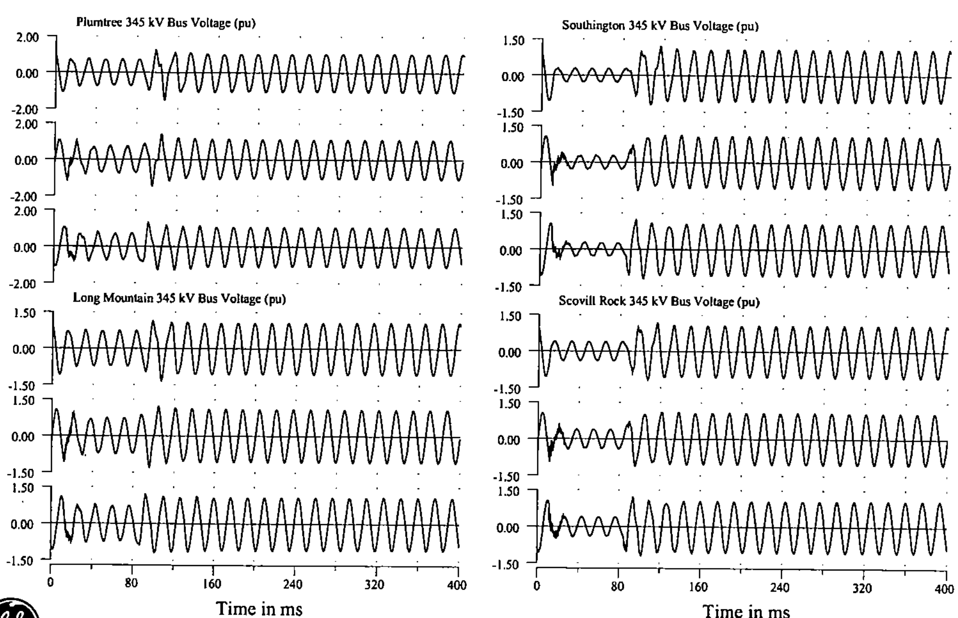
Devon-Beseck 345 kV Cables



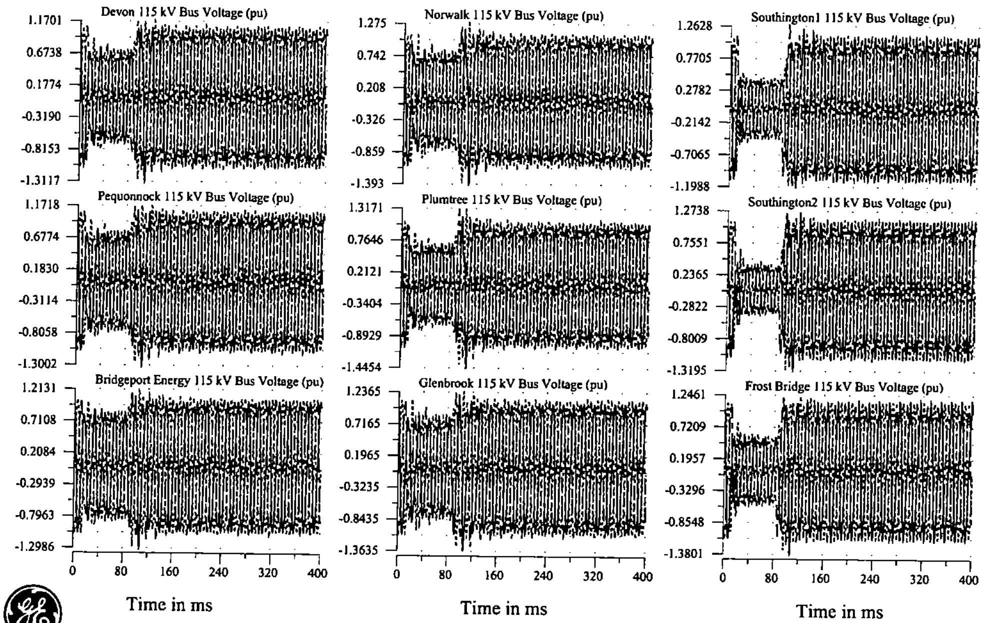
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_10_0
345 kV Bus Voltages



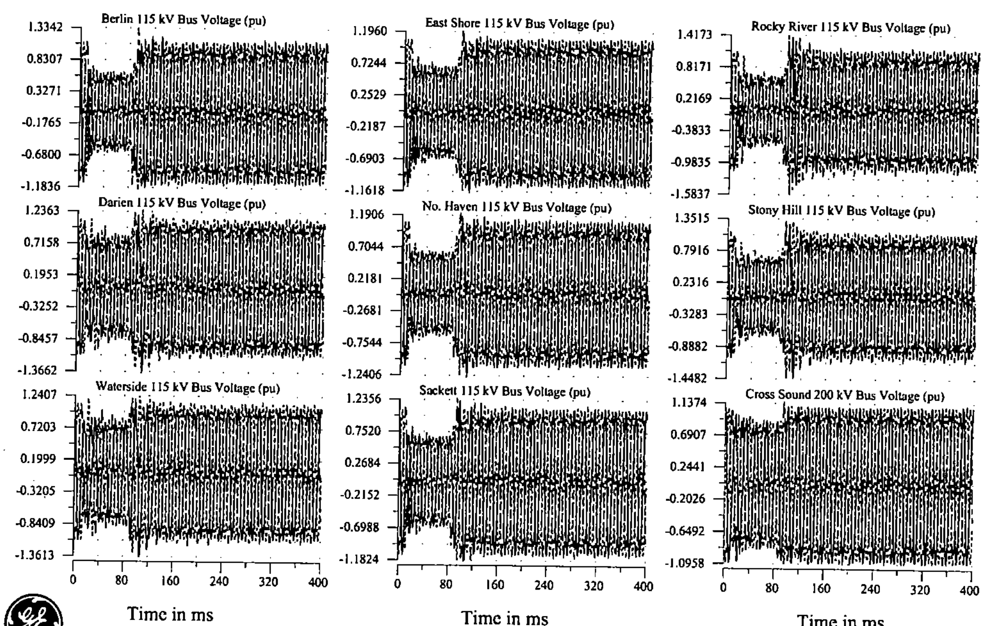
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_10_0
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_10_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_10_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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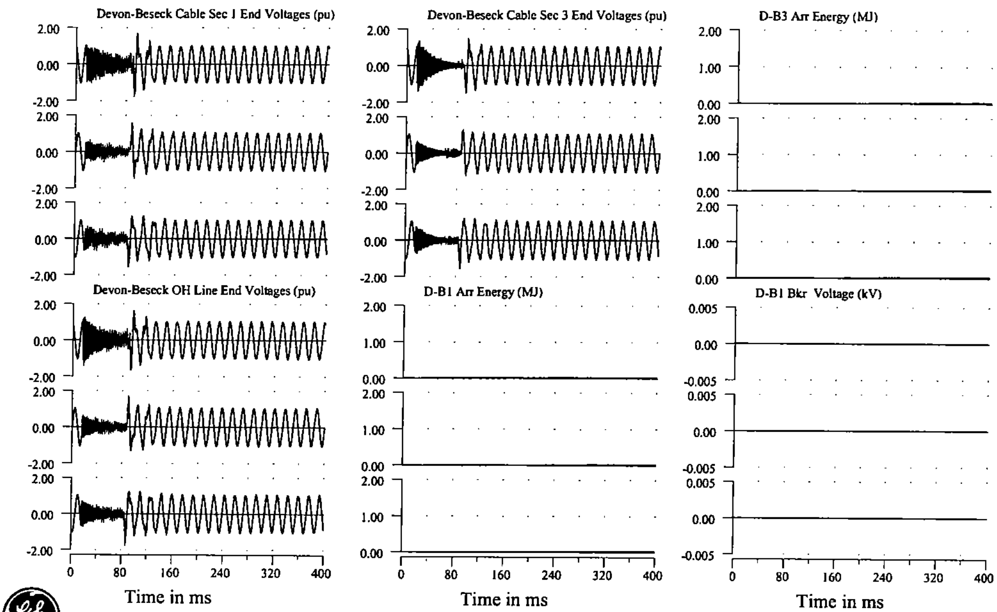
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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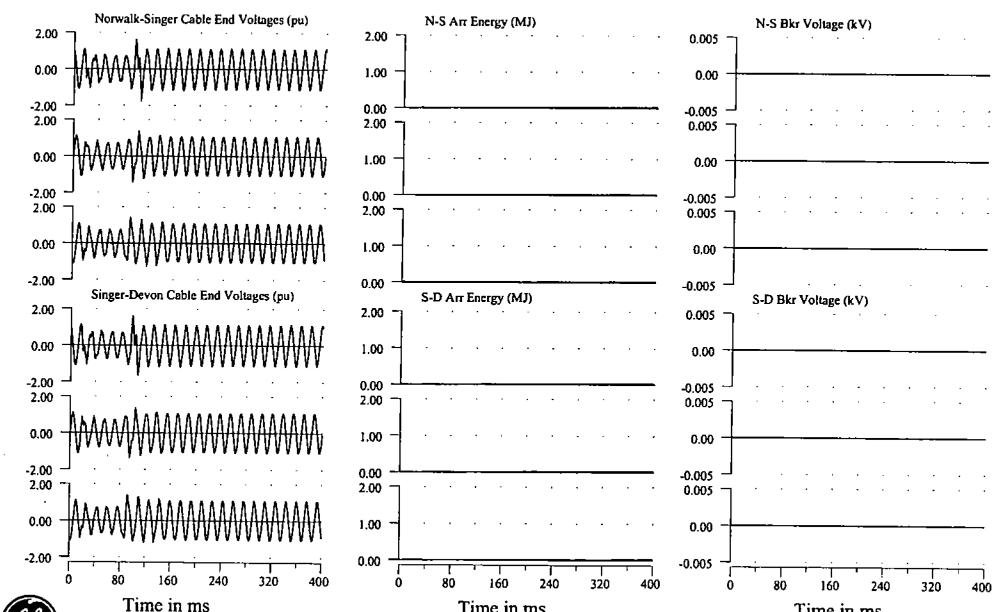
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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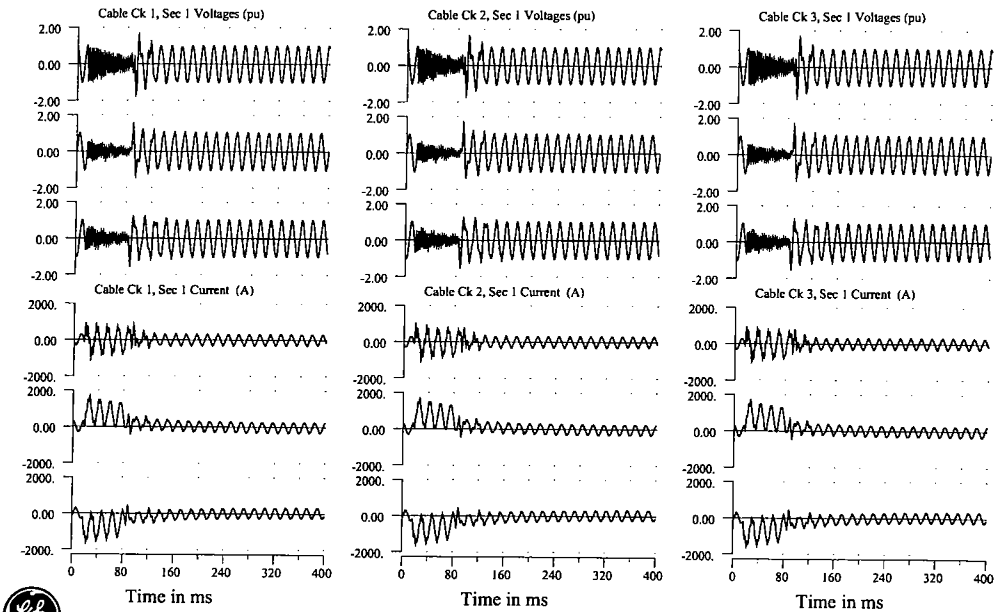
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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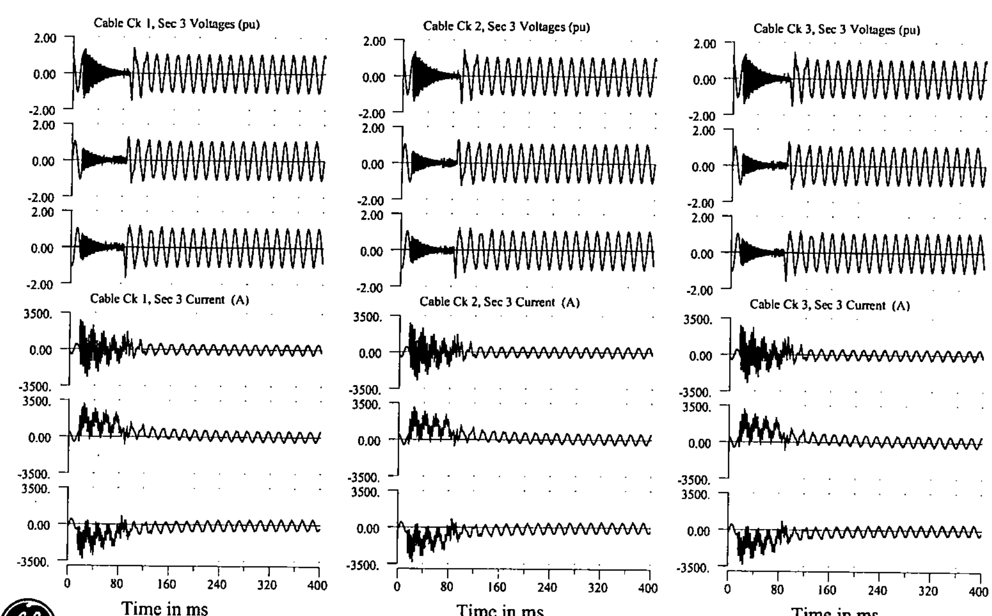
Devon-Beseck 345 kV Cables



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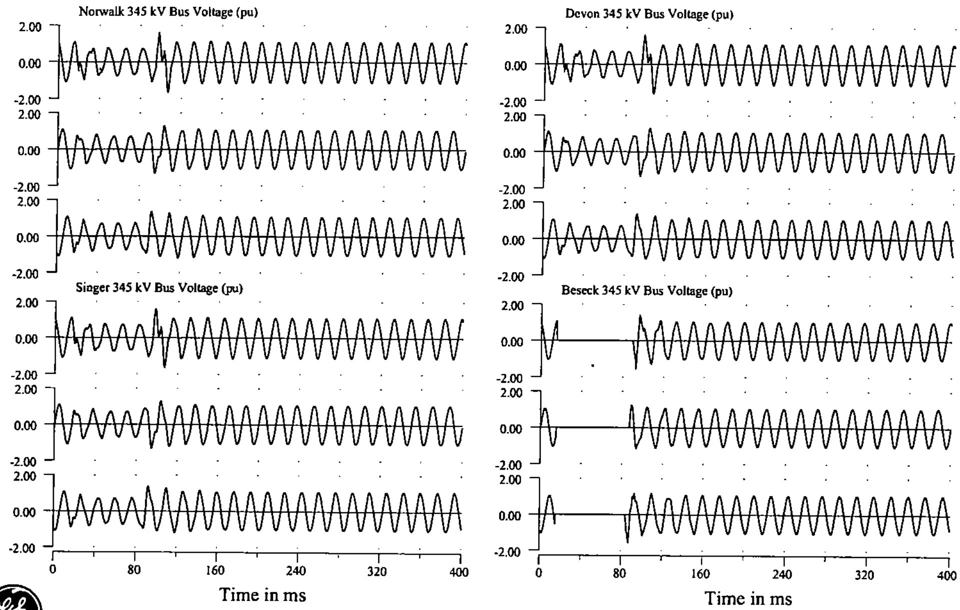
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_10_90
345 kV Bus Voltages



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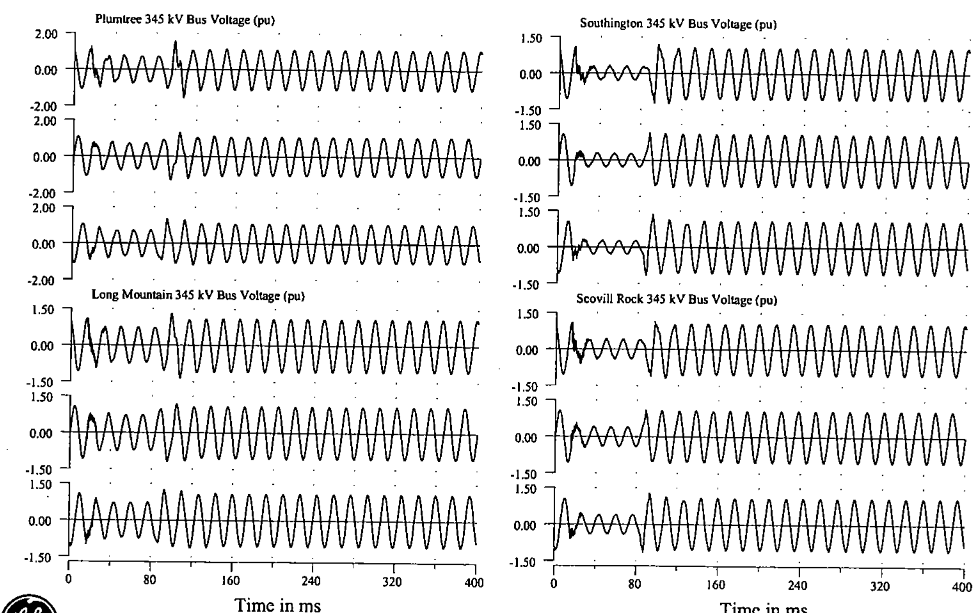
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_10_90
345 kV Bus Voltages



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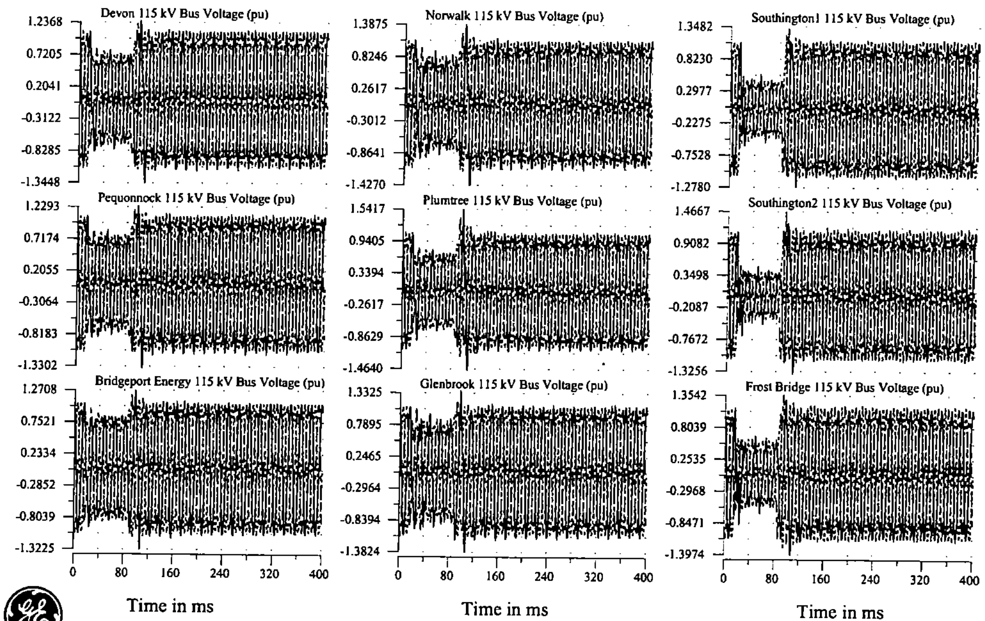
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_10_90
115 kV Bus Voltages and Capacitor Bank Locations



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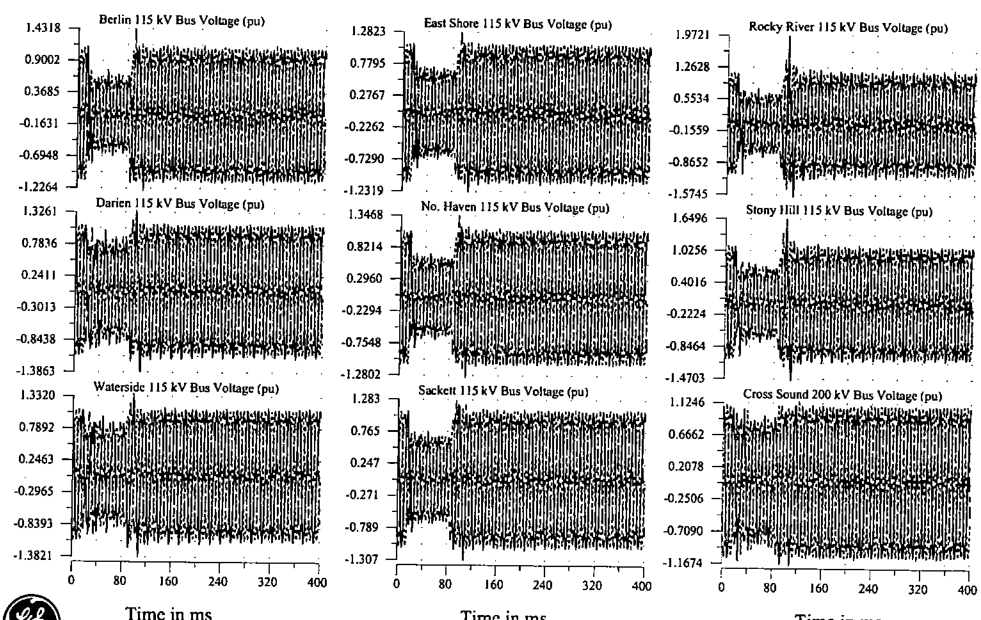
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_10_90
115 kV Bus Voltages and Capacitor Bank Locations



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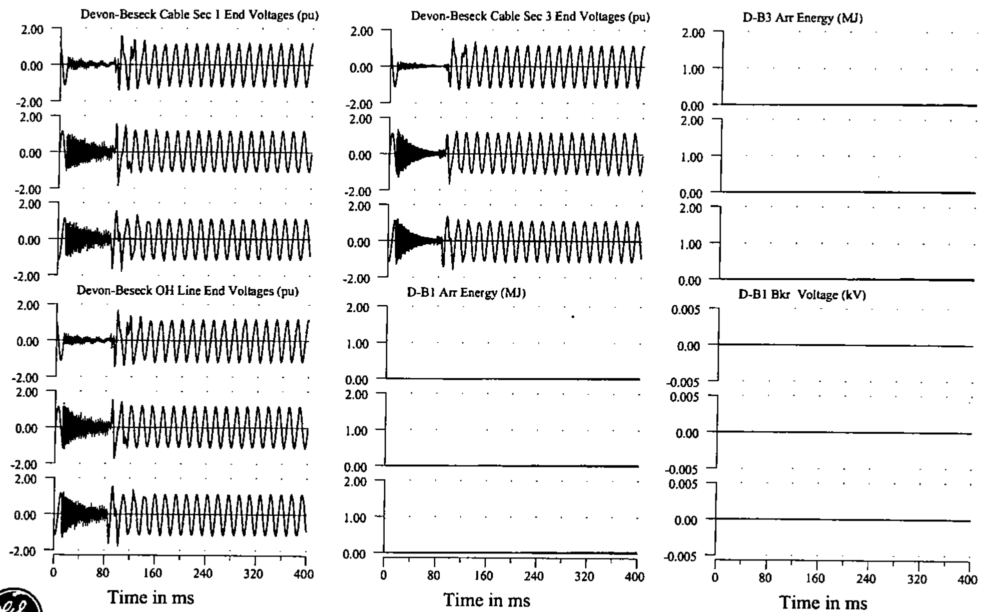
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_11_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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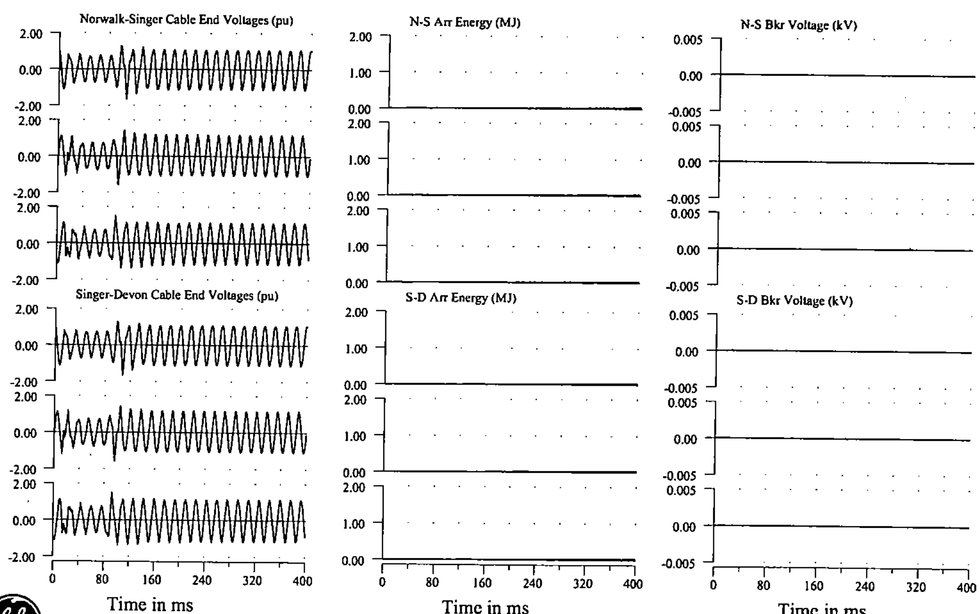
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_11_0
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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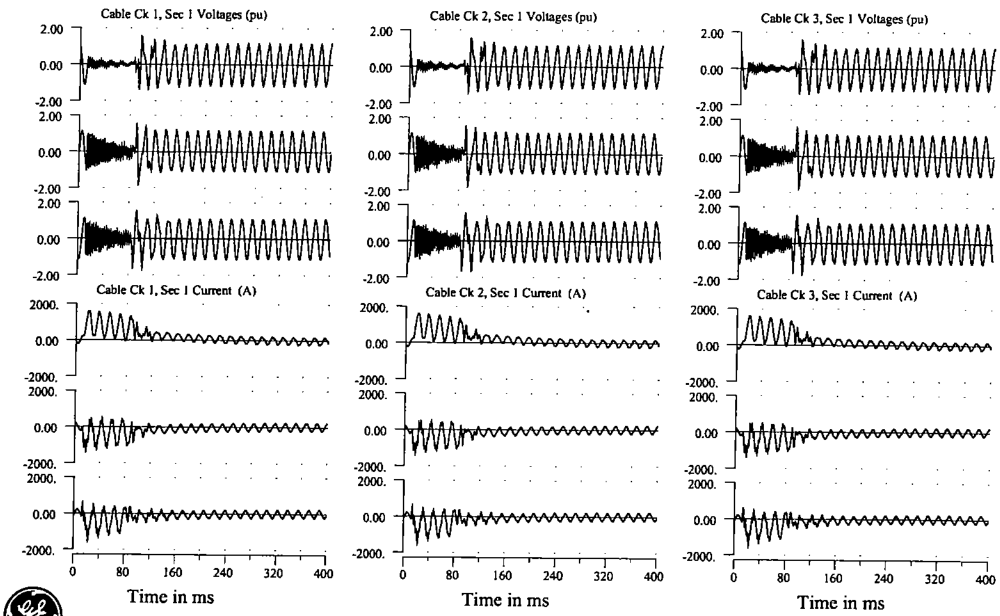
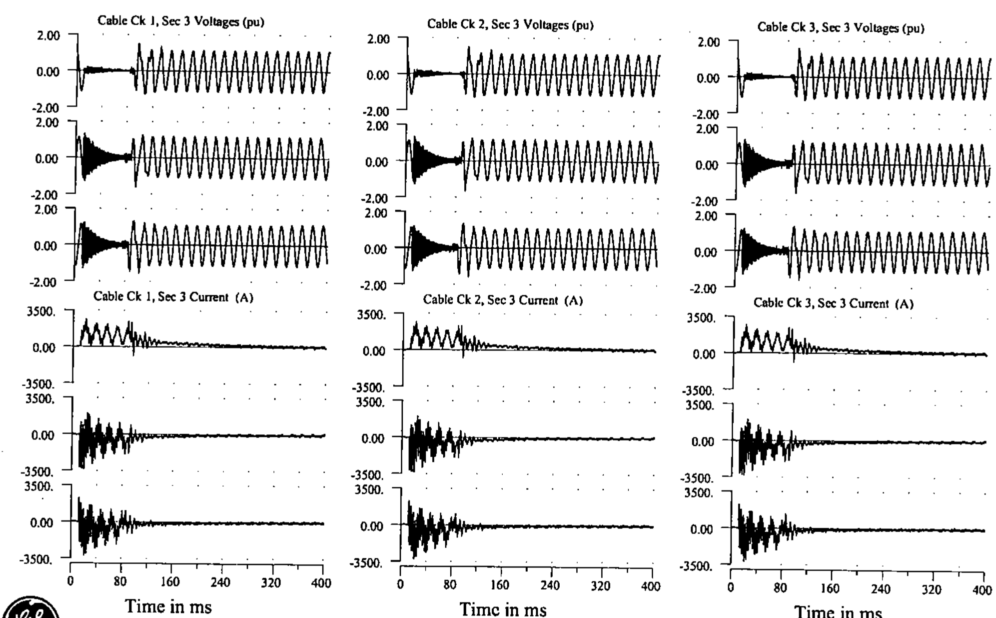
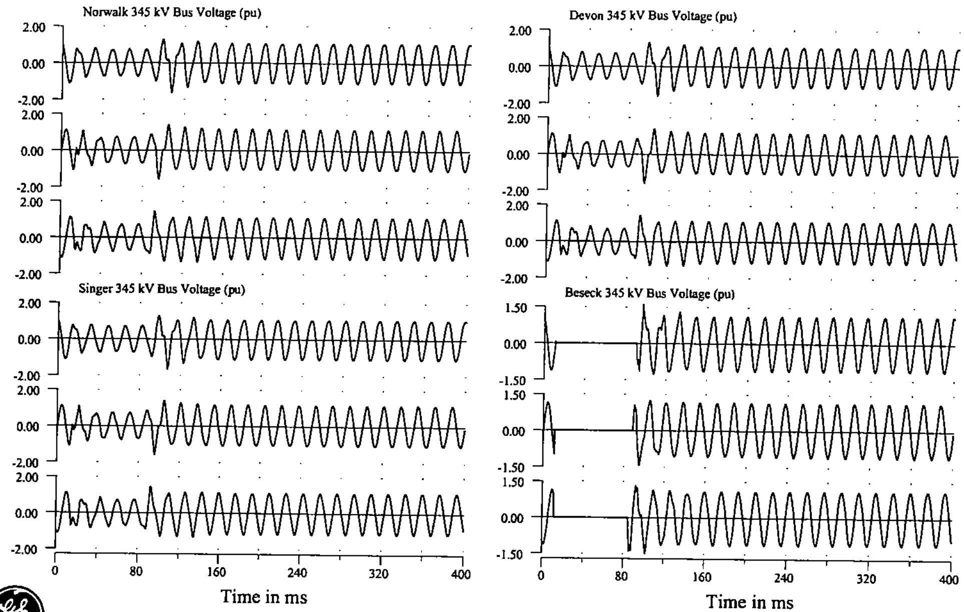
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_11_0
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_11_0
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_11_0
345 kV Bus Voltages



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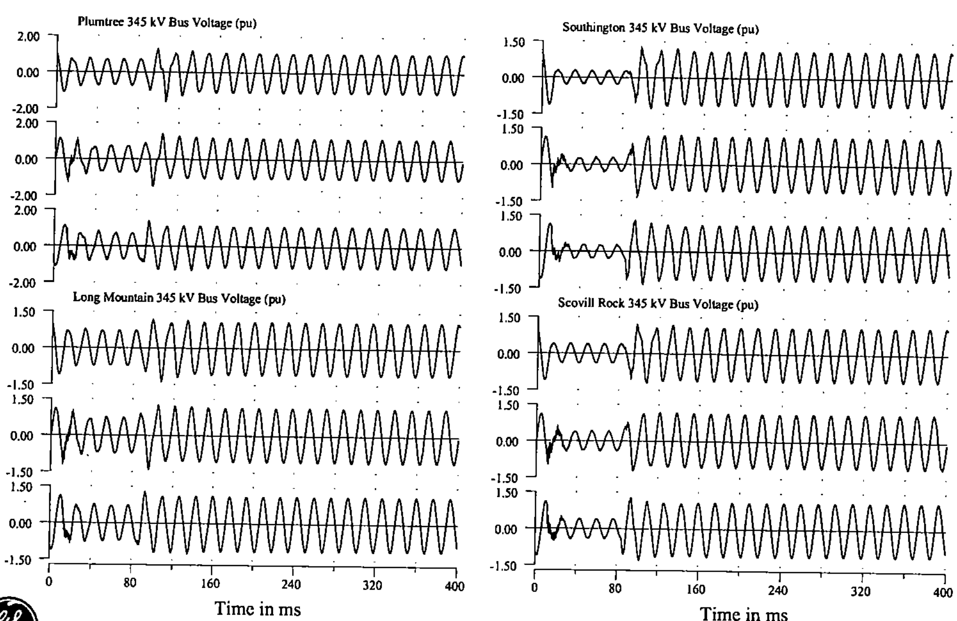
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_11_0
345 kV Bus Voltages



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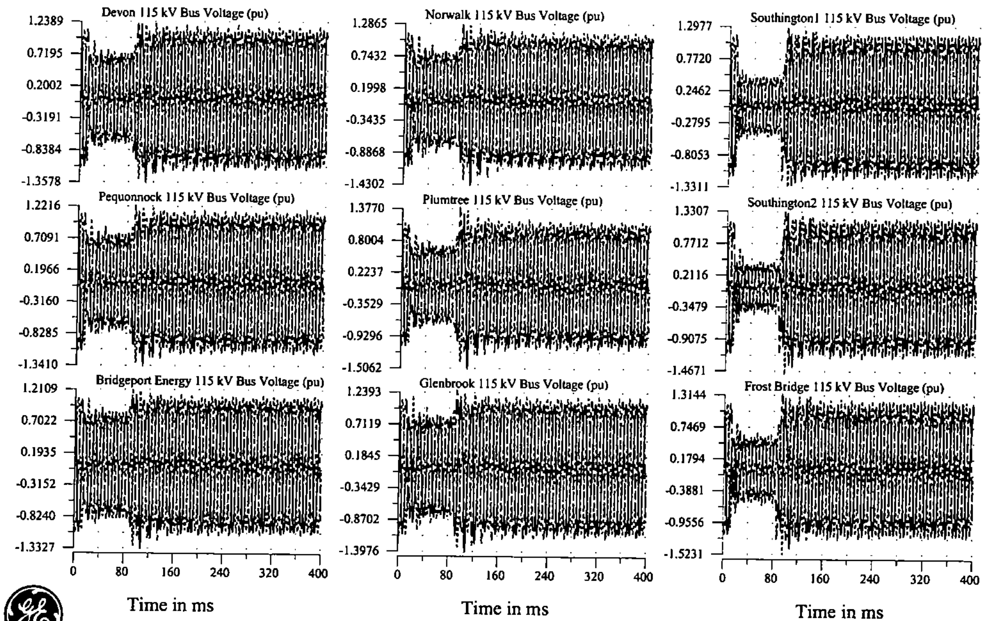
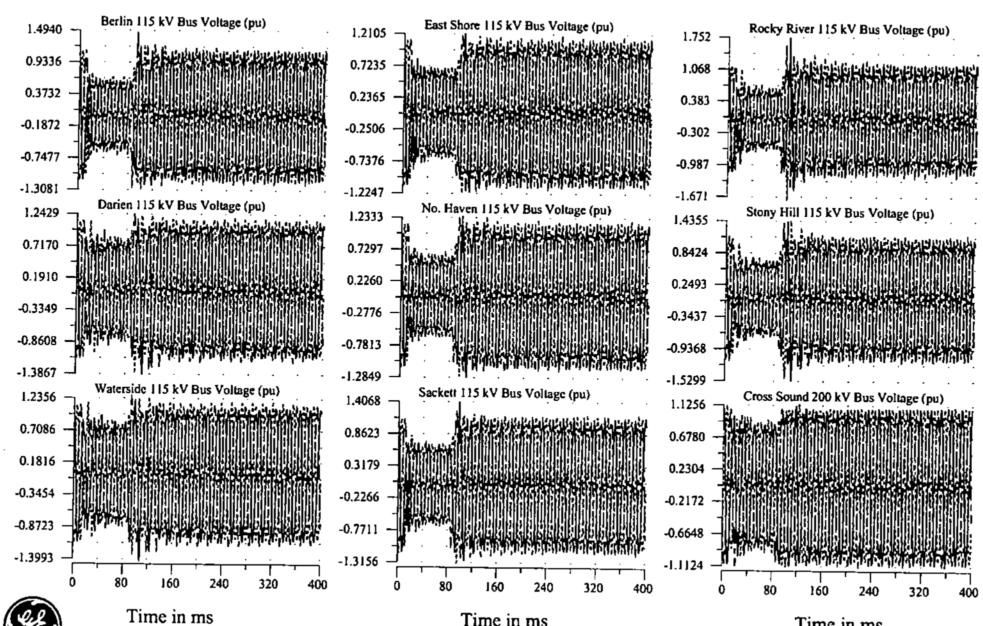
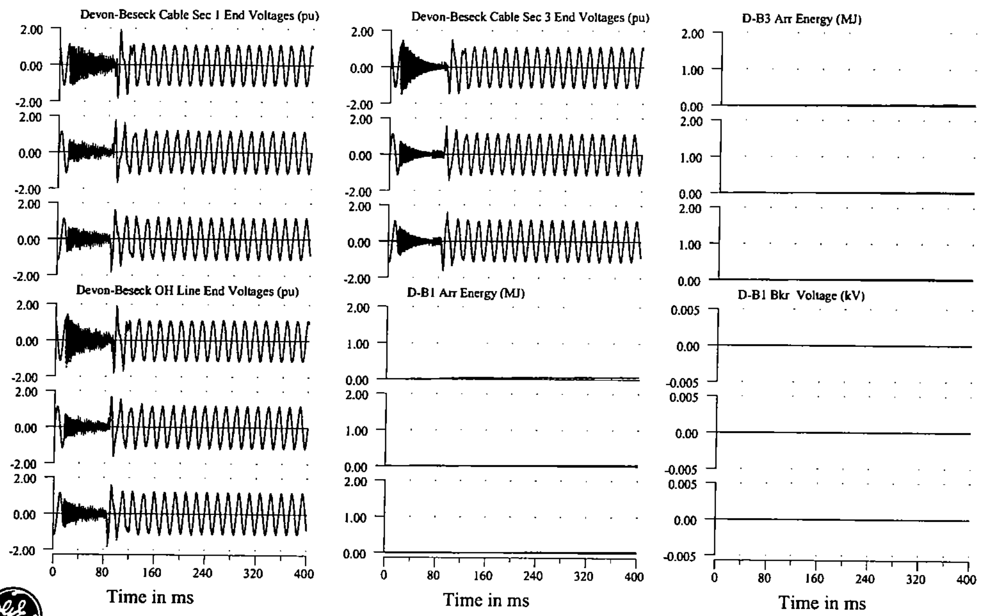
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_11_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_11_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_11_90
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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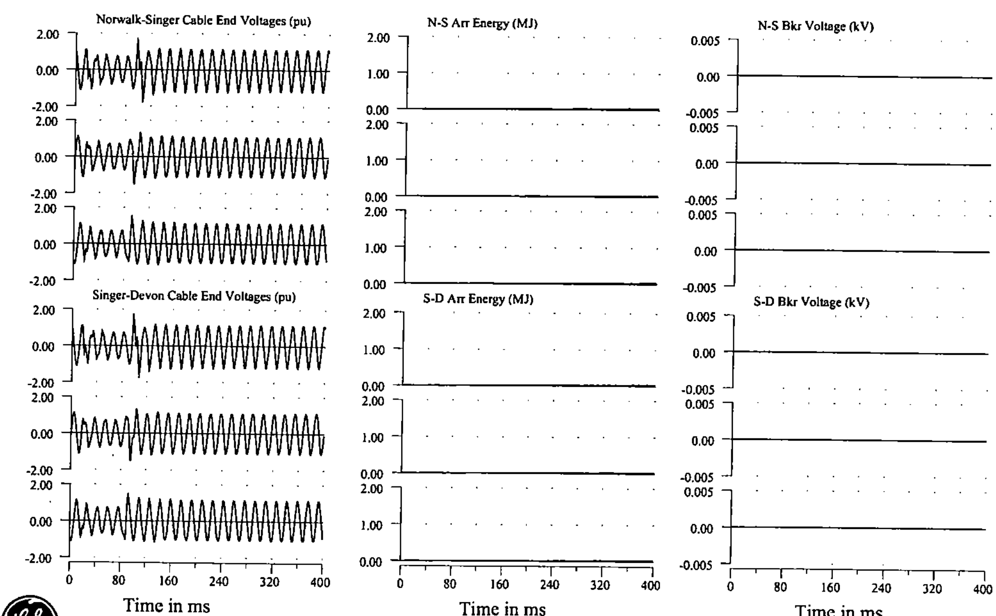
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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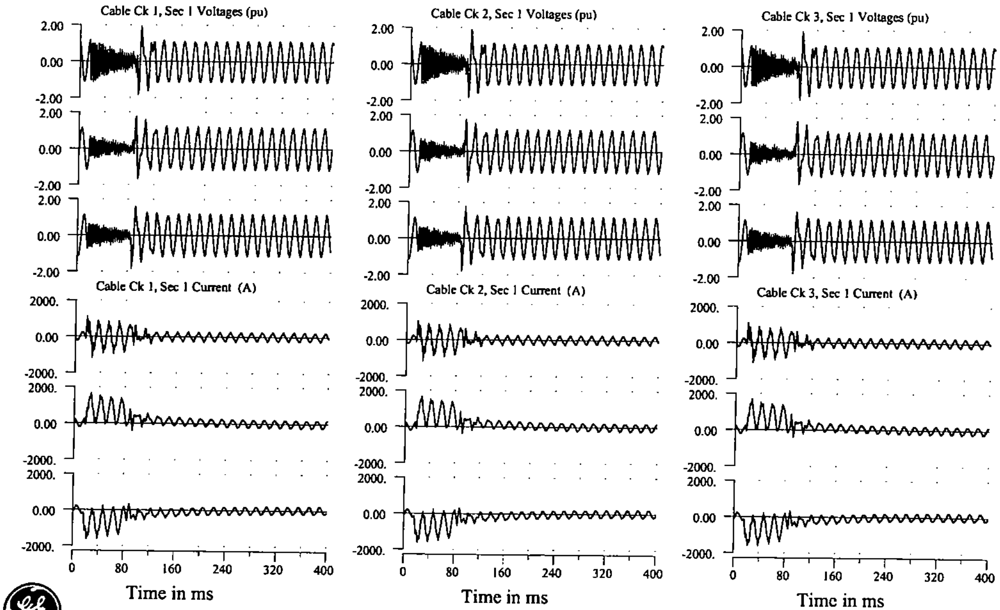
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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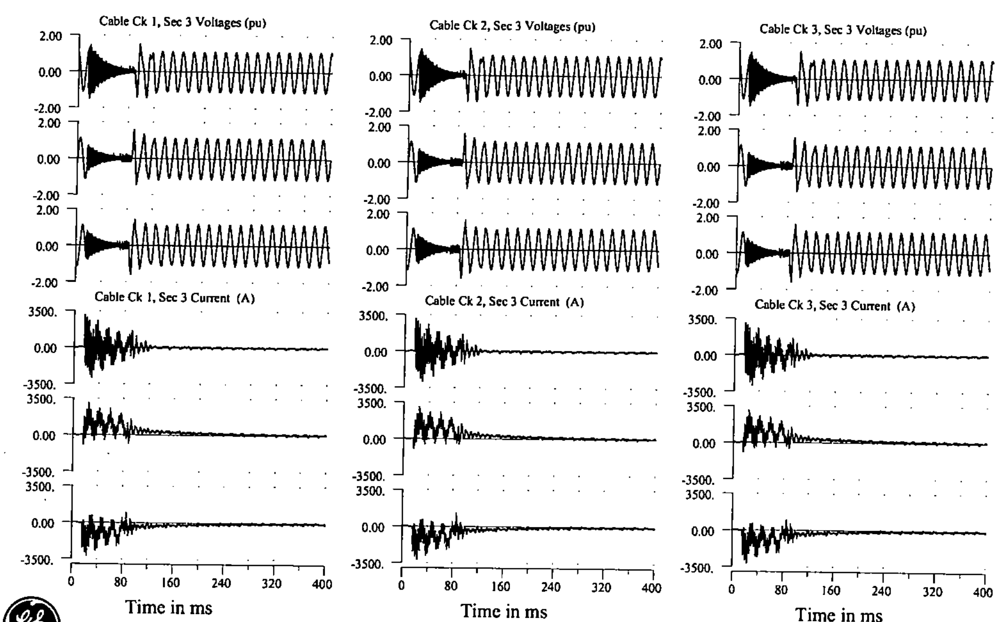
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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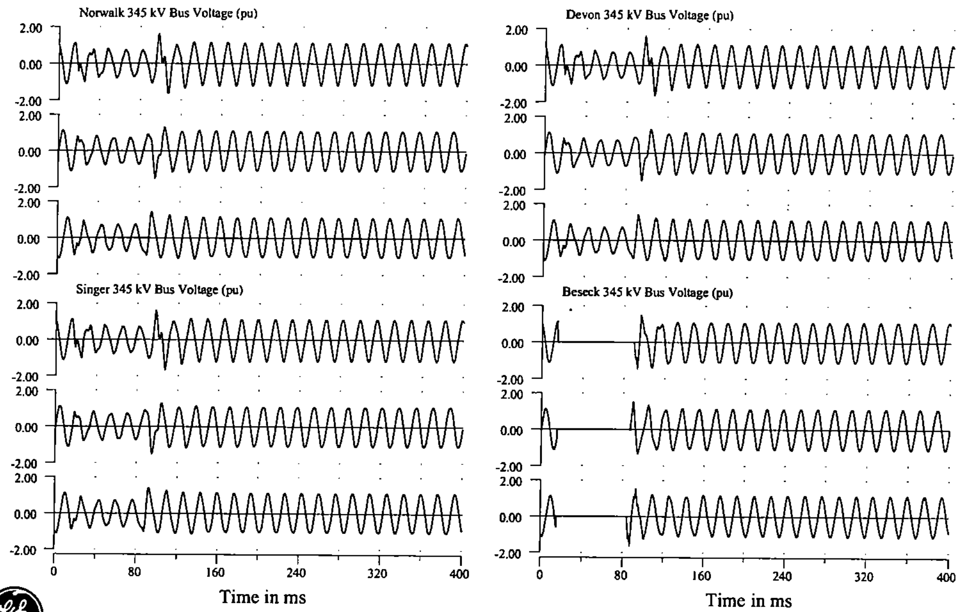
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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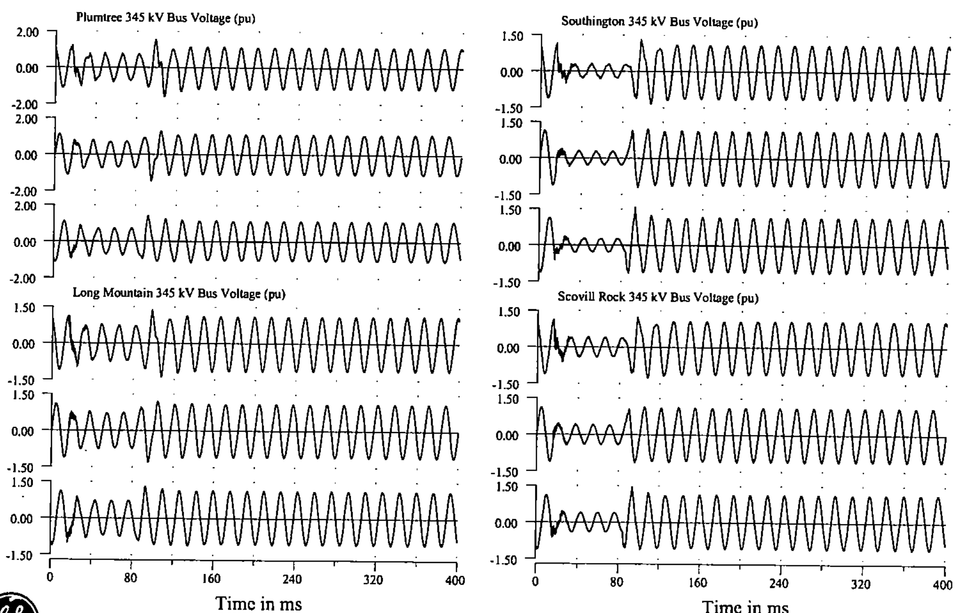
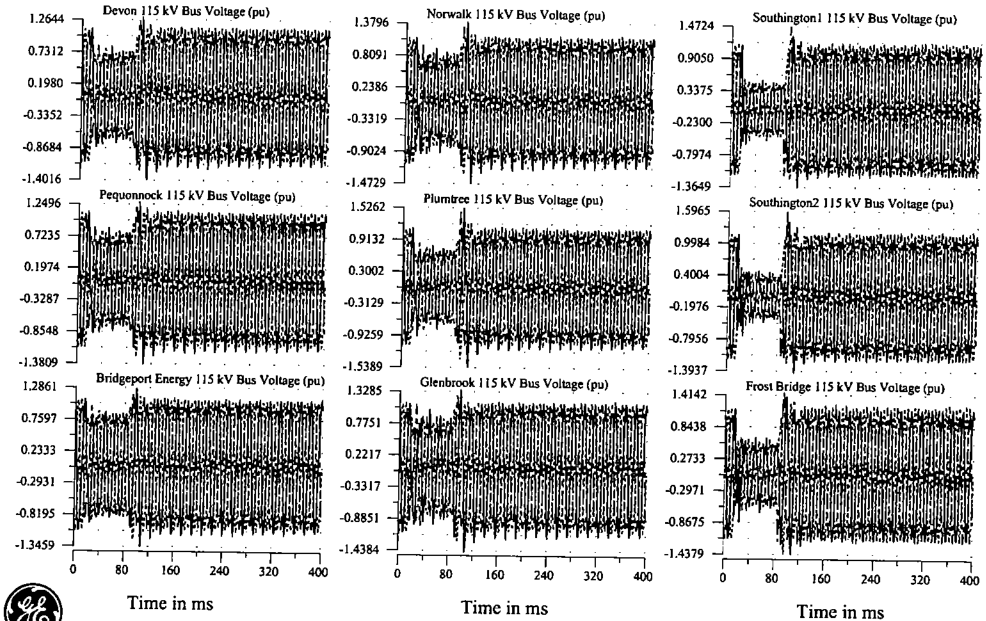
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_11_90
115 kV Bus Voltages and Capacitor Bank Locations



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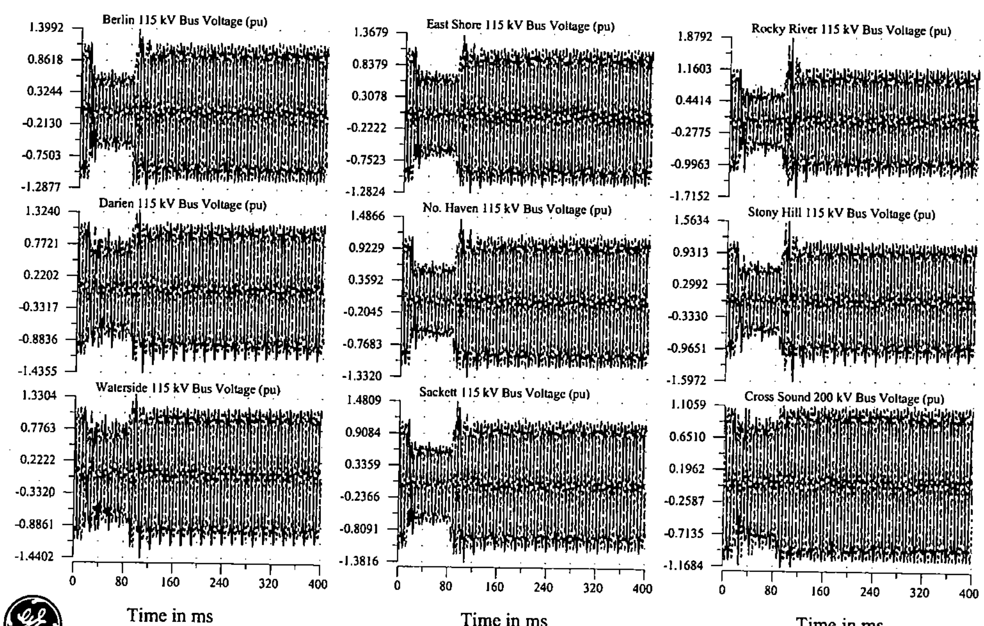
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_11_90
115 kV Bus Voltages and Capacitor Bank Locations



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

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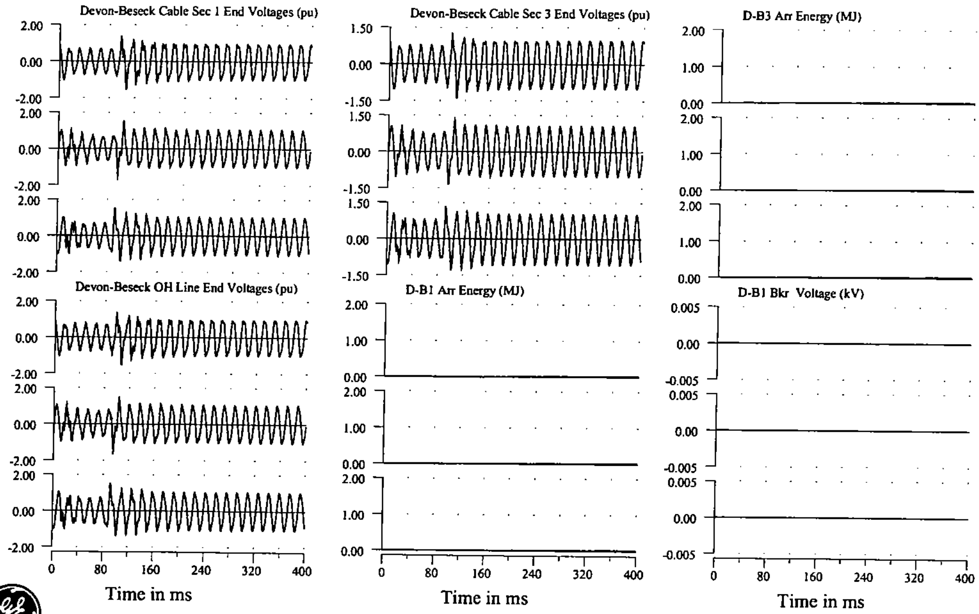
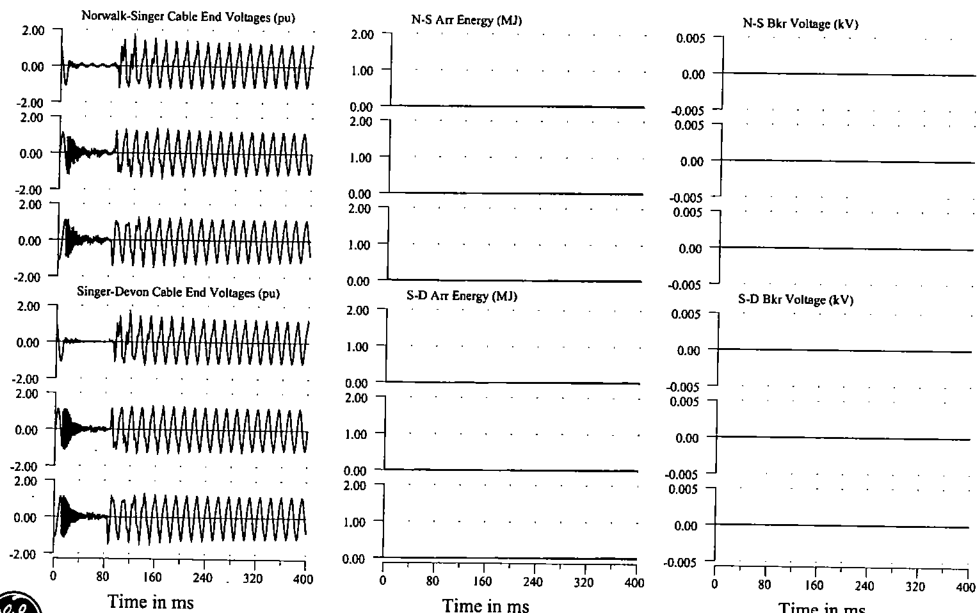
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



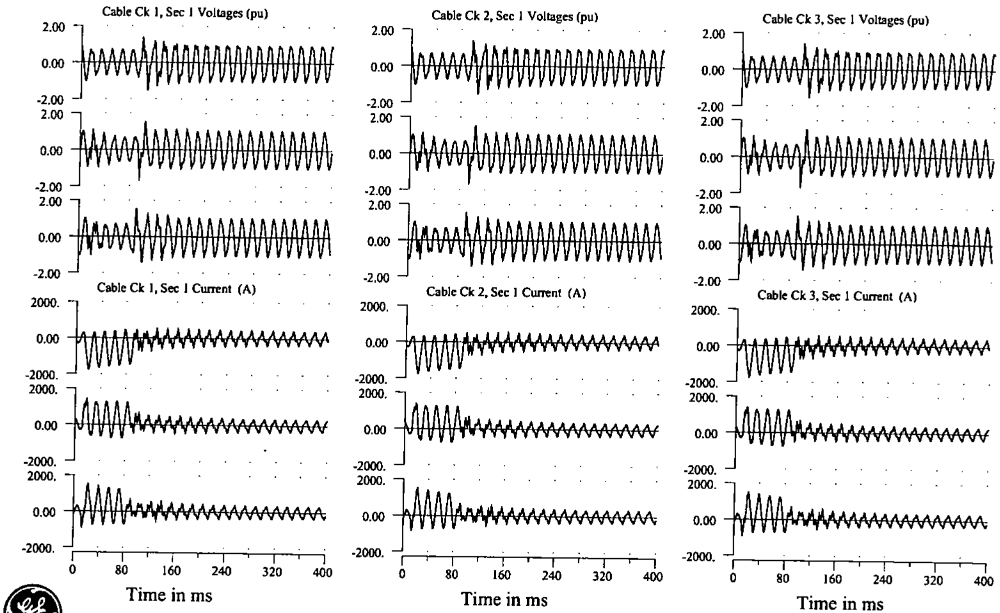
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_12_0

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_0
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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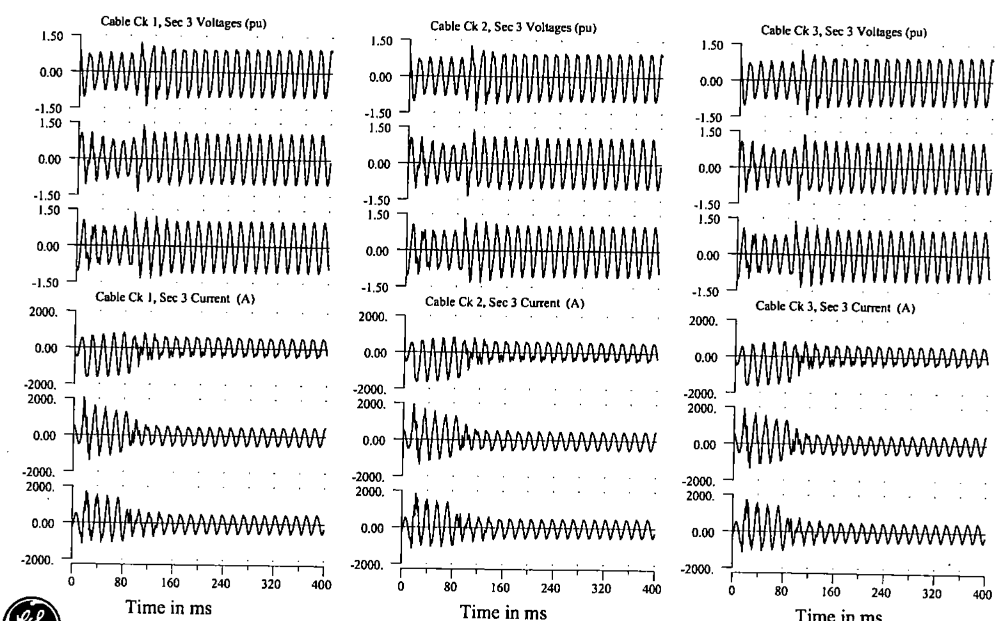
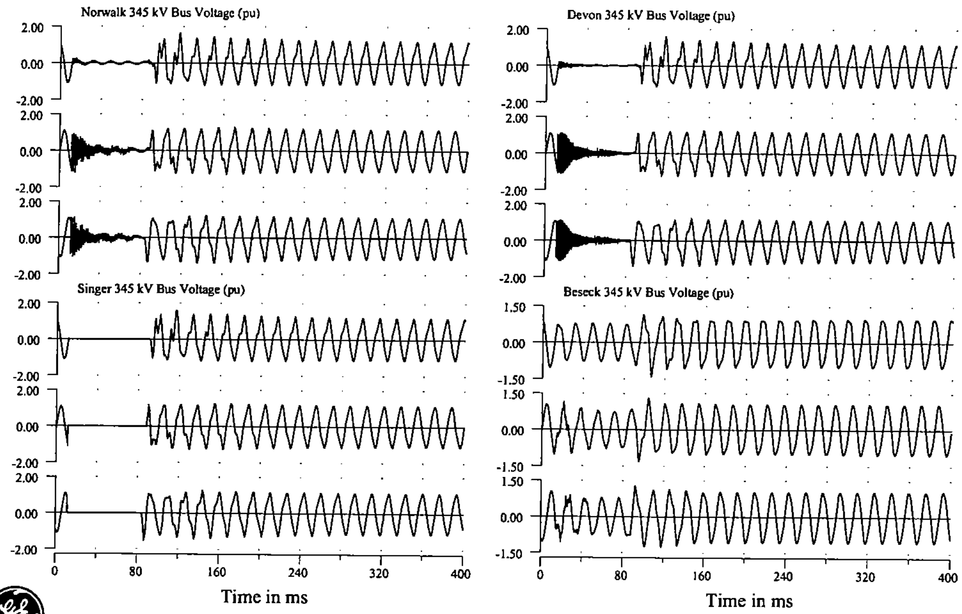
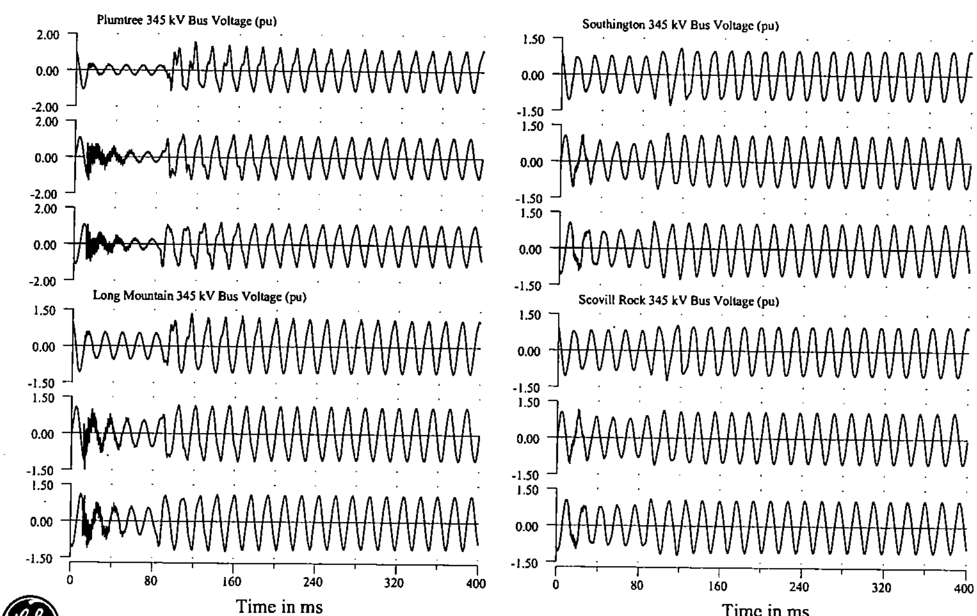
Devon-Beseck 345 kV Cables



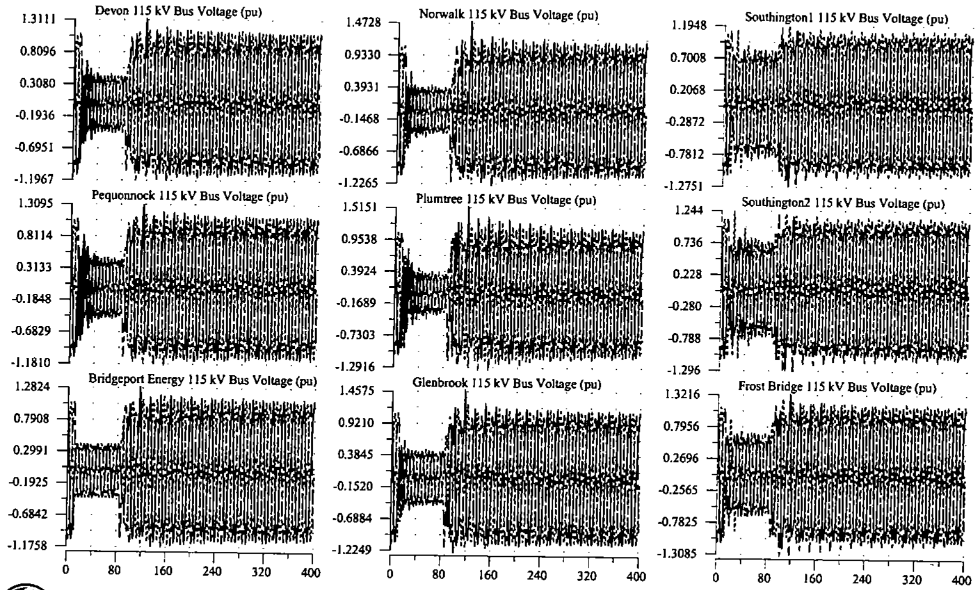
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_0
345 kV Bus Voltages



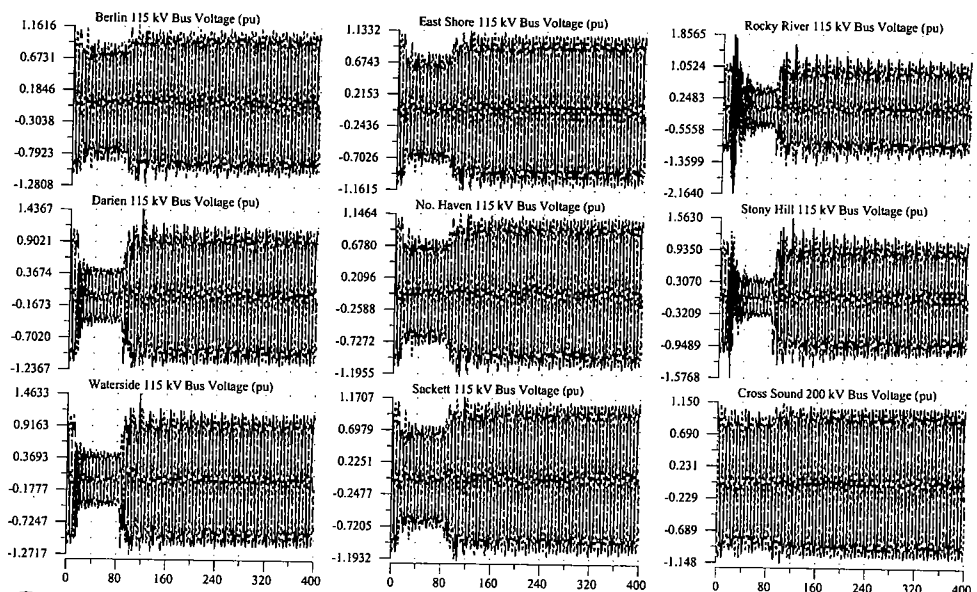
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_0
345 kV Bus Voltages



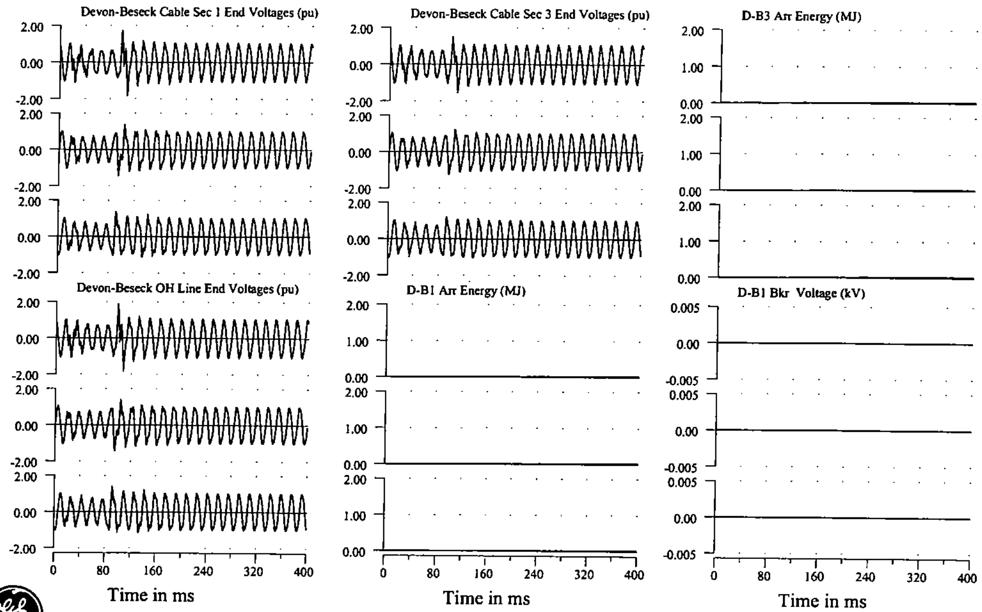
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_90
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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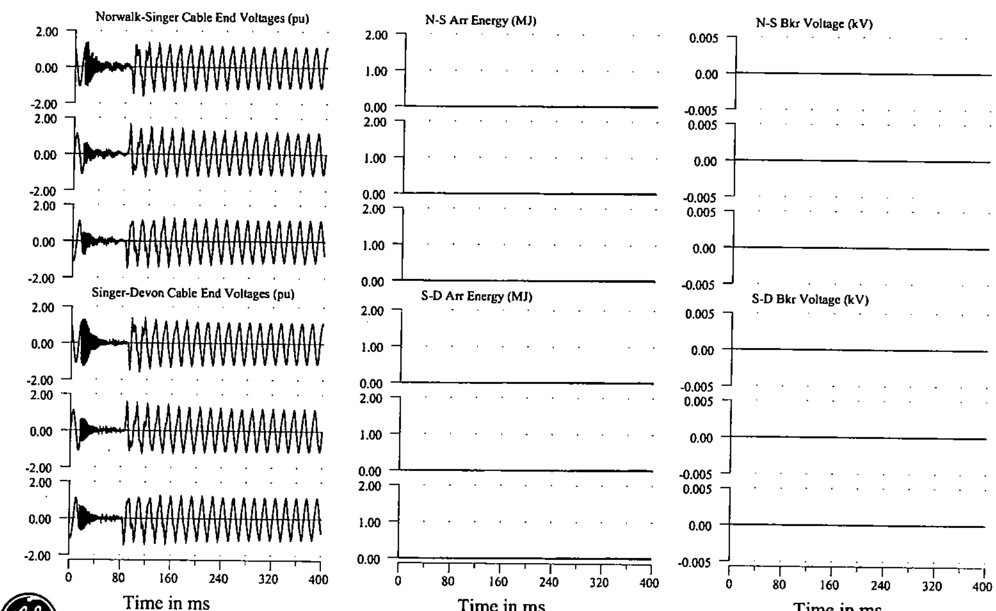
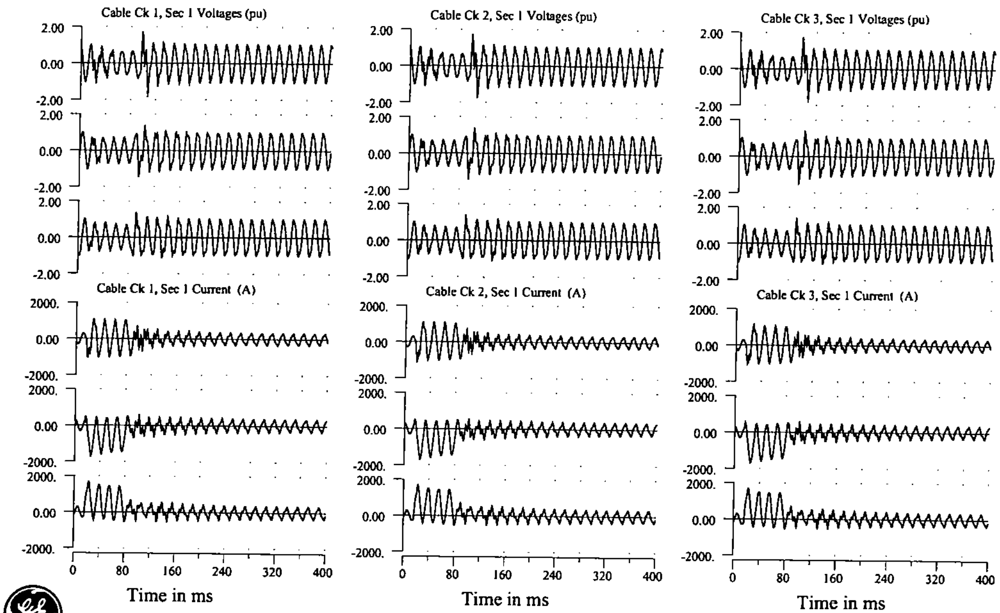
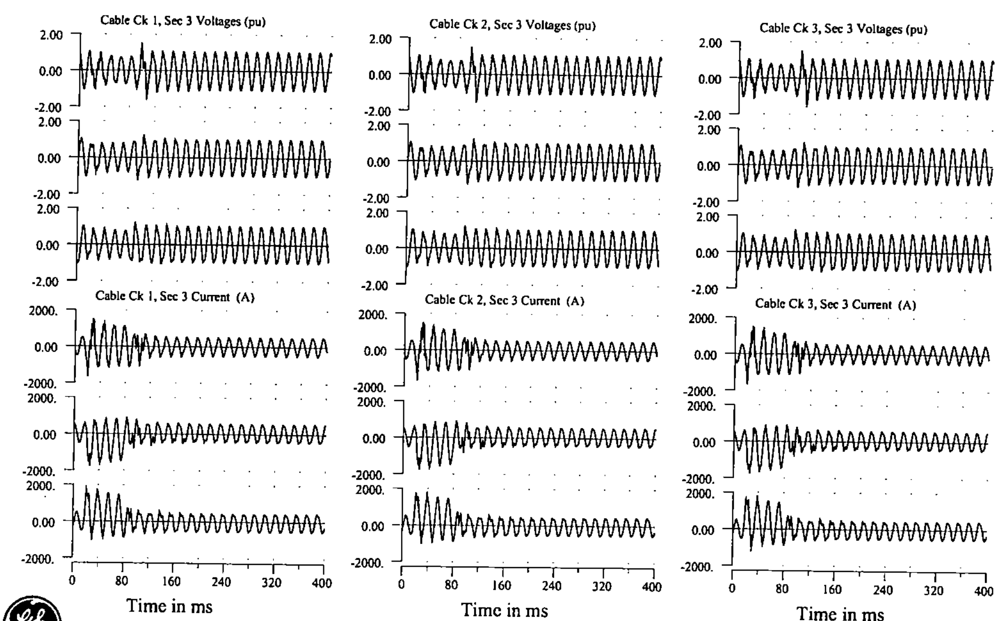
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



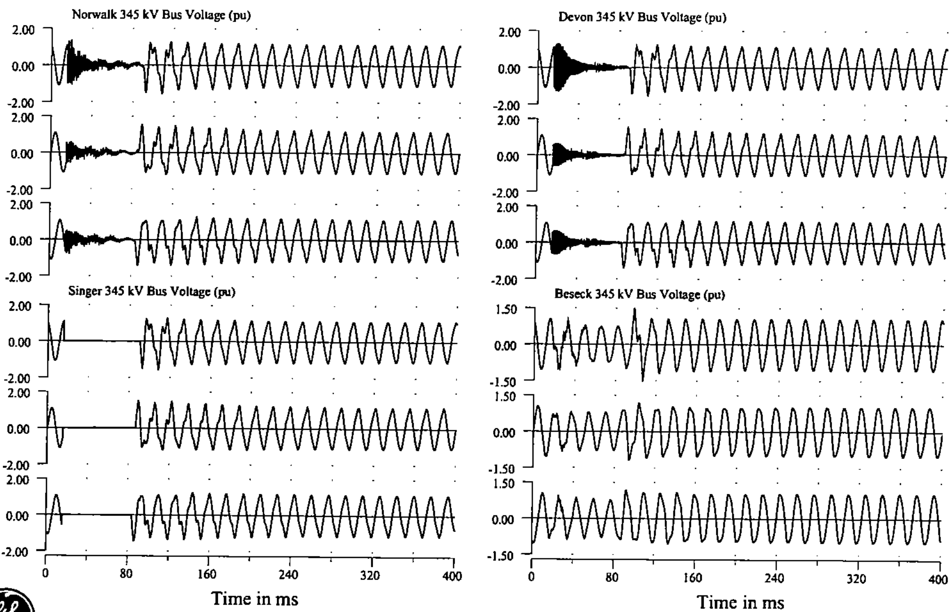
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_90
Devon-Beseck 345 kV Cables



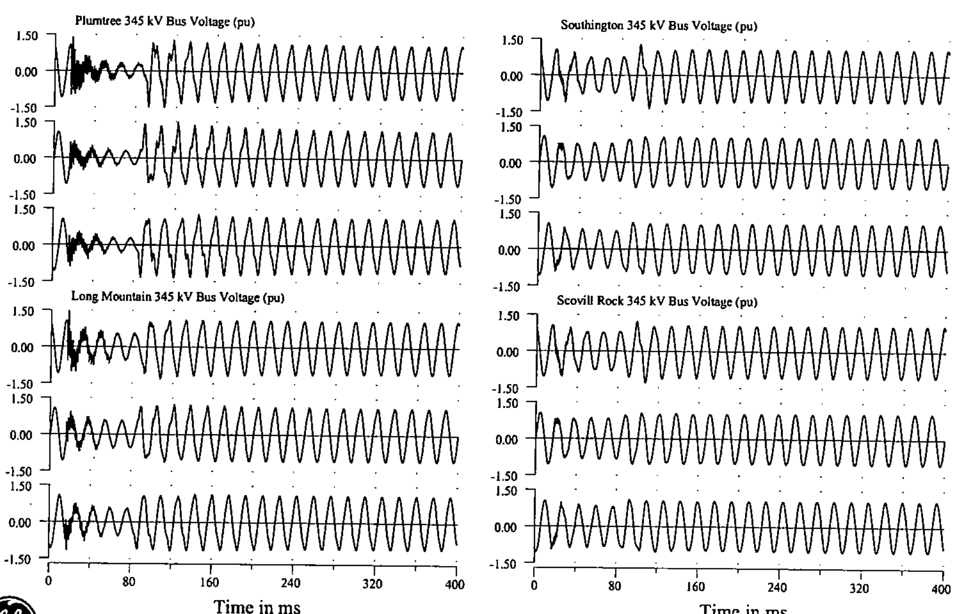
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_90
Devon-Beseck 345 kV Cables



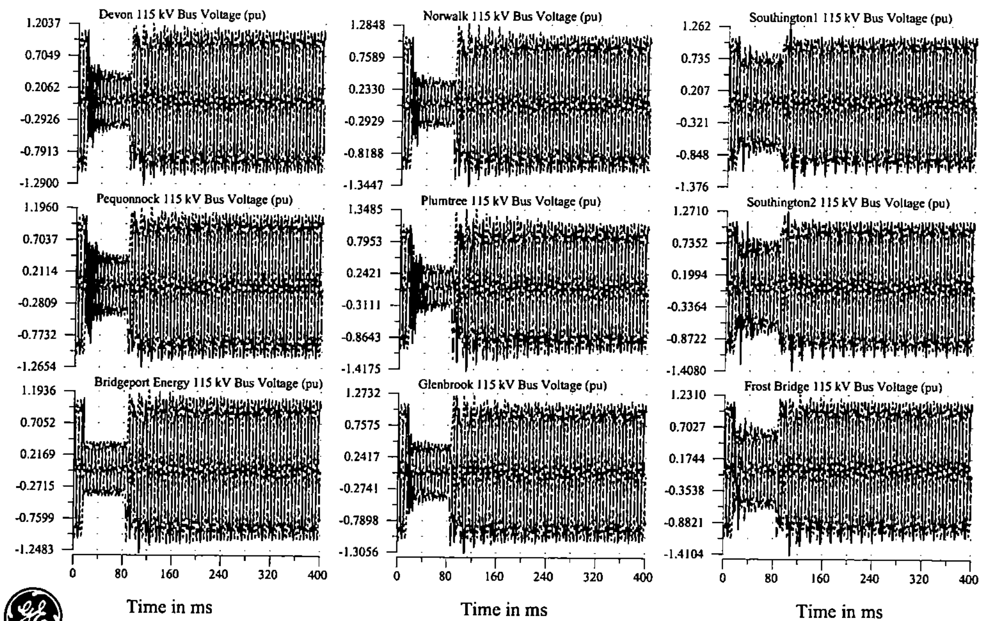
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_90
345 kV Bus Voltages



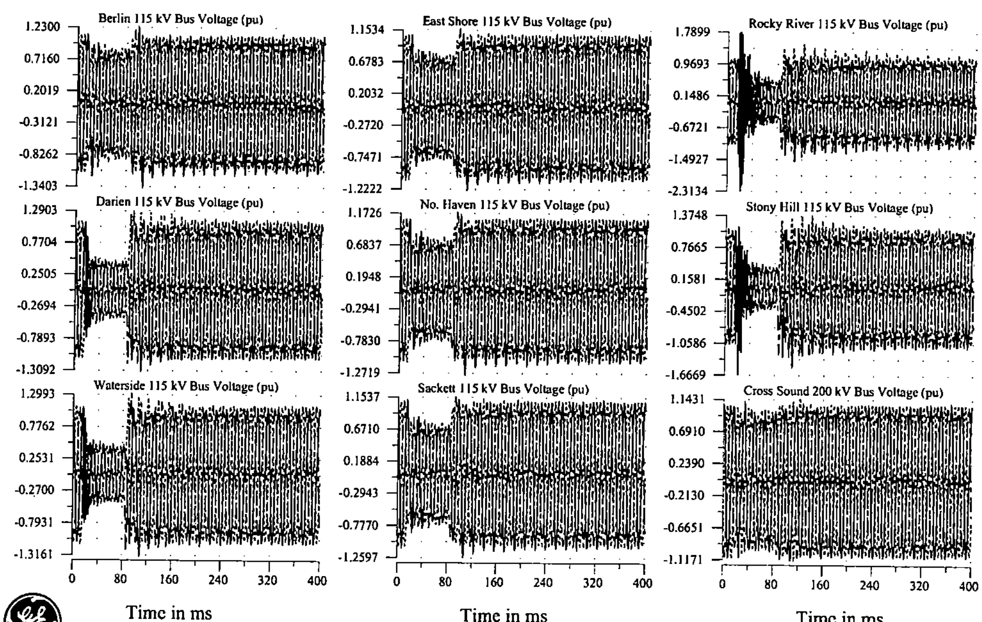
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_90
345 kV Bus Voltages



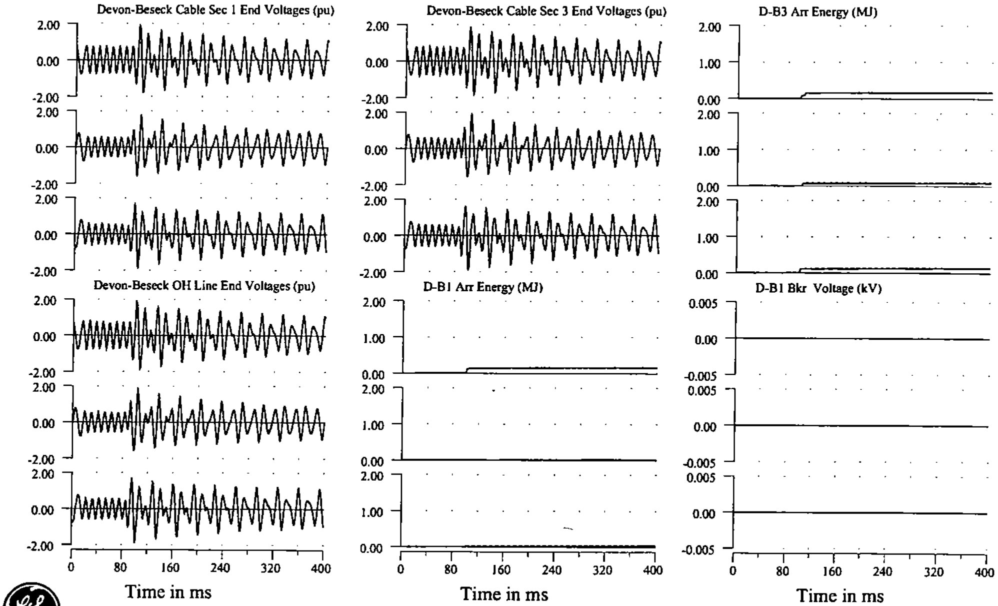
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_90
115 kV Bus Voltages and Capacitor Bank Locations



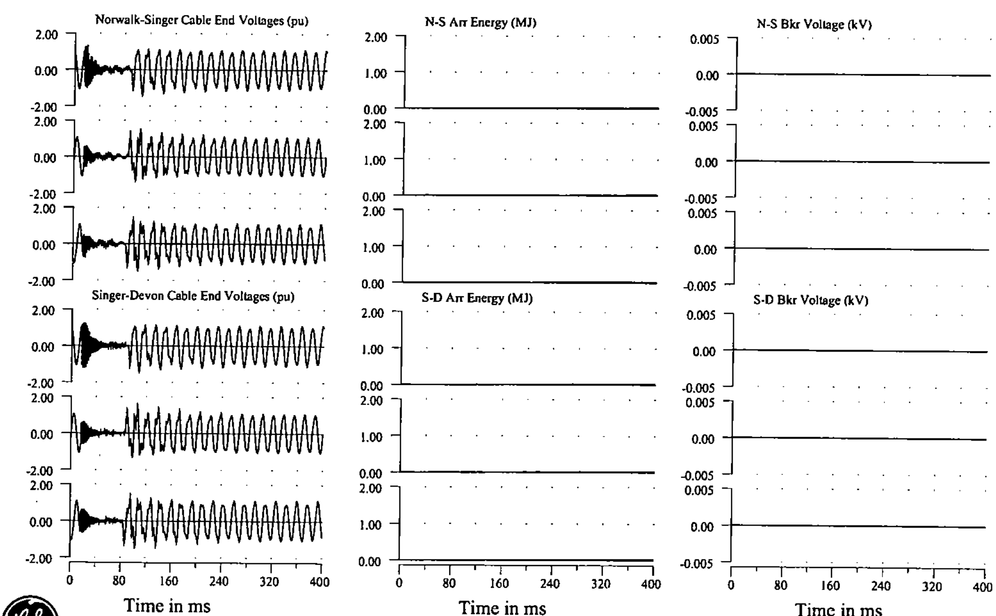
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12_90
115 kV Bus Voltages and Capacitor Bank Locations



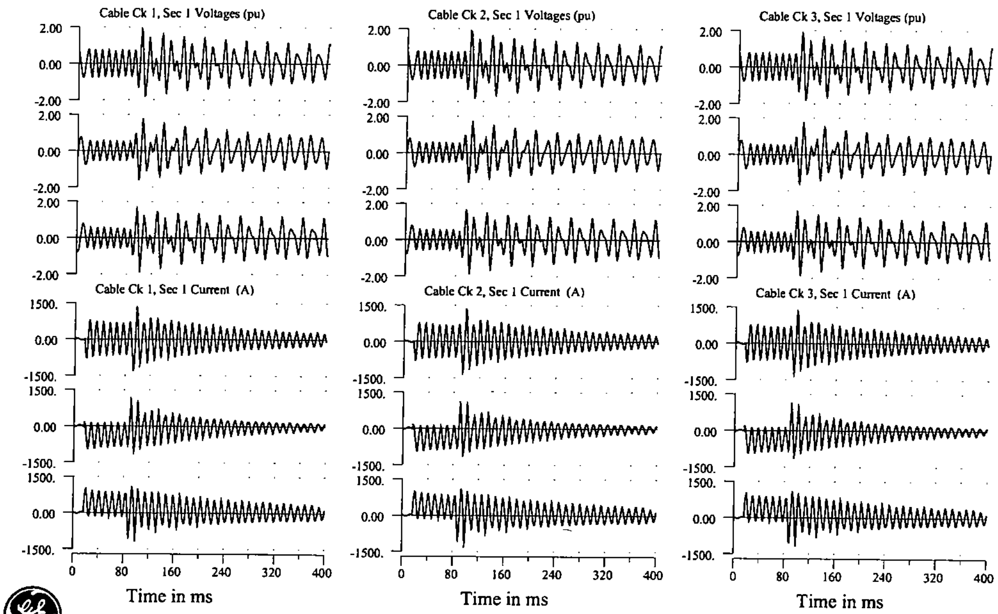
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12A_90
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



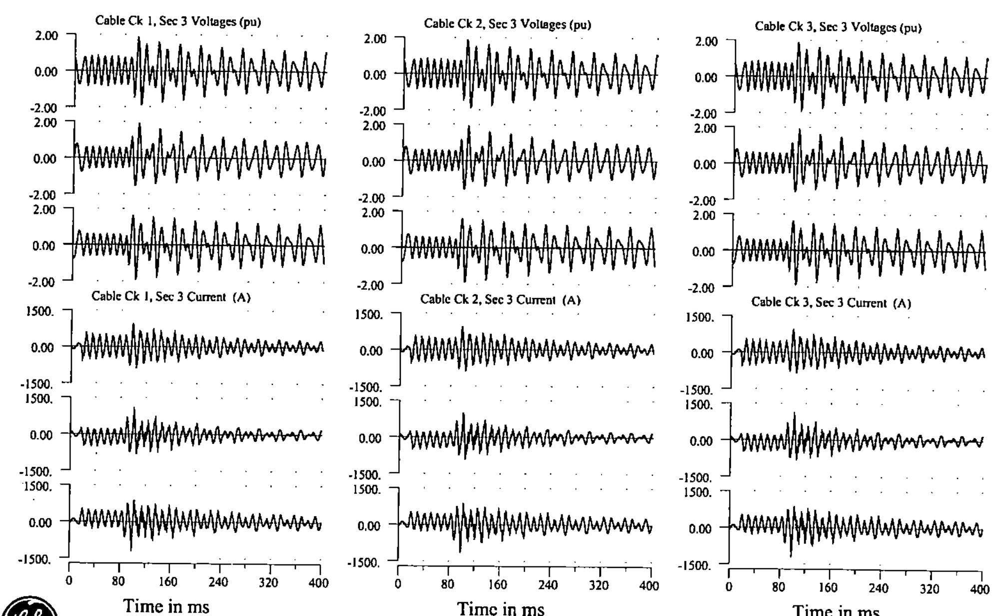
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12A_90
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



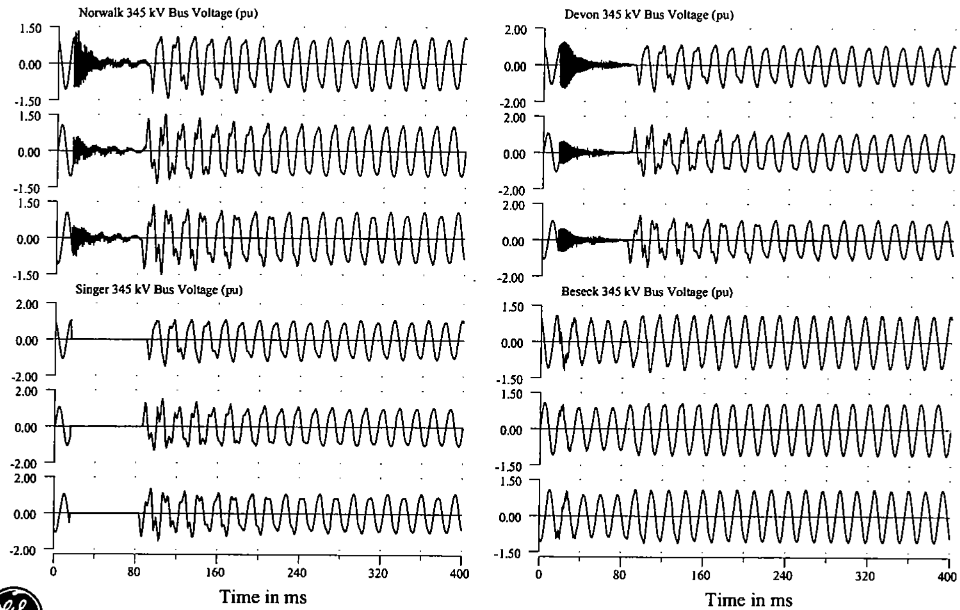
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12A_90
Devon-Beseck 345 kV Cables



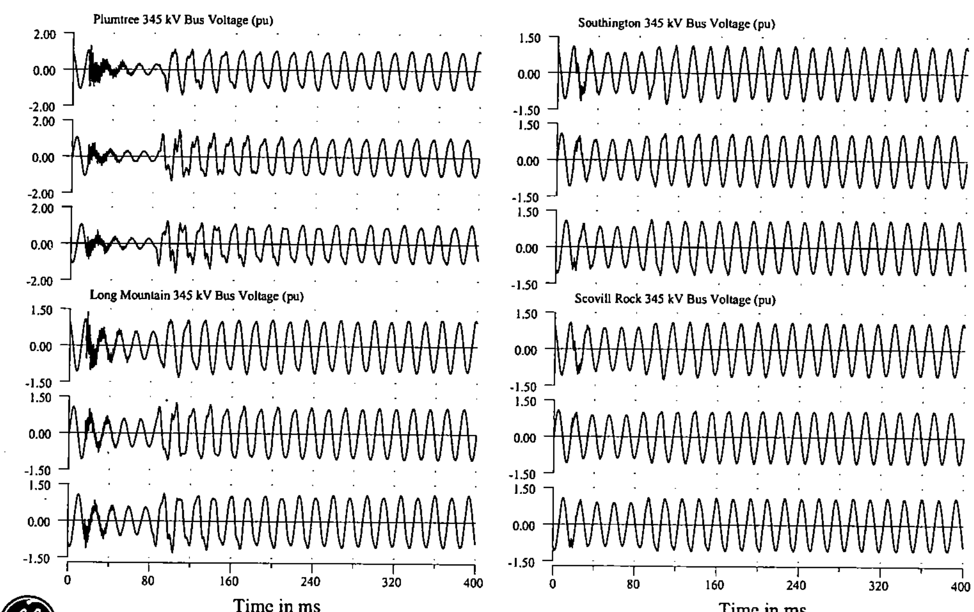
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12A_90
Devon-Beseck 345 kV Cables



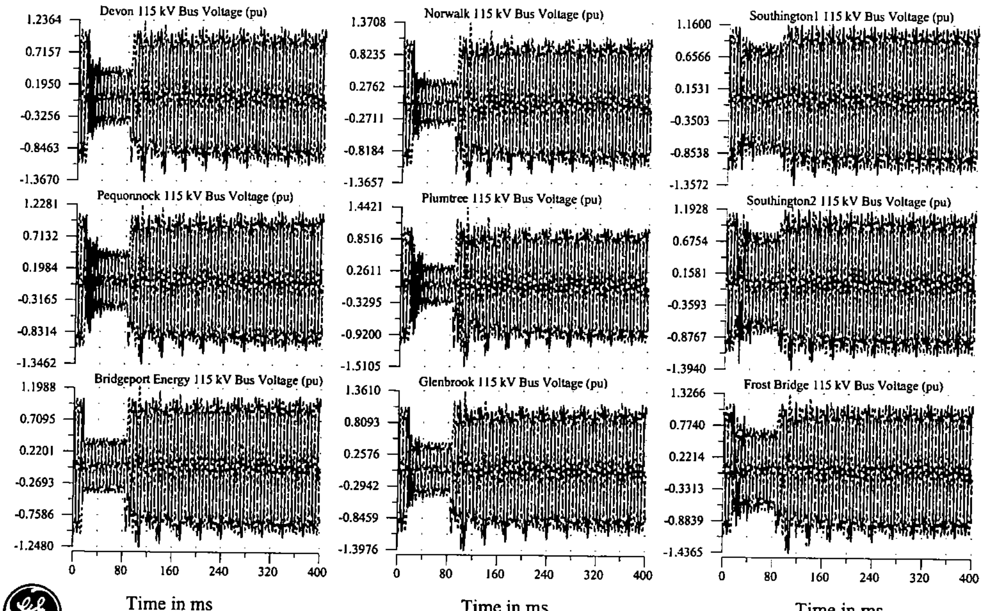
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12A_90
345 kV Bus Voltages



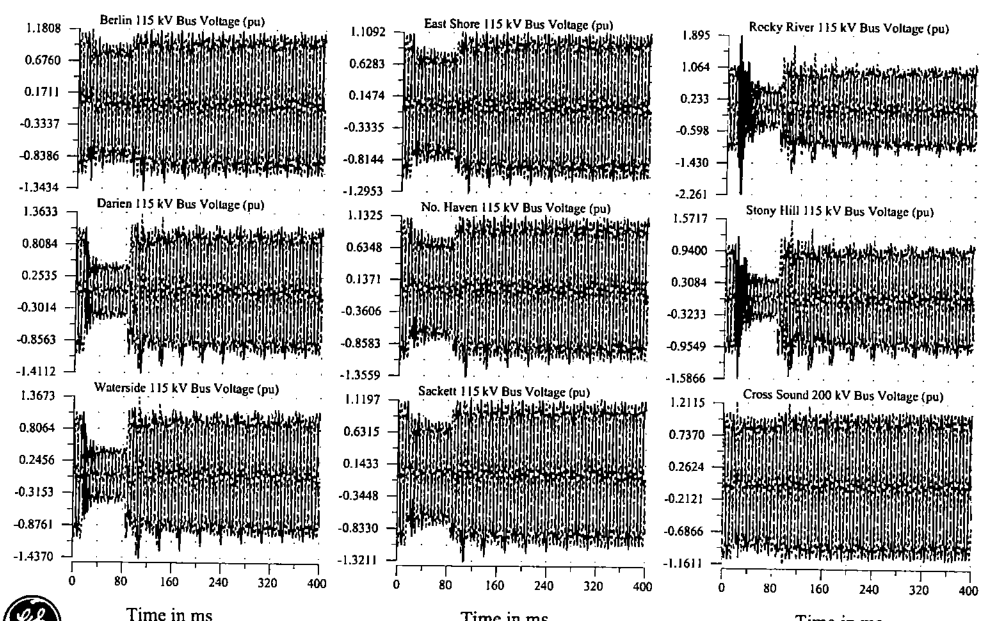
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12A_90
345 kV Bus Voltages



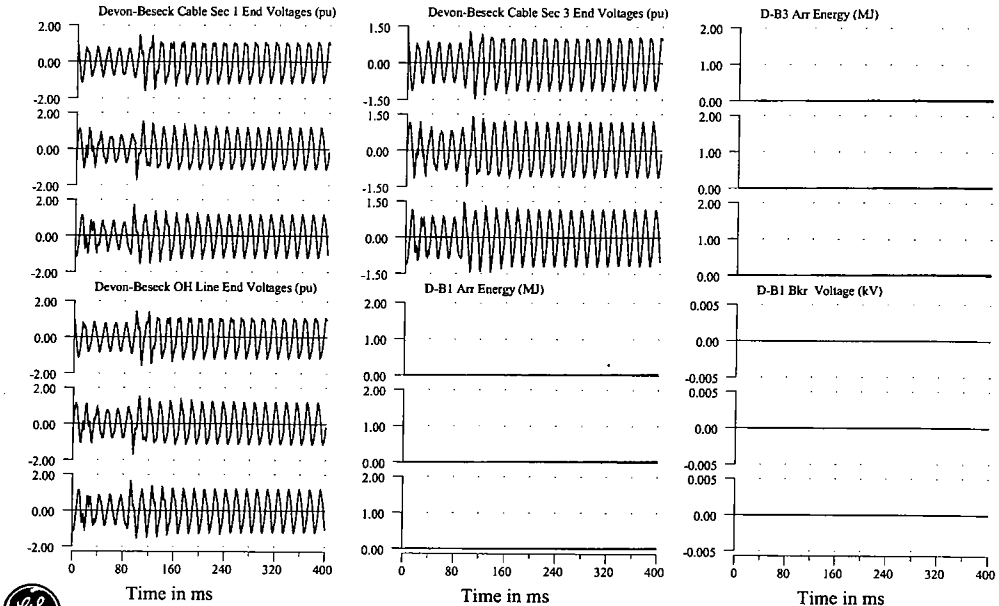
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12A_90
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_12A_90
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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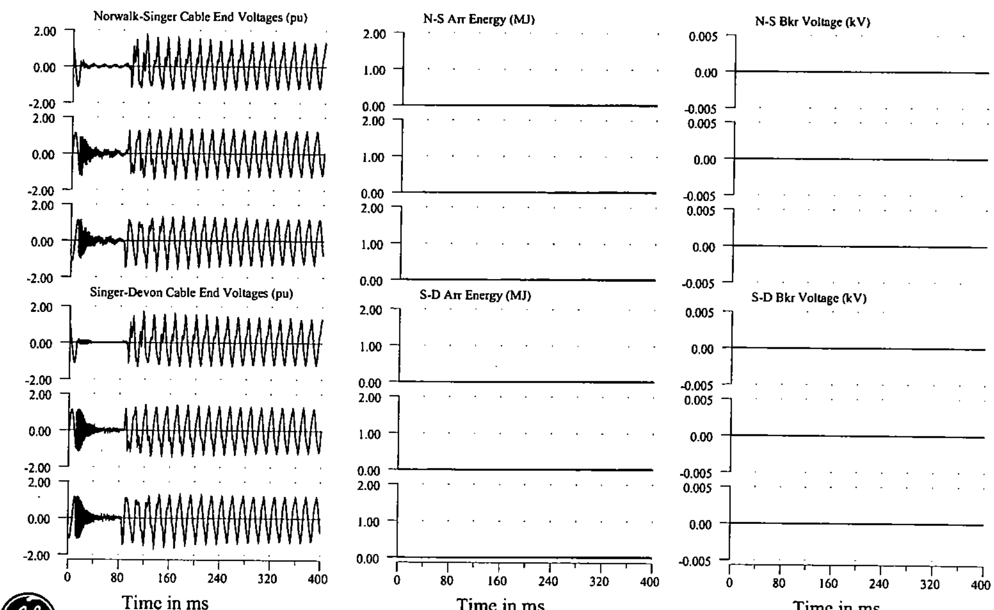
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_0
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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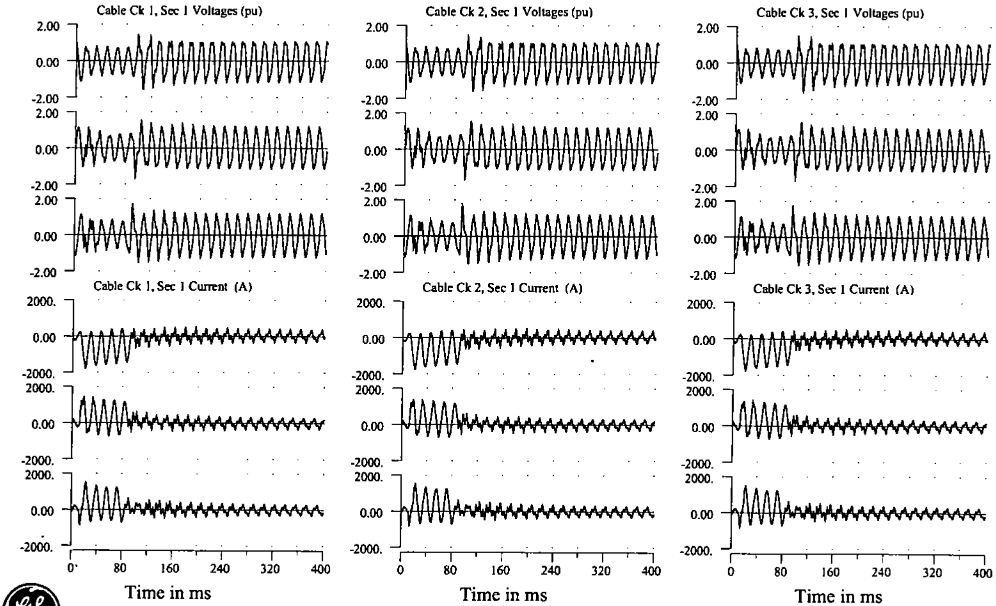
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_0
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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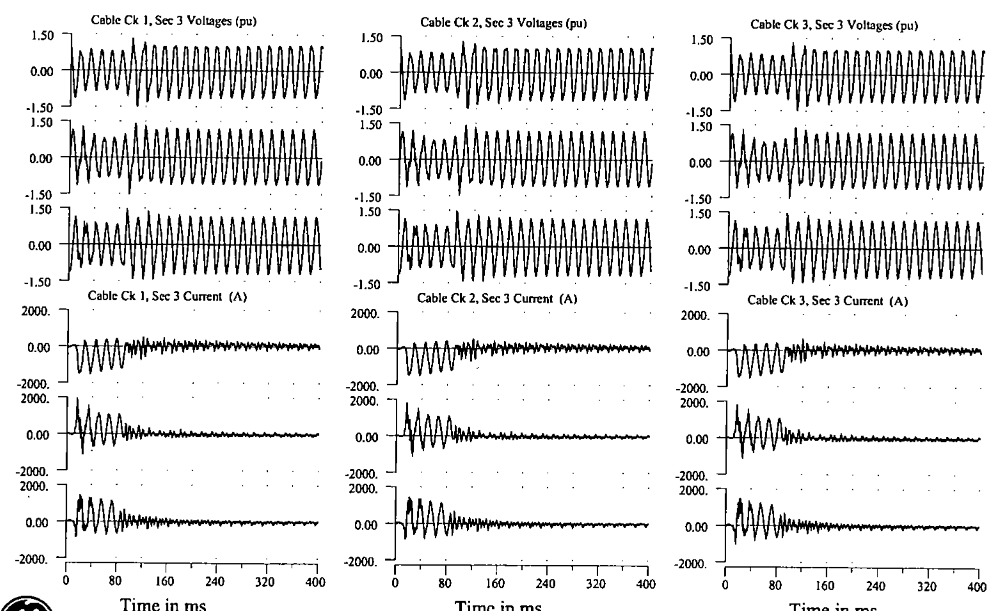
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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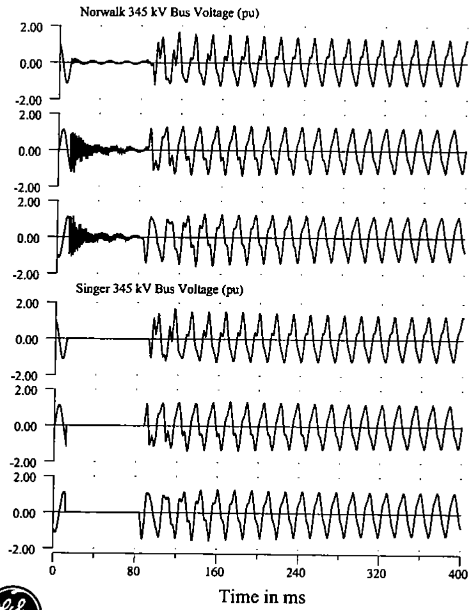
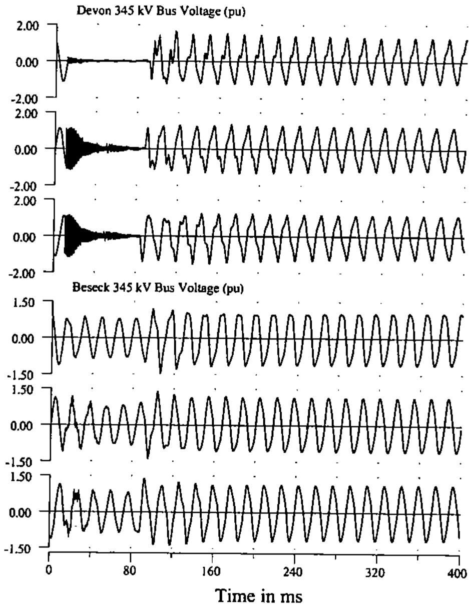
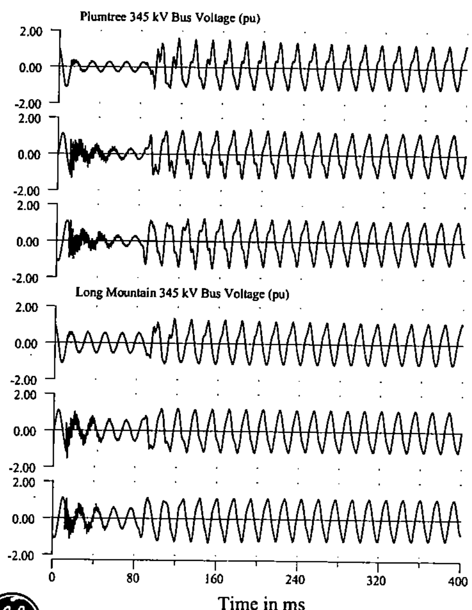
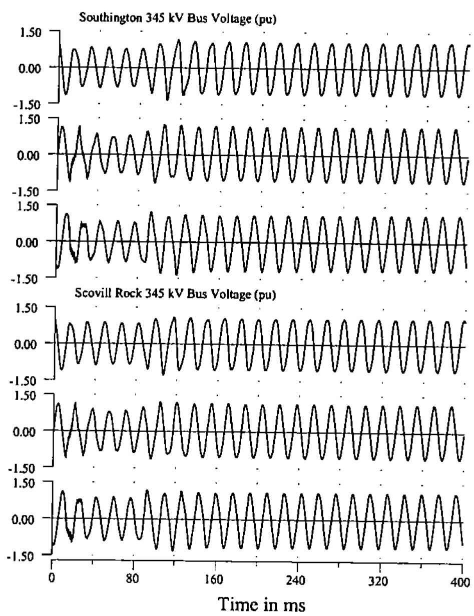
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_0
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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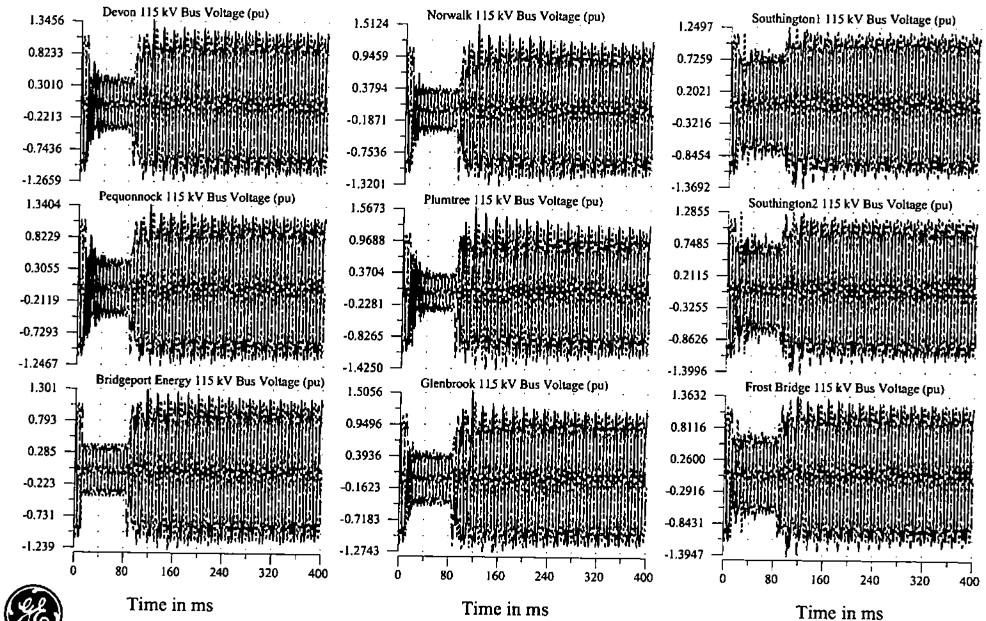
115 kV Bus Voltages and Capacitor Bank Locations



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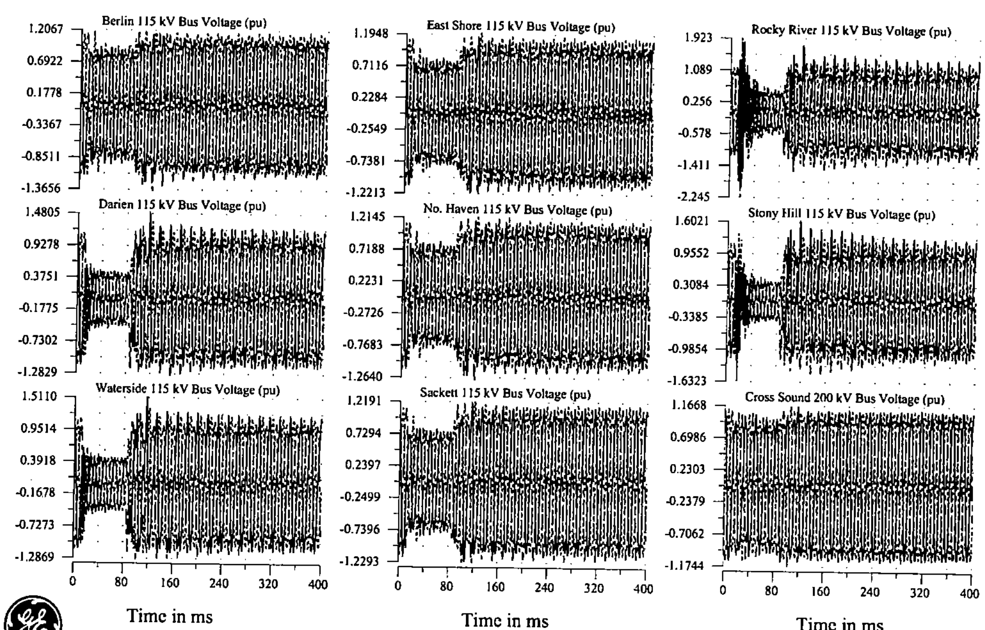
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_0
115 kV Bus Voltages and Capacitor Bank Locations



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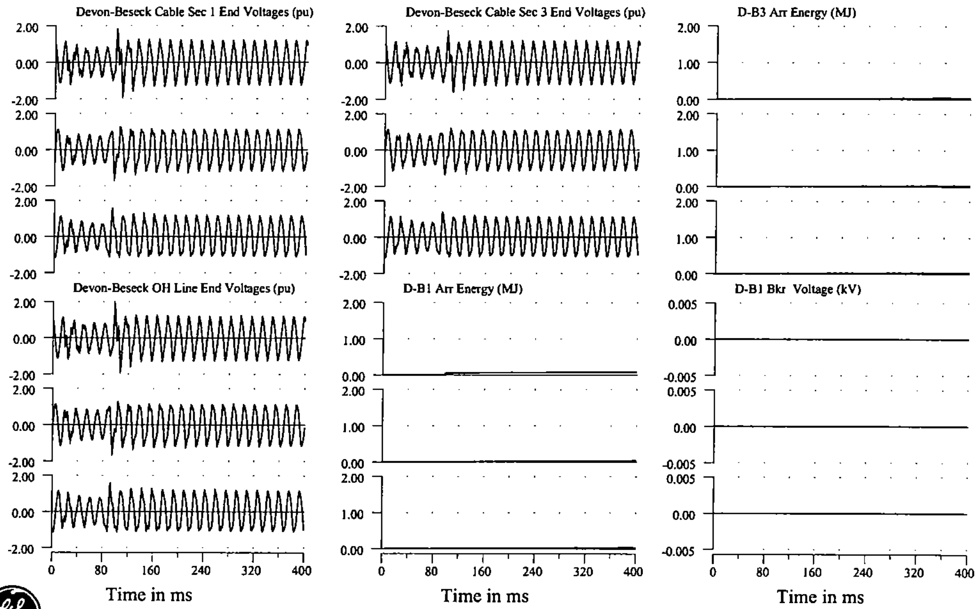
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_90
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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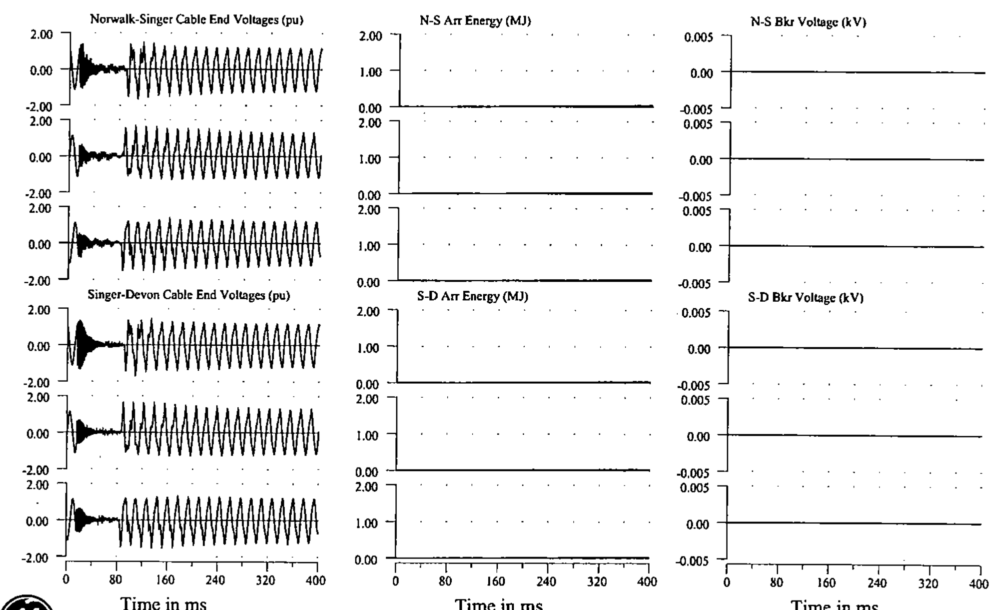
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_90
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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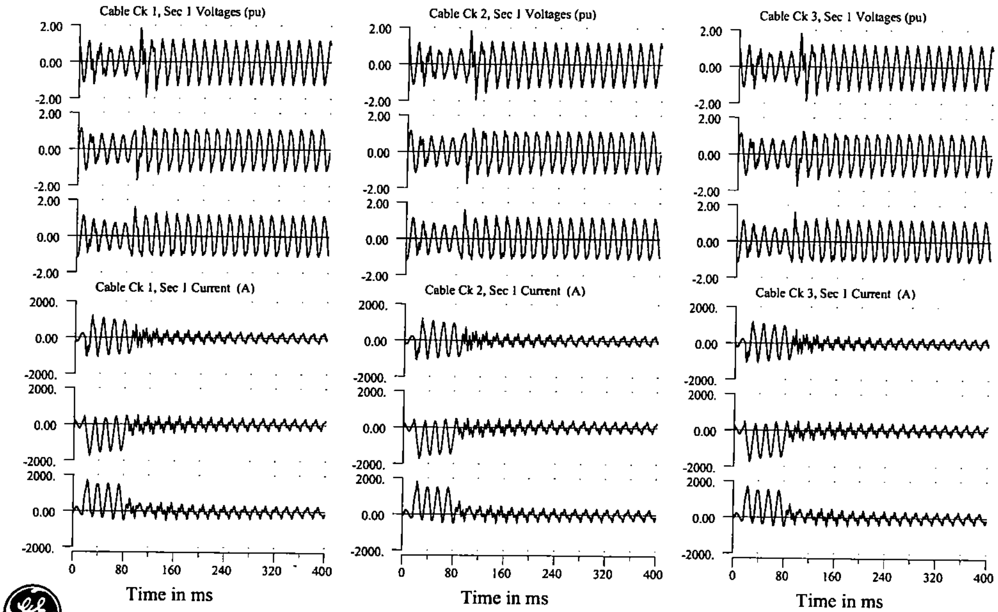
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_90
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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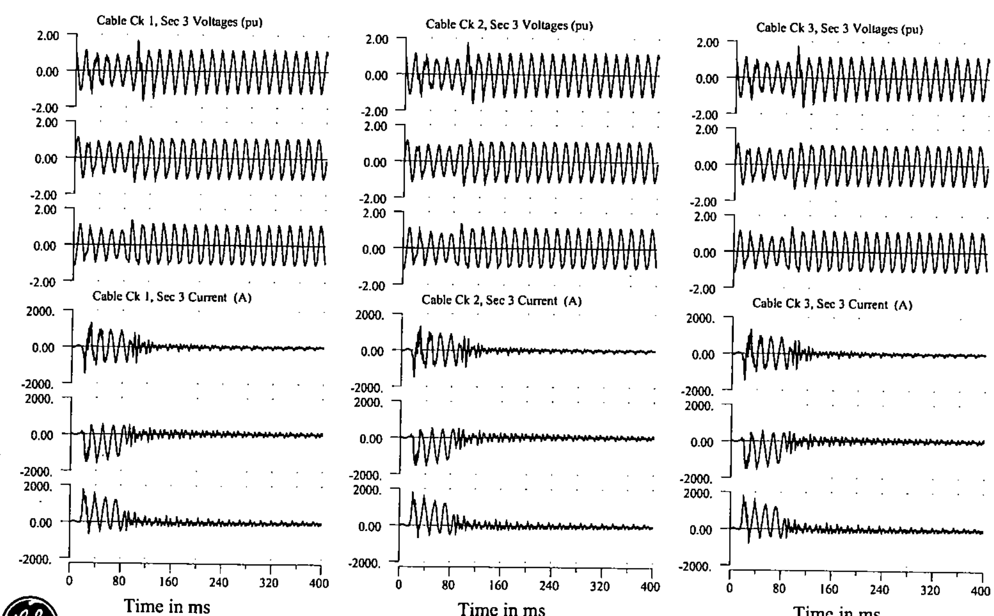
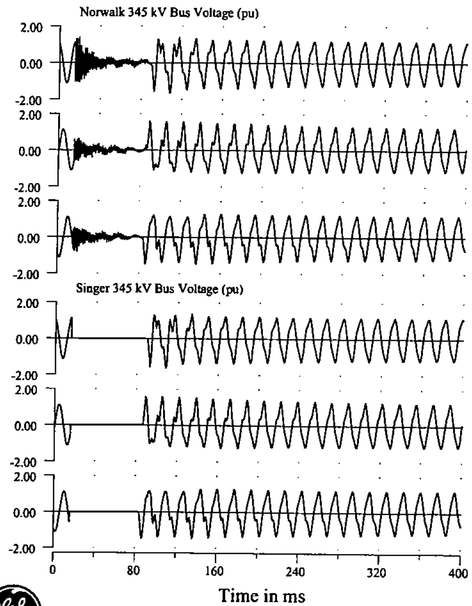
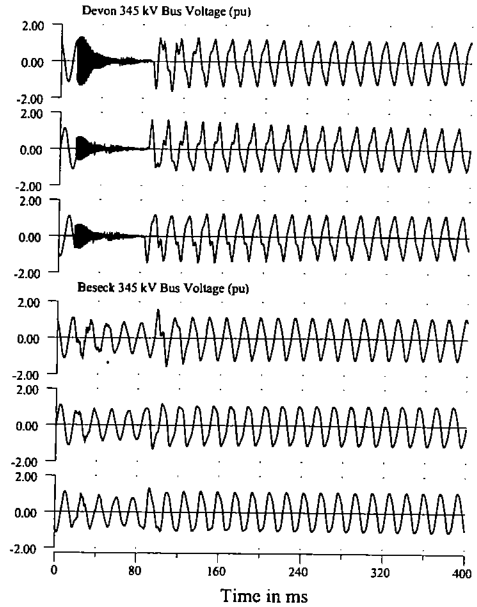
Devon-Beseck 345 kV Cables

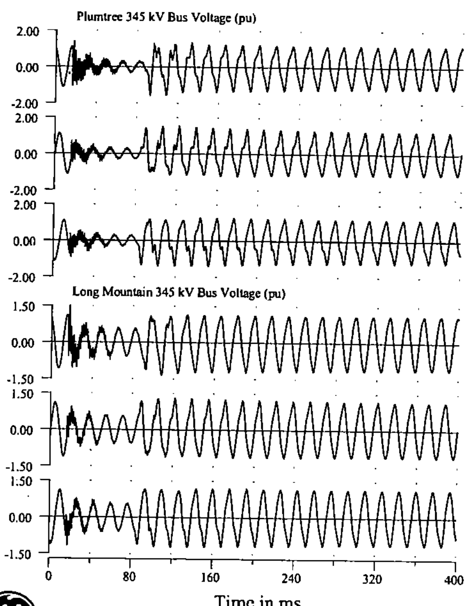


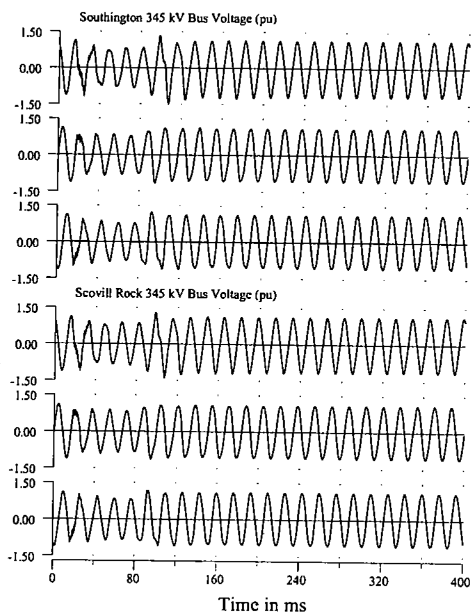
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_90
345 kV Bus Voltages



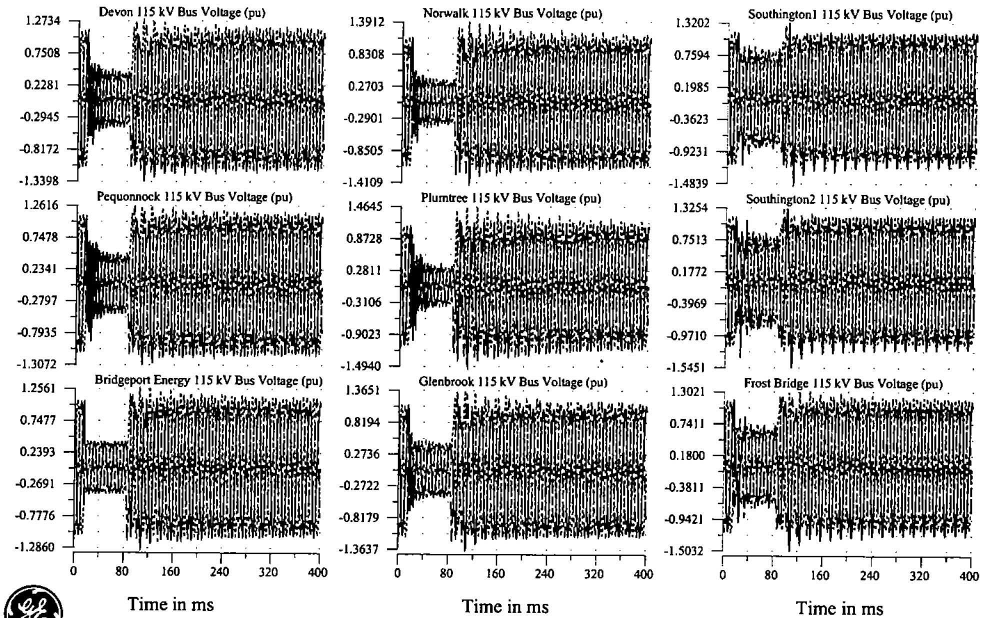


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_90
345 kV Bus Voltages

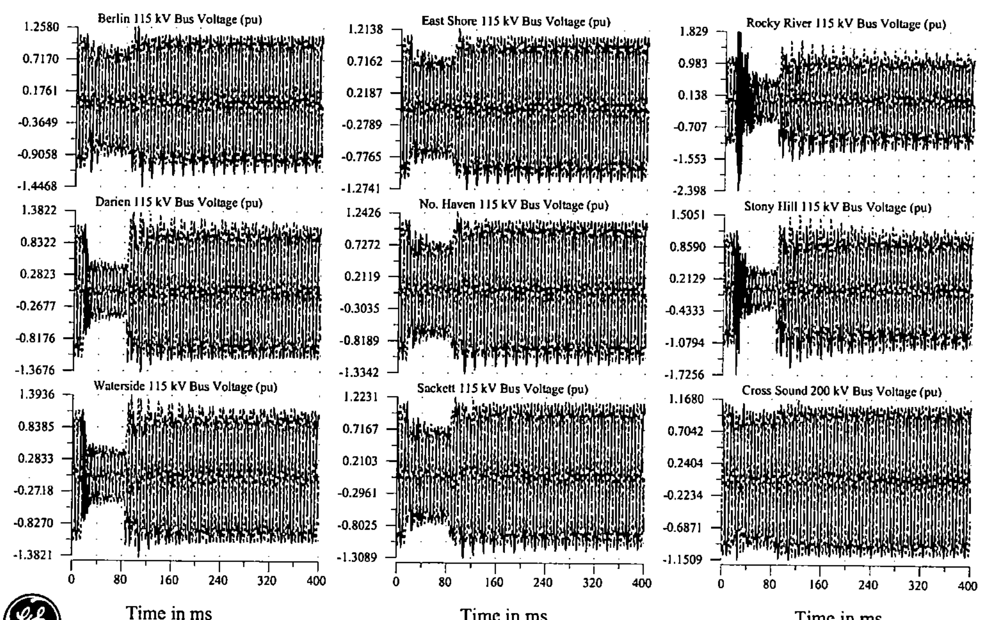




Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_90
115 kV Bus Voltages and Capacitor Bank Locations



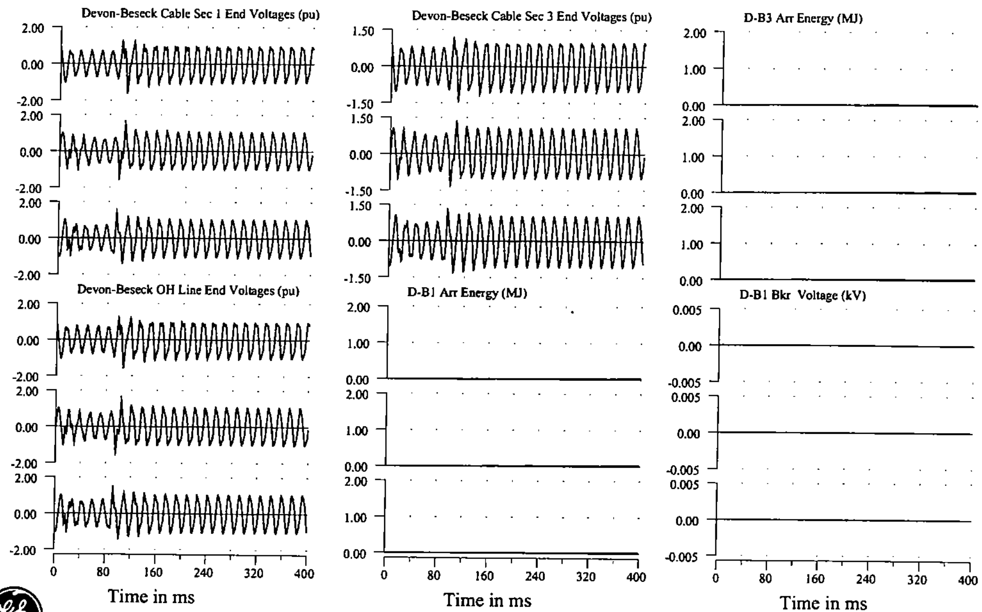
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_13_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_14_0

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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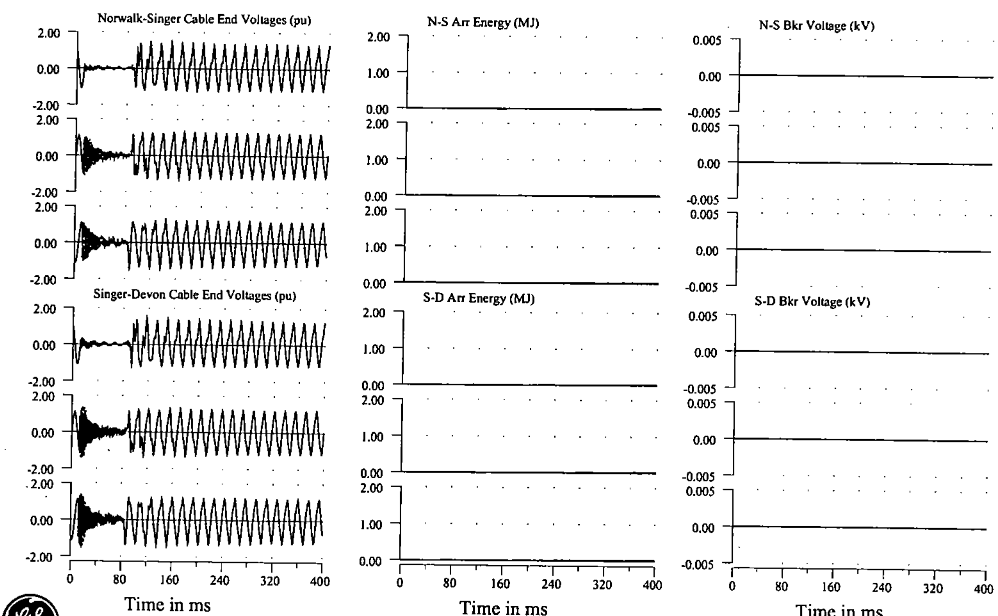
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_14_0

Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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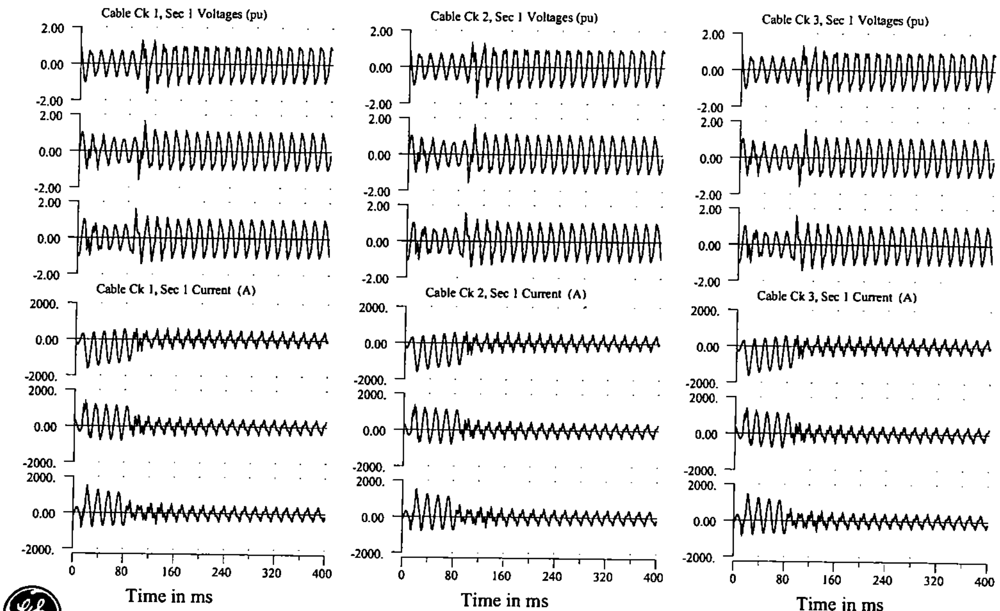
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_14_0
Devon-Beseck 345 kV Cables



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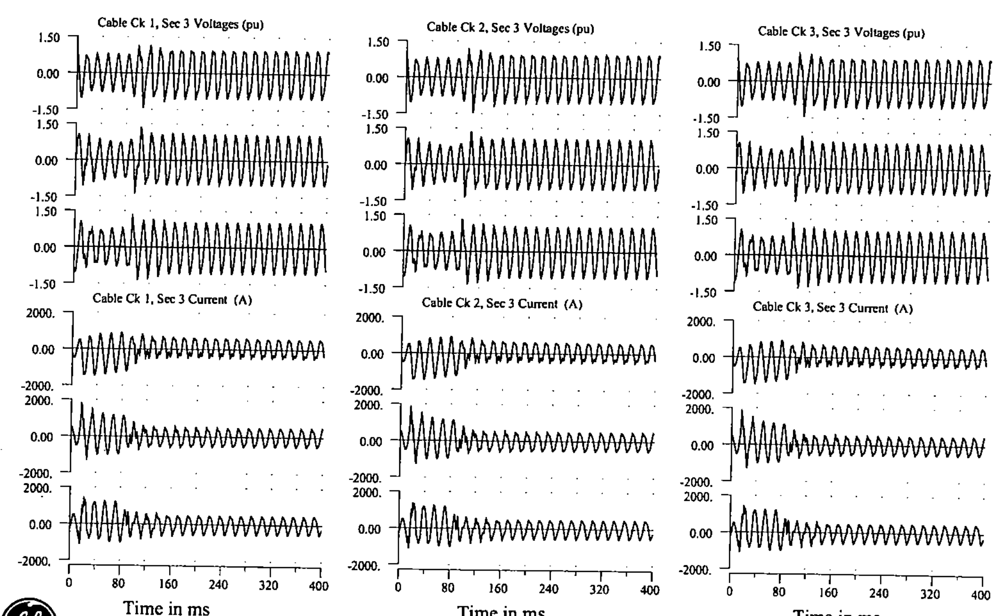
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_14_0
Devon-Beseck 345 kV Cables



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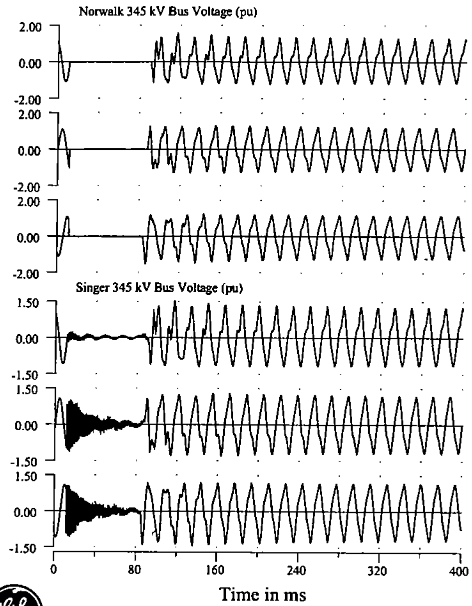
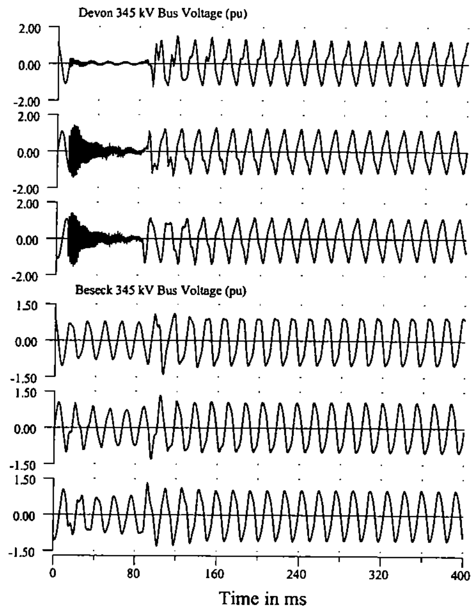
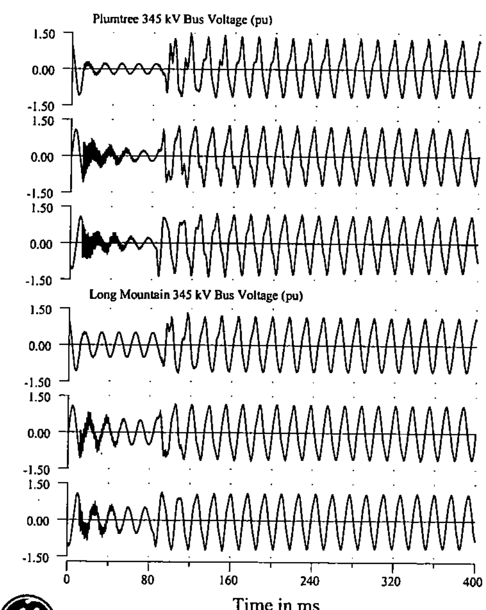
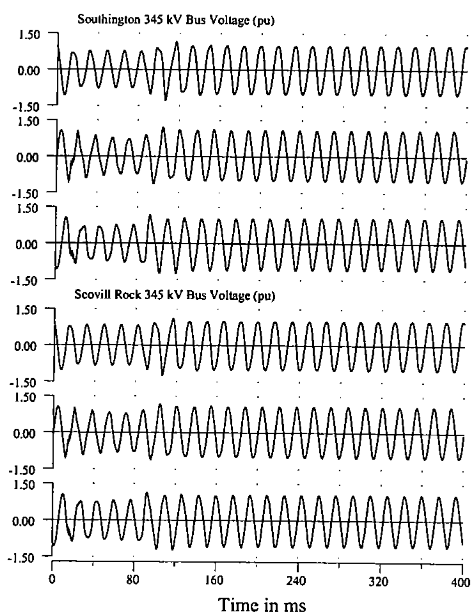
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_14_0
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_14_0
345 kV Bus Voltages

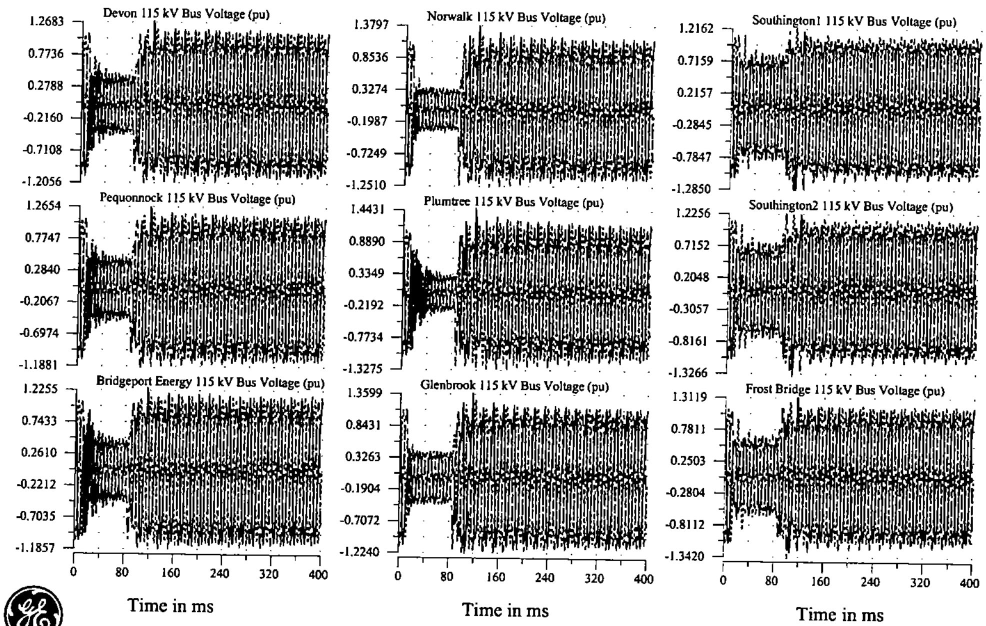




Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_14_0

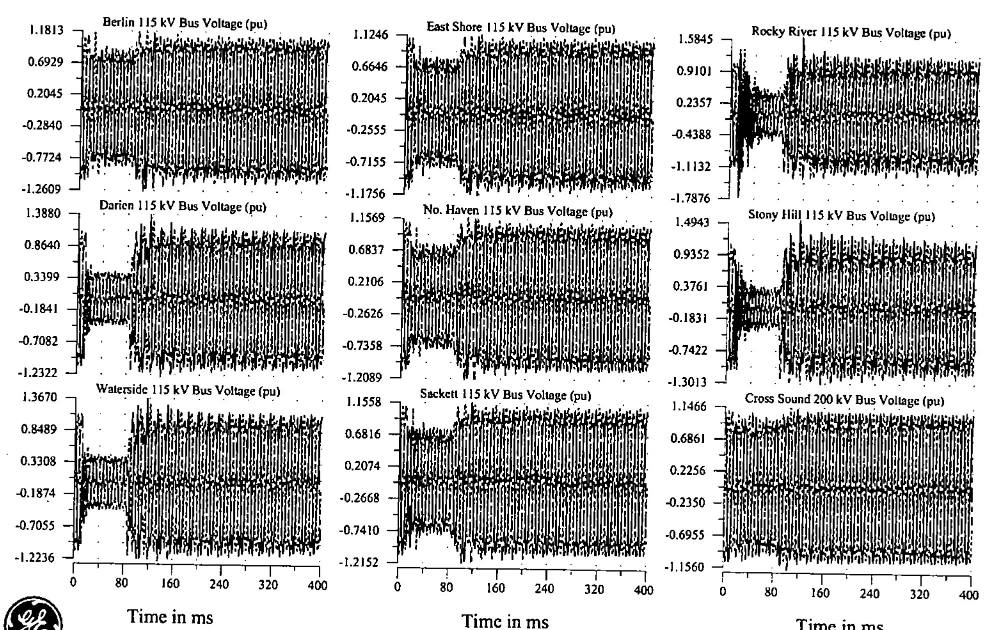
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_14_0

115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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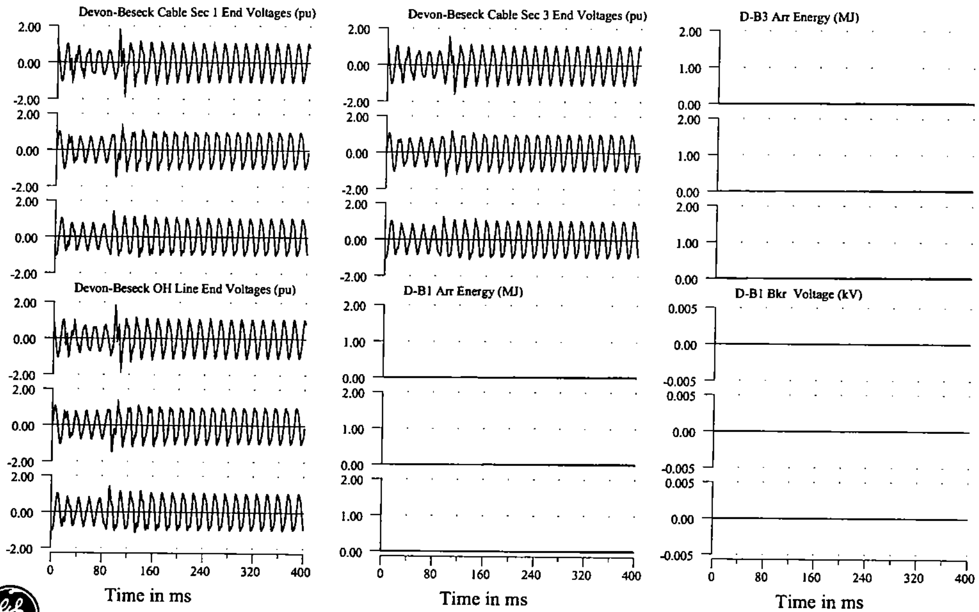
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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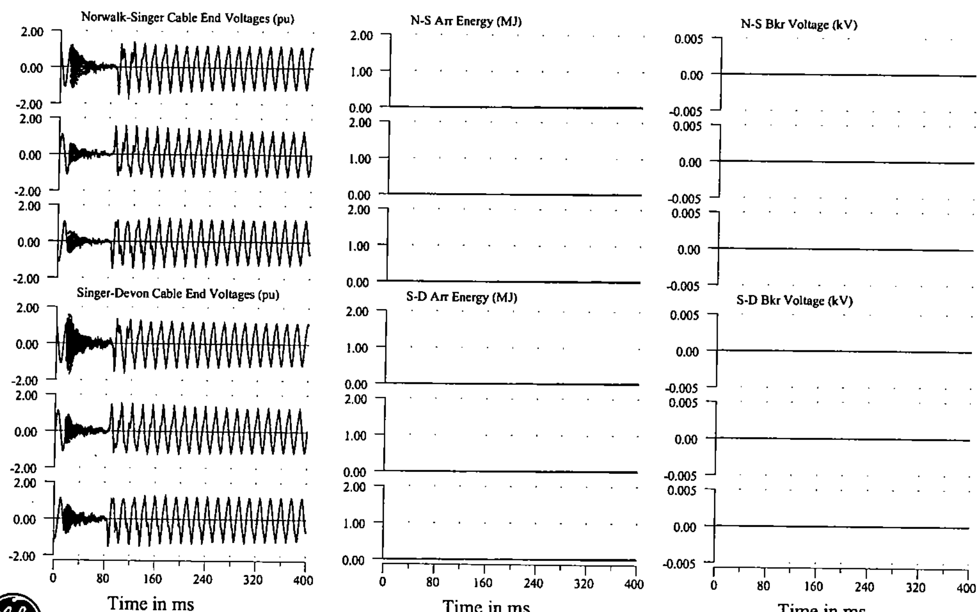
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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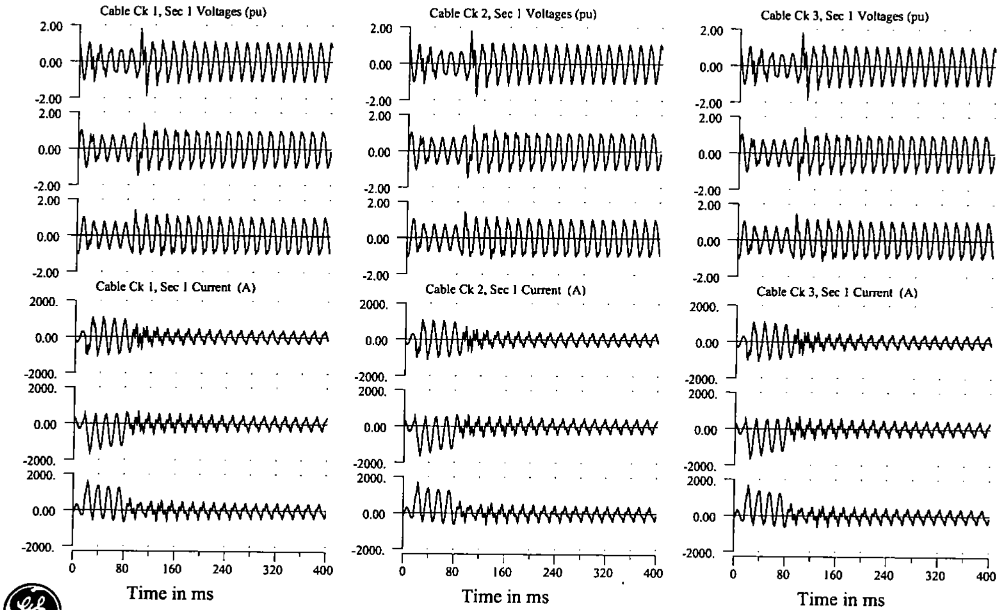
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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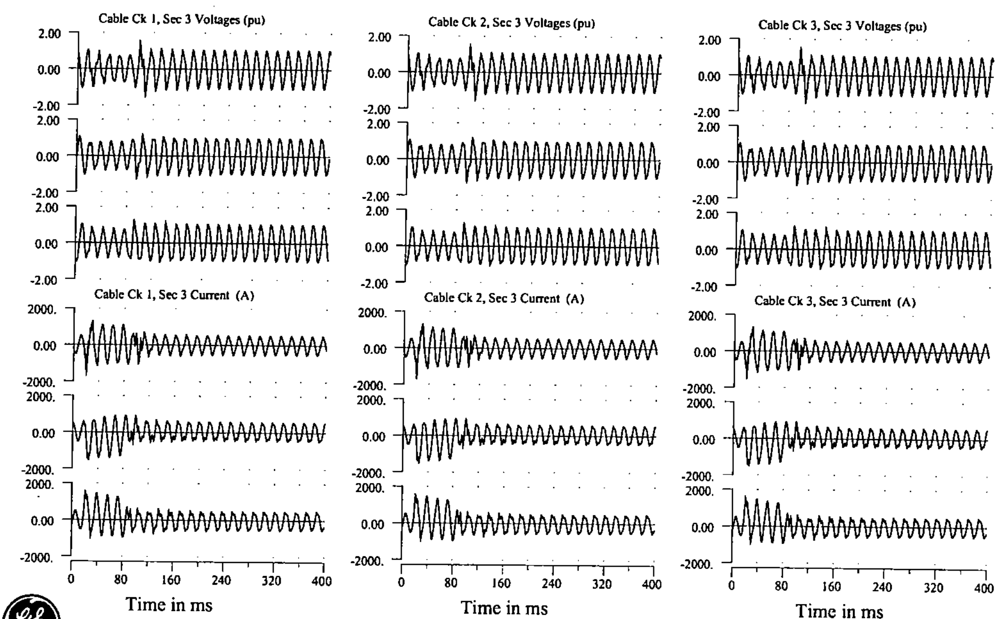
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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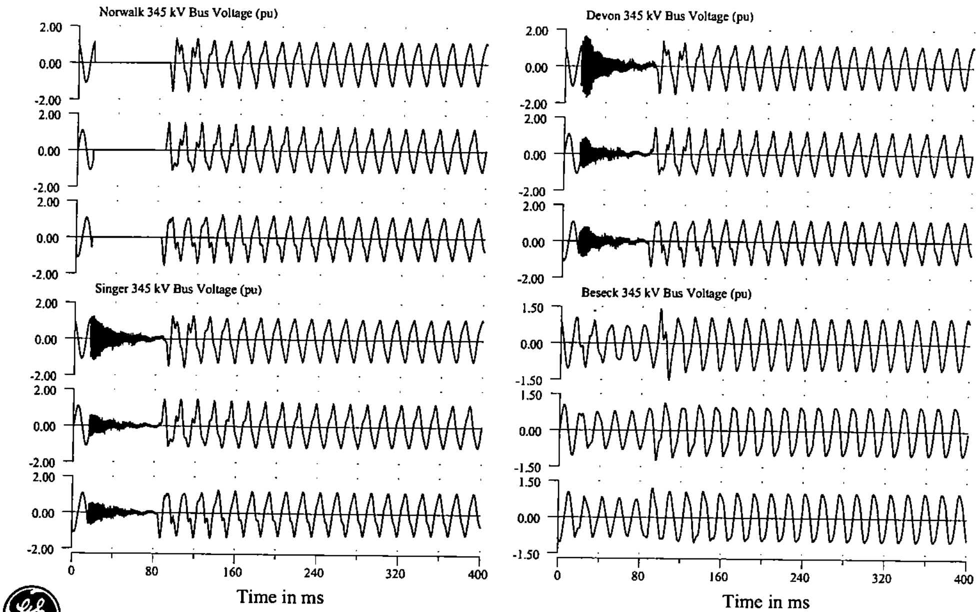
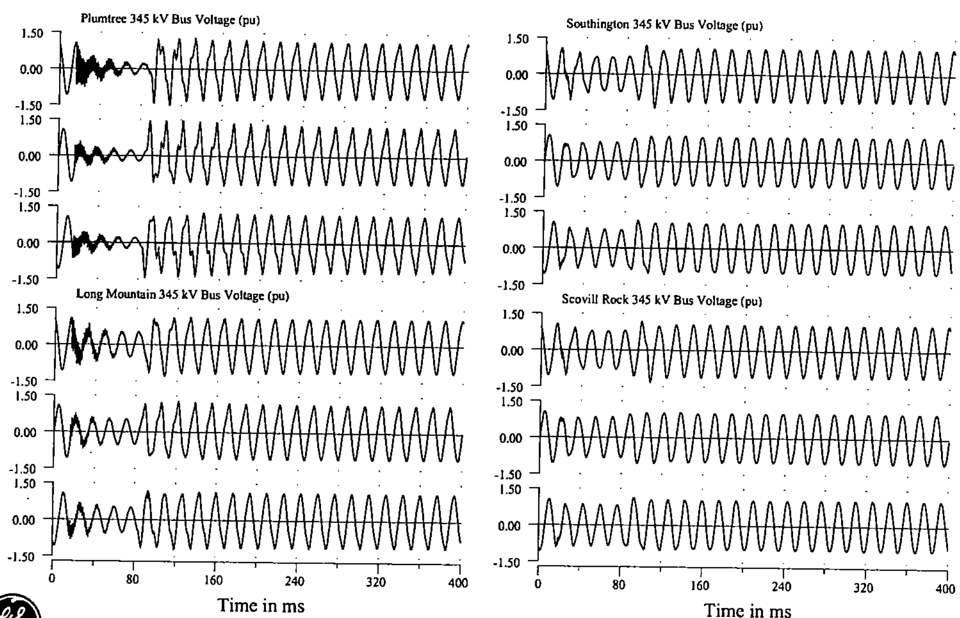
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_14_90
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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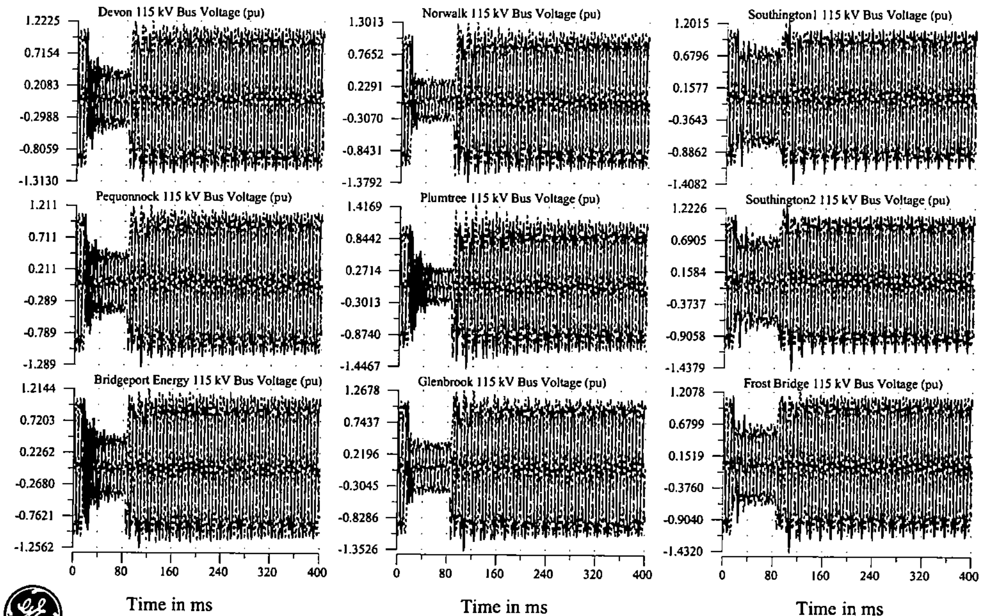
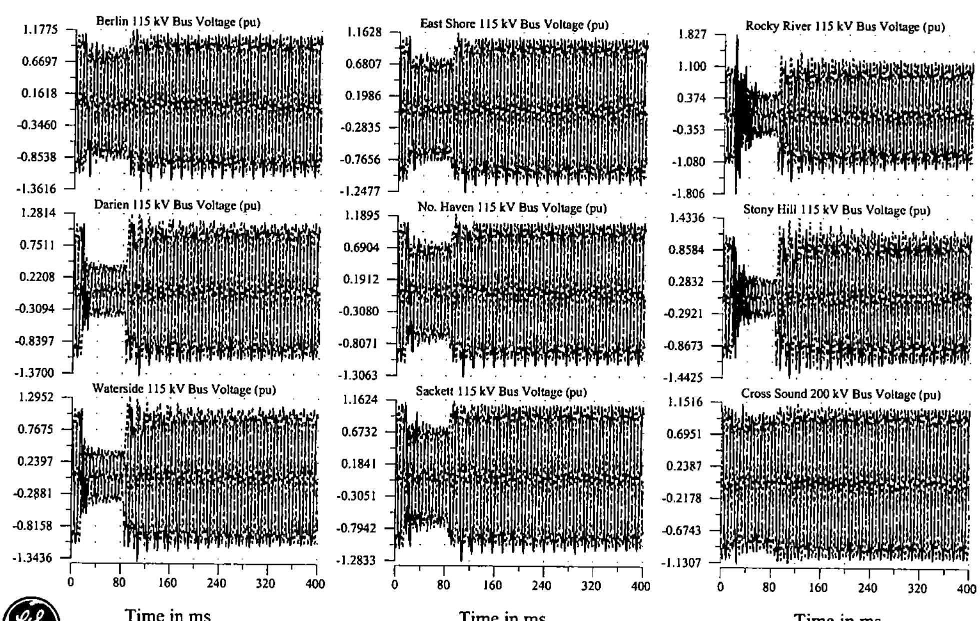
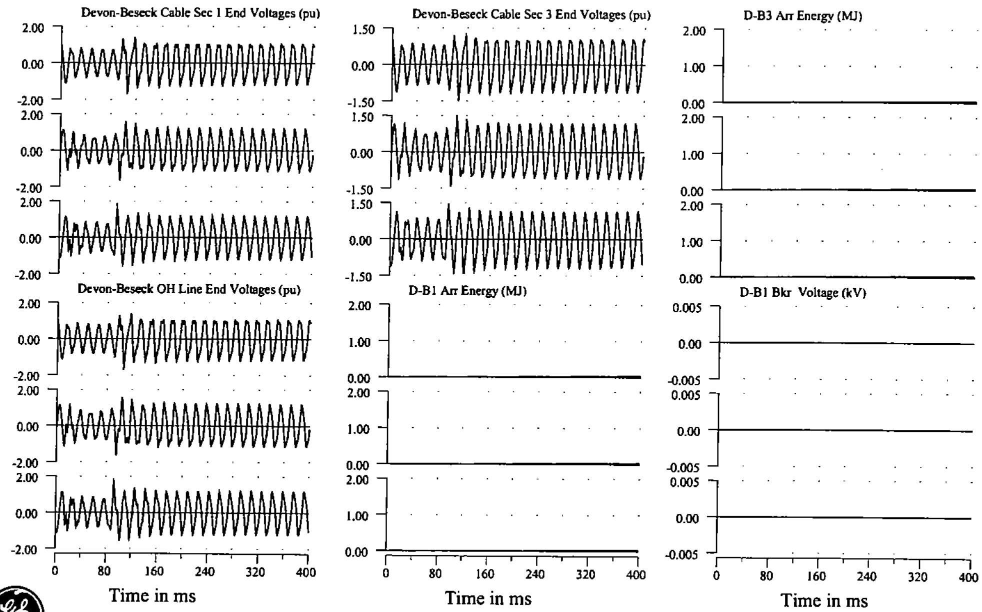
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_14_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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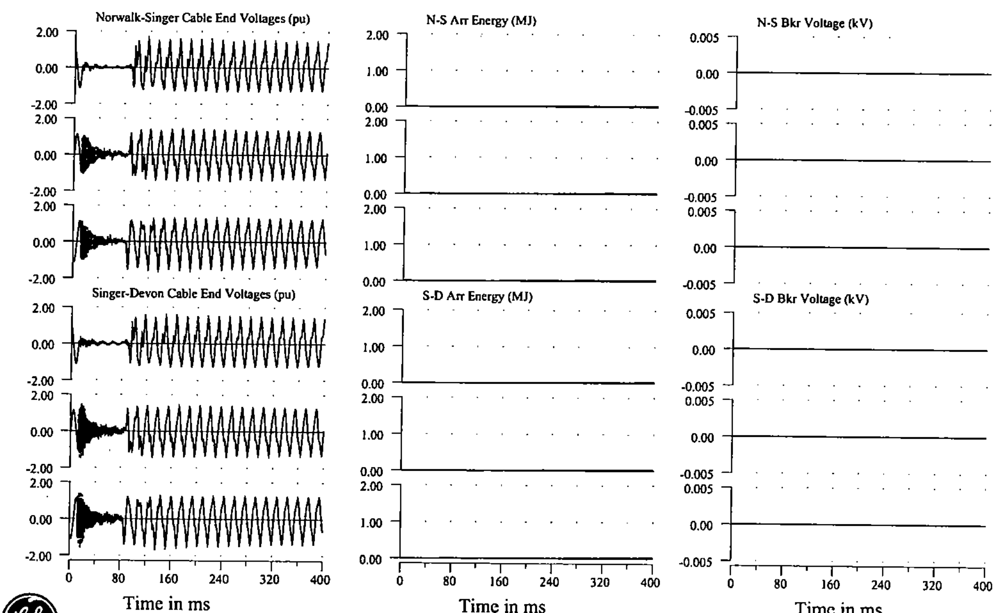
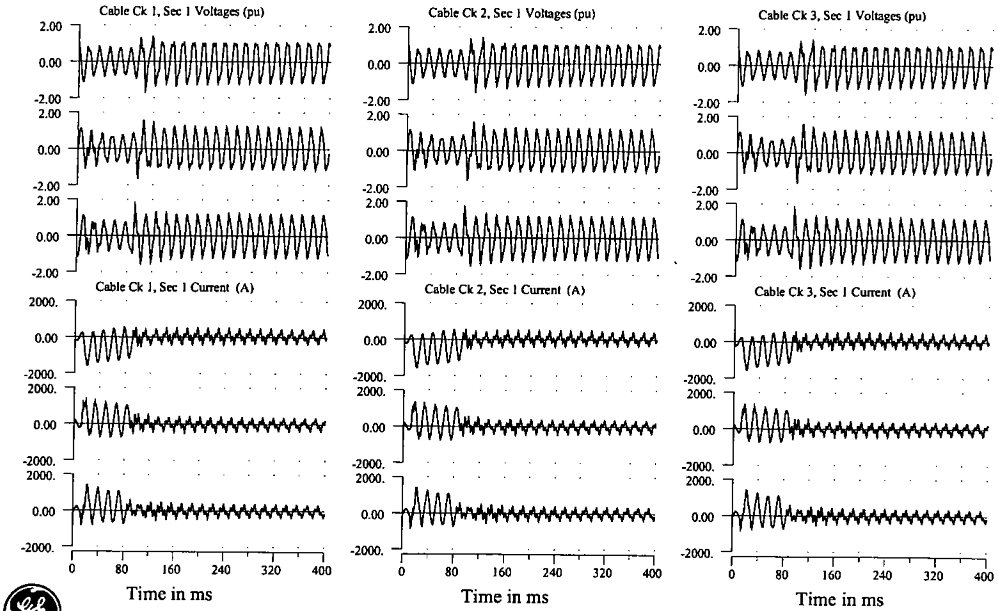
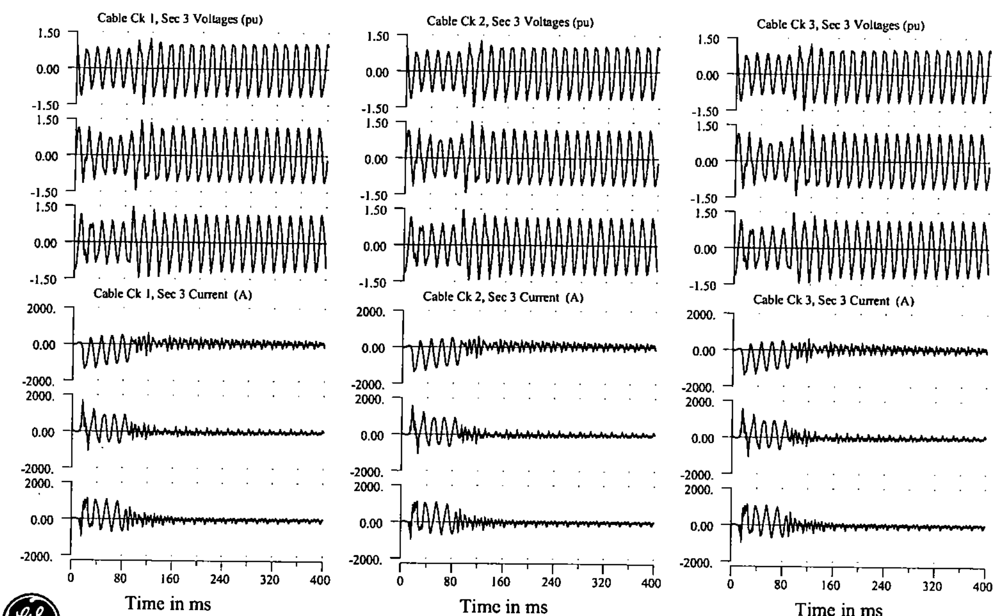
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



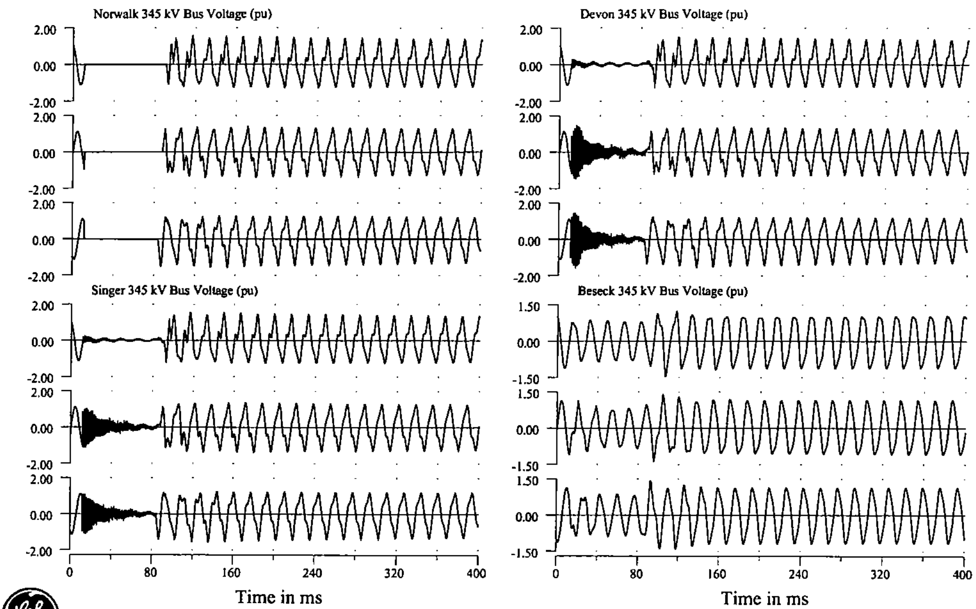
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_0
Devon-Beseck 345 kV Cables



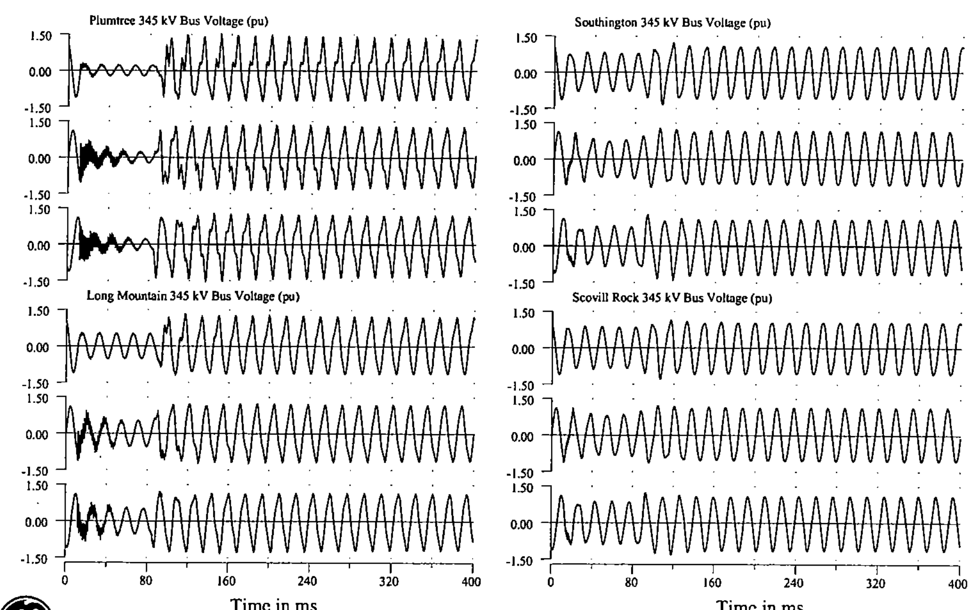
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_0
Devon-Beseck 345 kV Cables



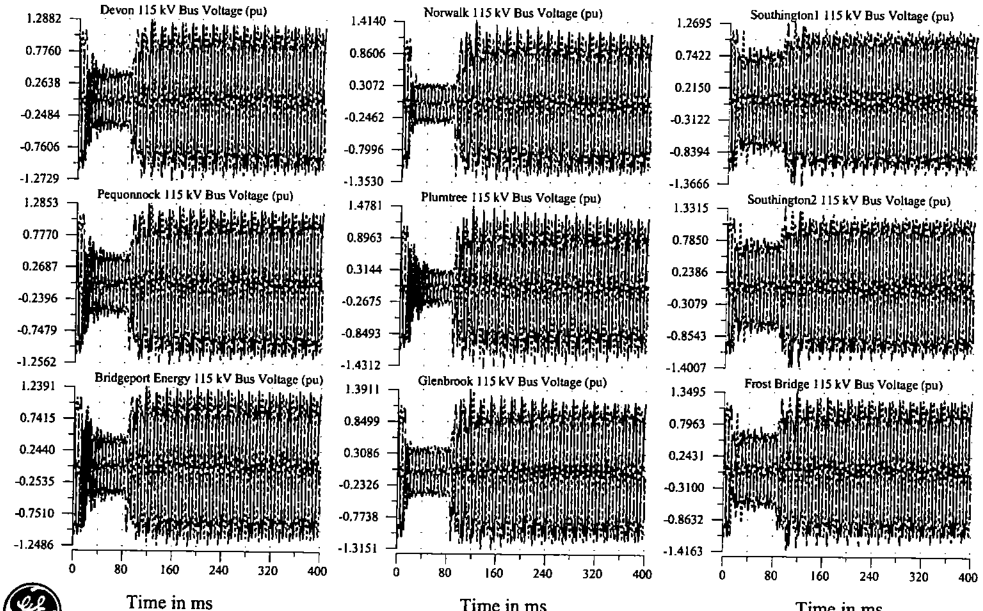
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_0
345 kV Bus Voltages



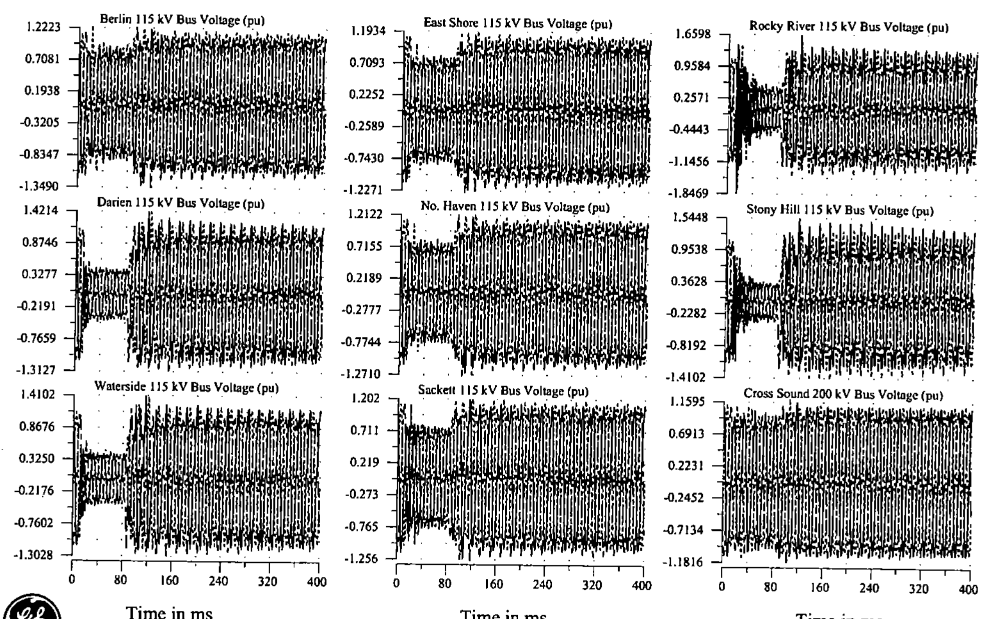
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_0
345 kV Bus Voltages



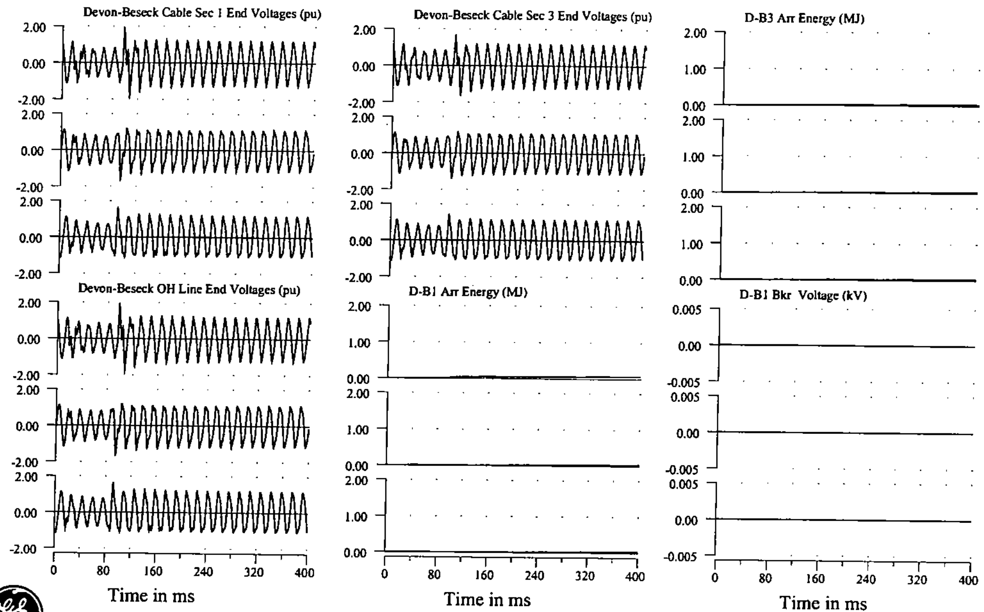
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_90
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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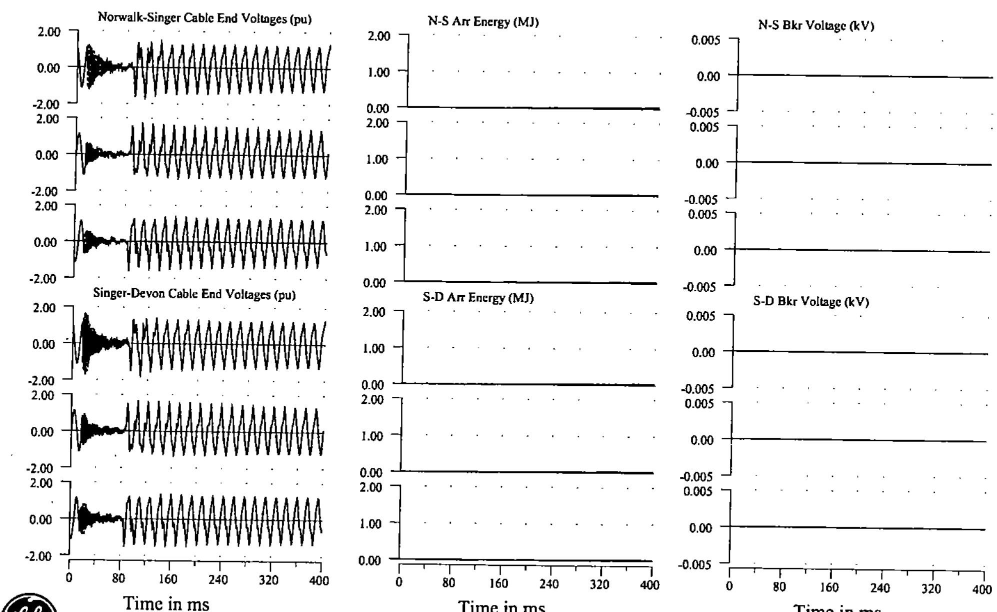
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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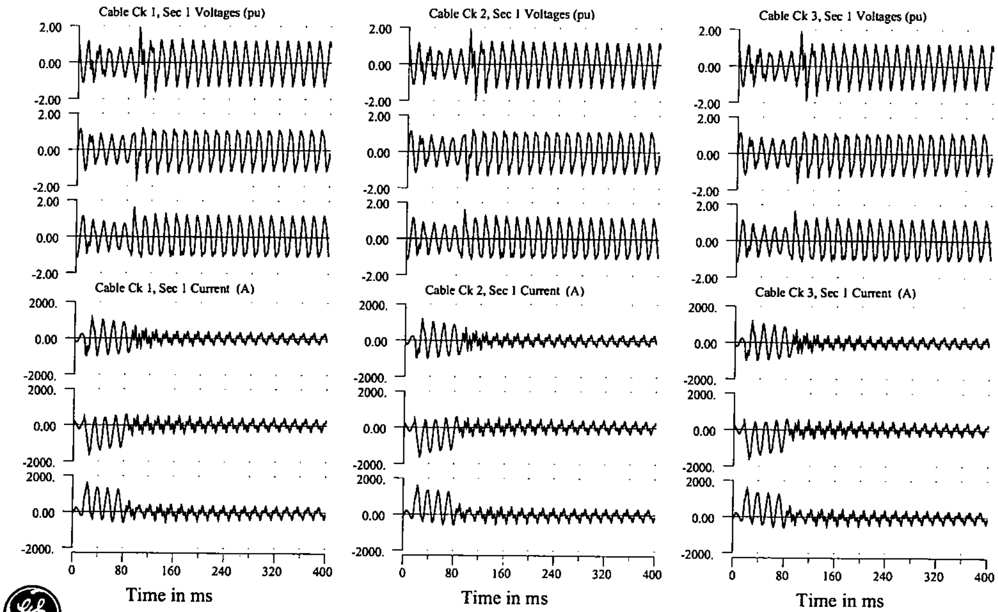
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_90
Devon-Beseck 345 kV Cables



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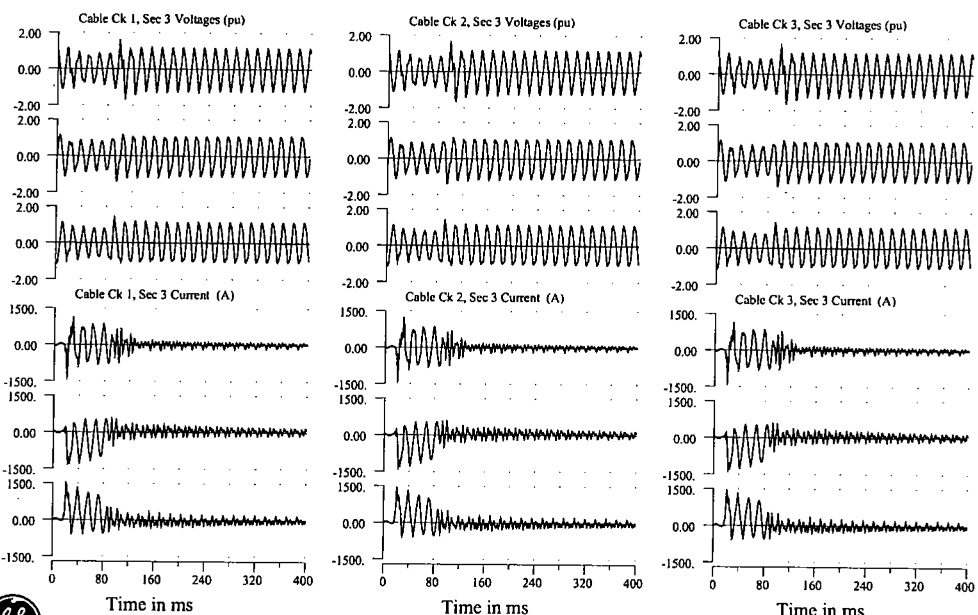
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_90
Devon-Beseck 345 kV Cables



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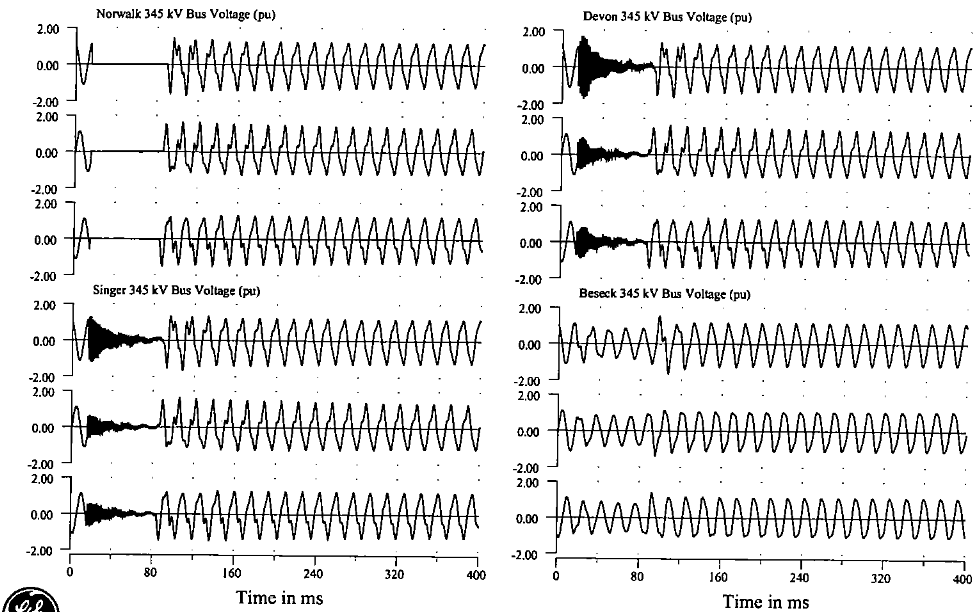
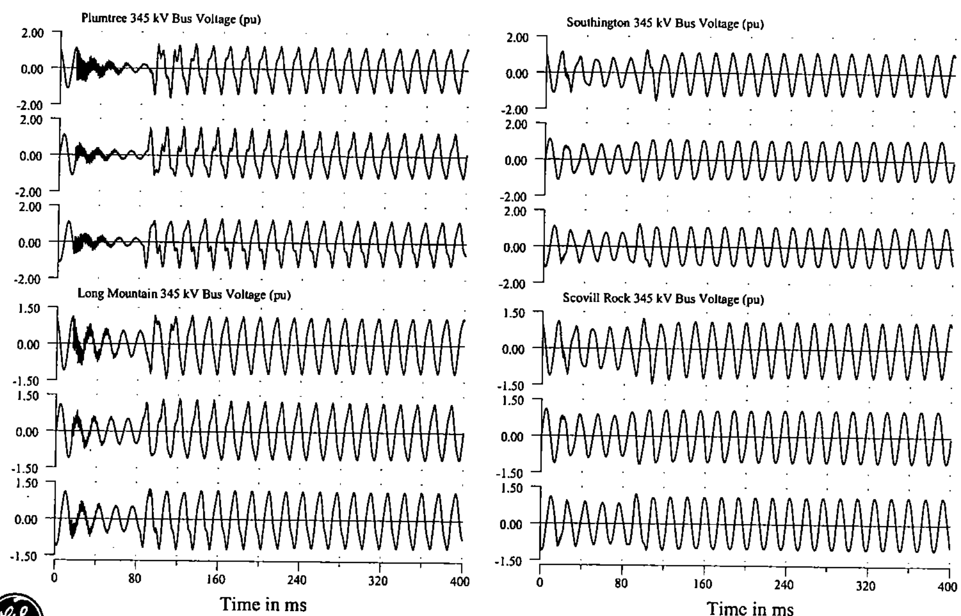
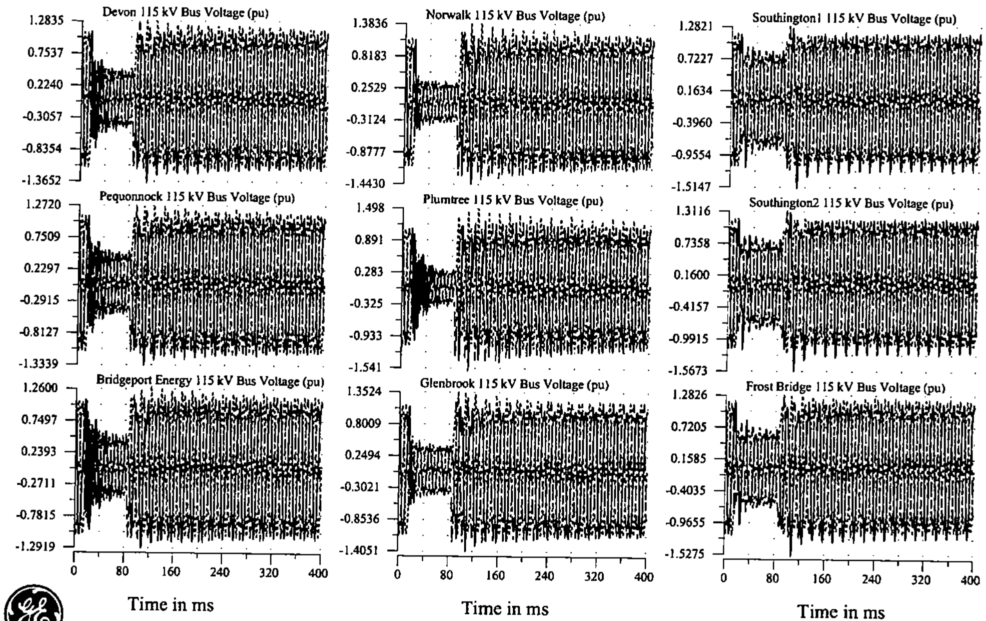
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_90
345 kV Bus Voltages



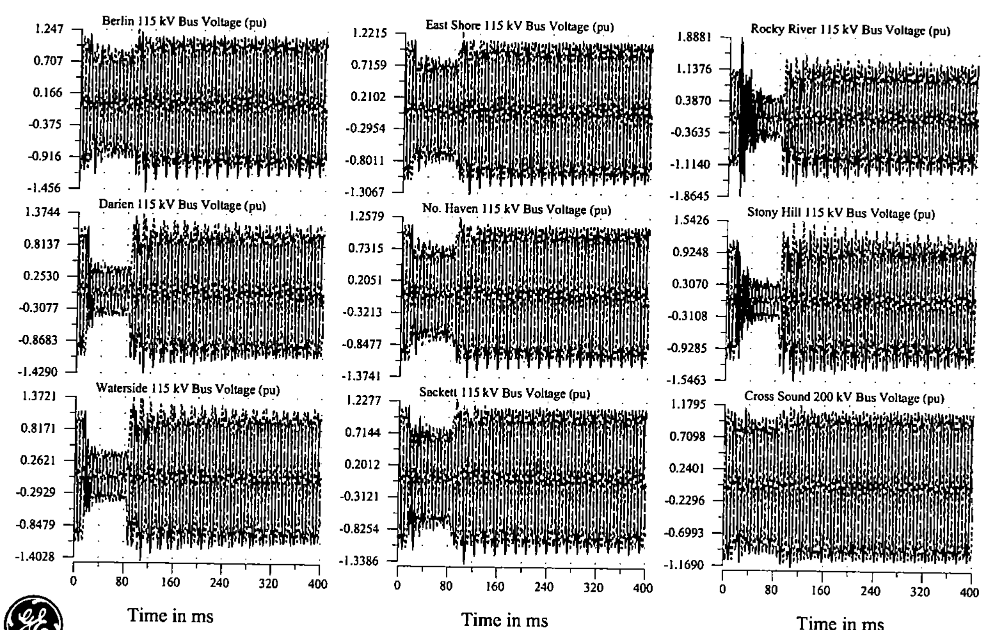
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_90
345 kV Bus Voltages



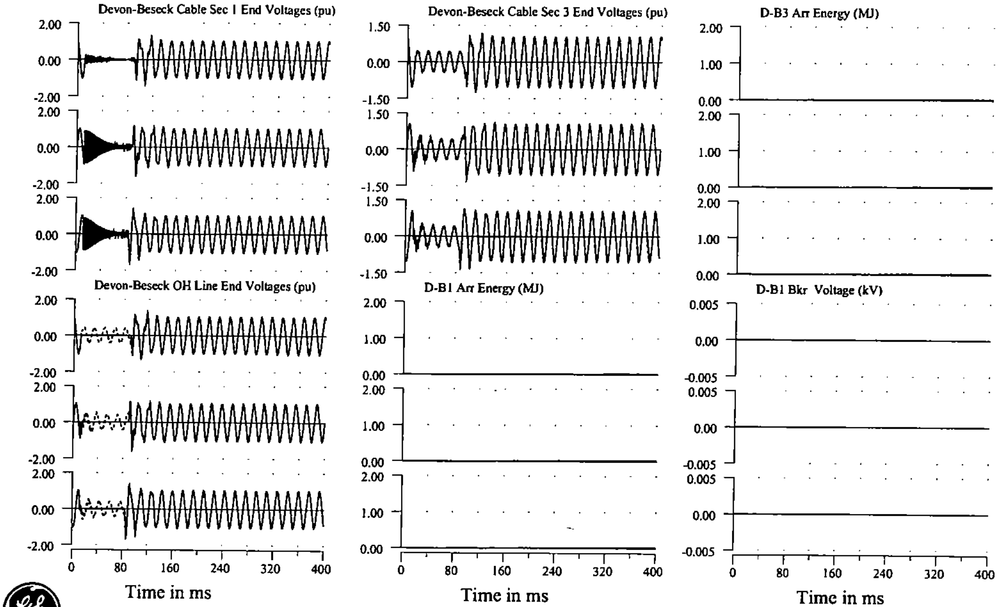
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_15_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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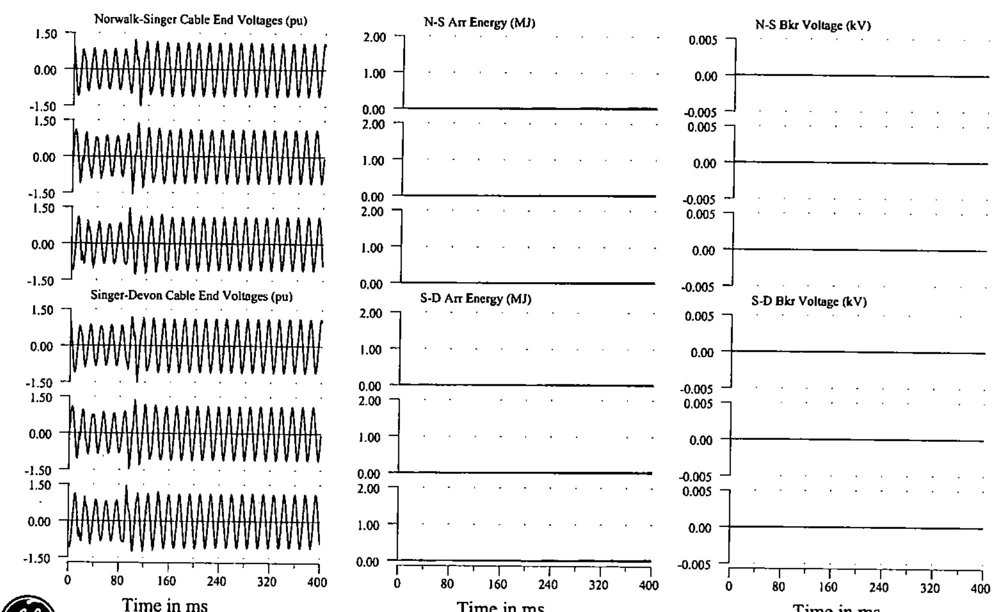
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_0
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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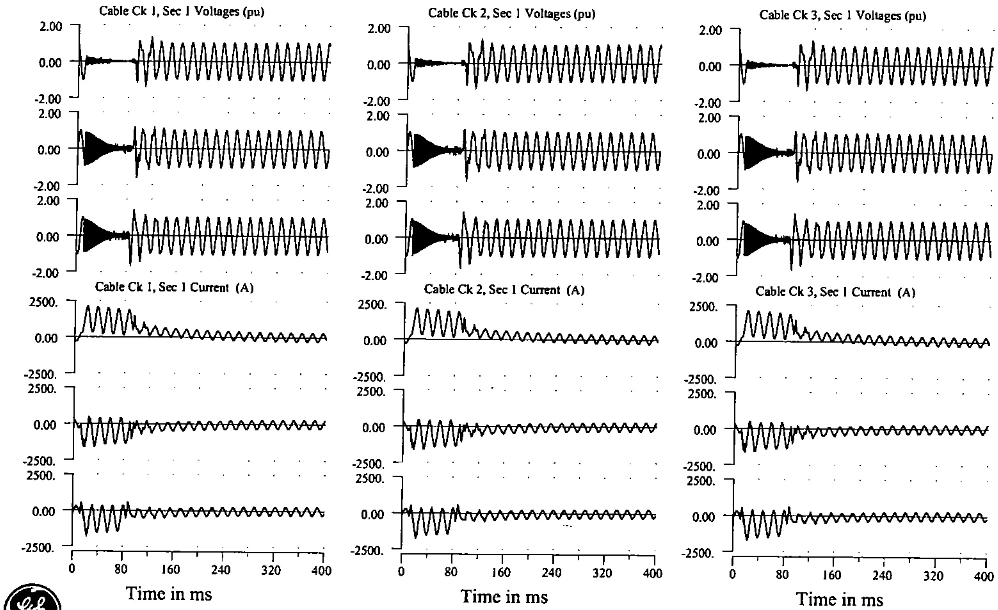
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_0

Devon-Beseck 345 kV Cables



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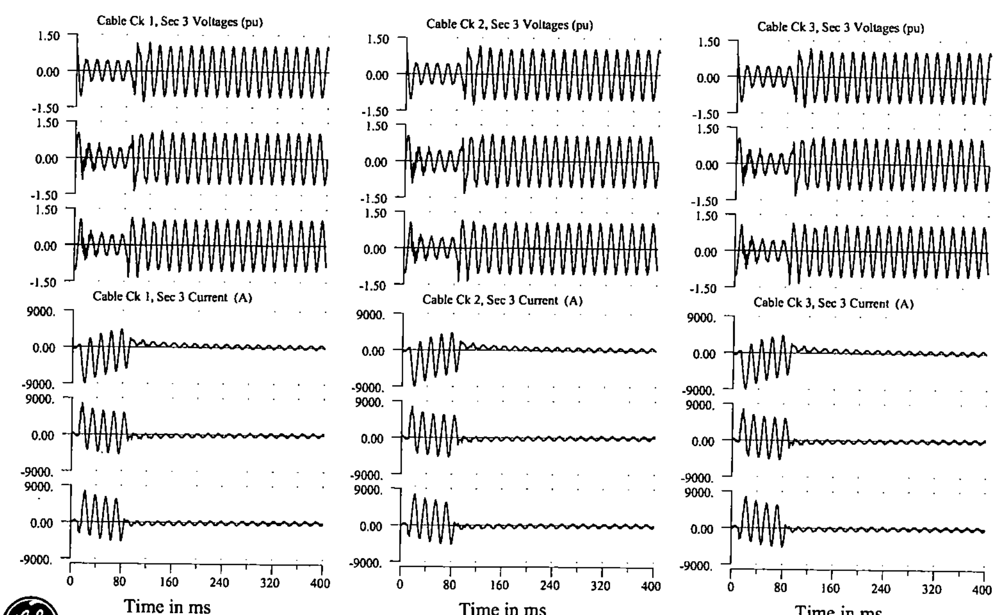
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_0

Devon-Beseck 345 kV Cables



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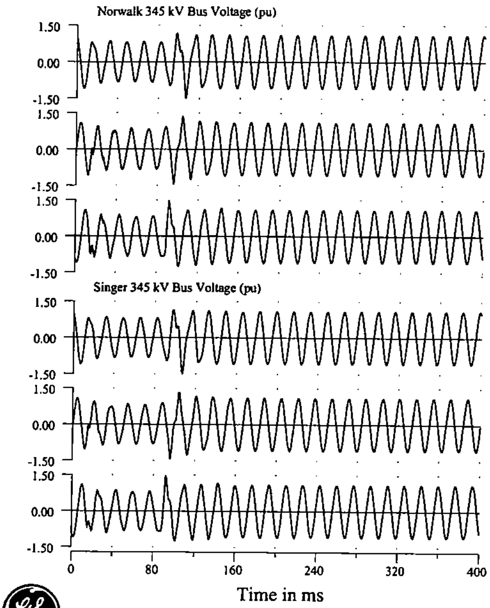
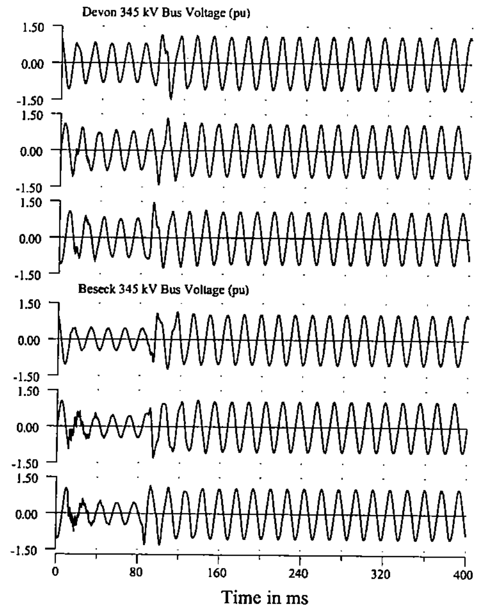
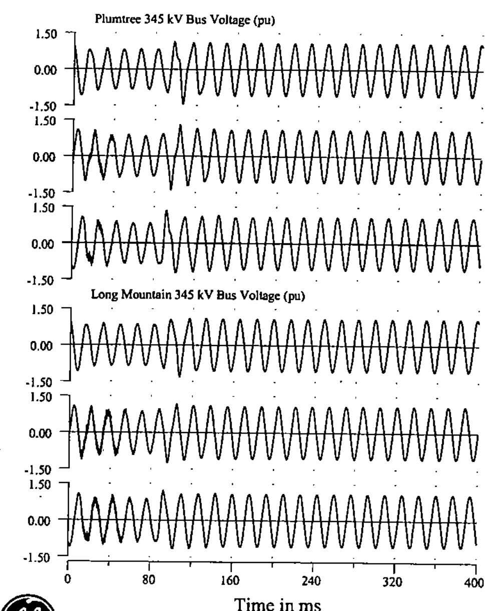
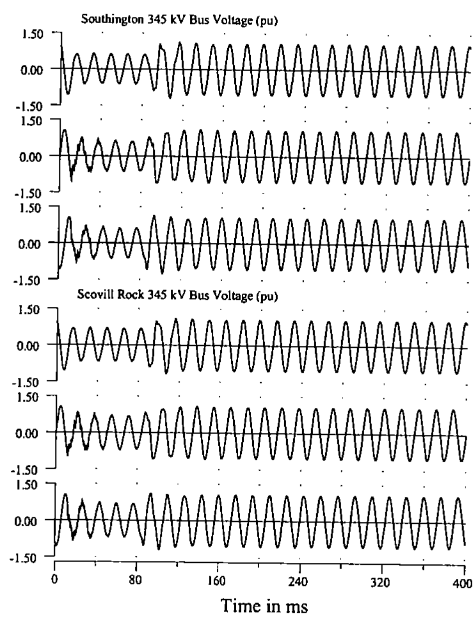
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_0
345 kV Bus Voltages



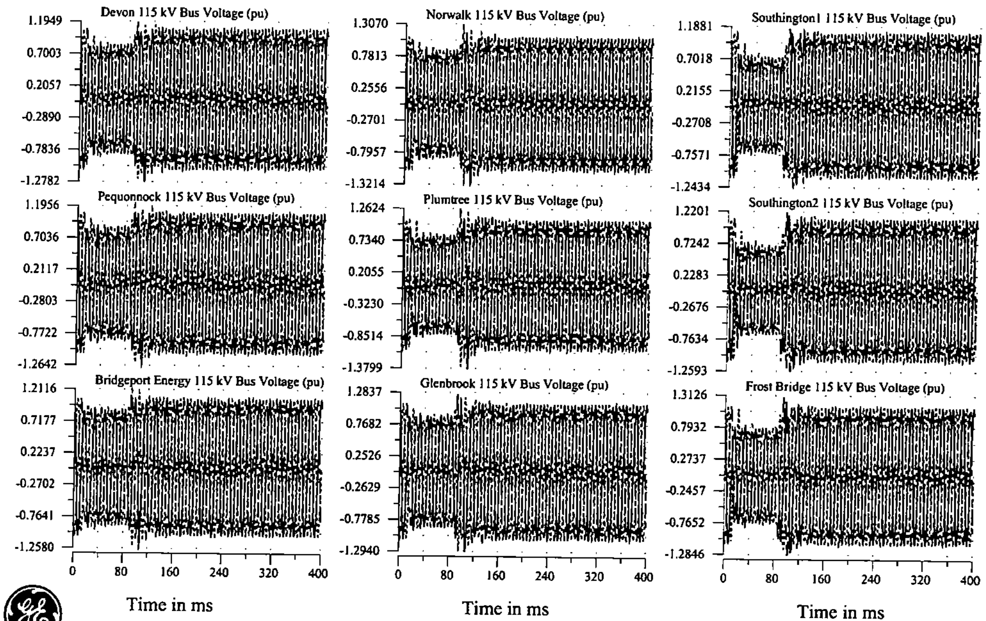


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_0
345 kV Bus Voltages





Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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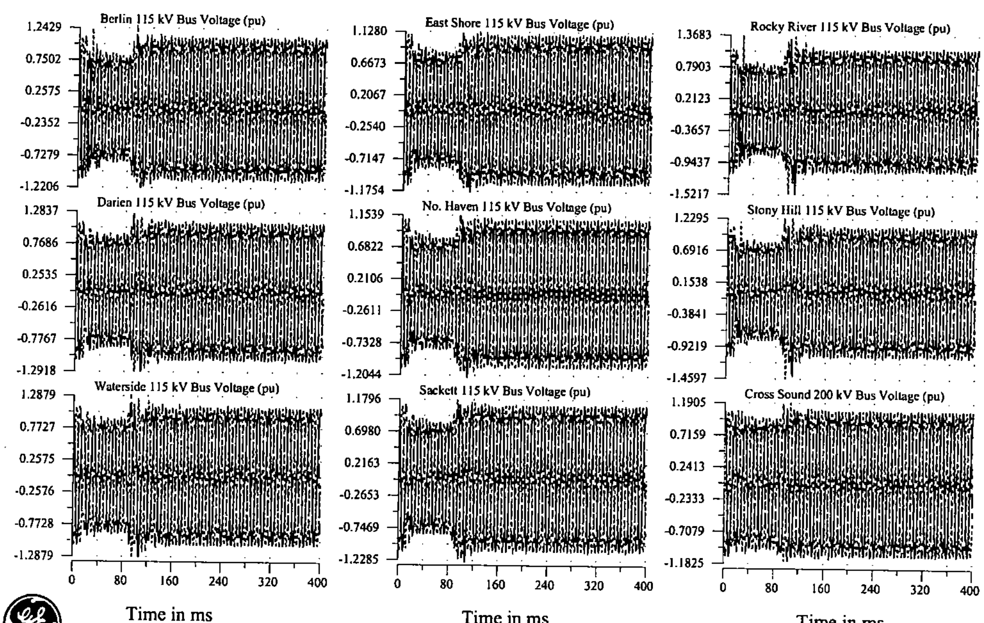
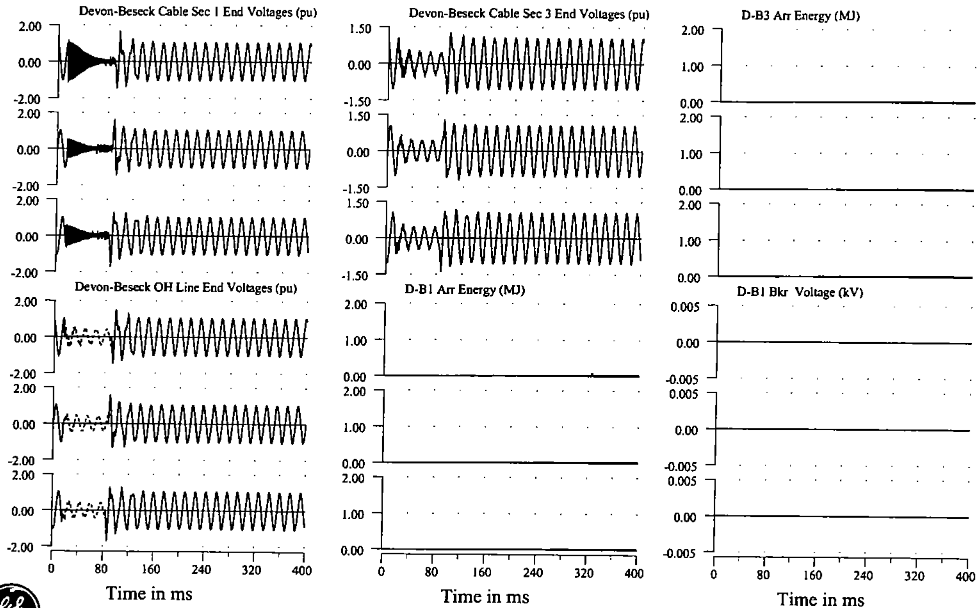
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_90
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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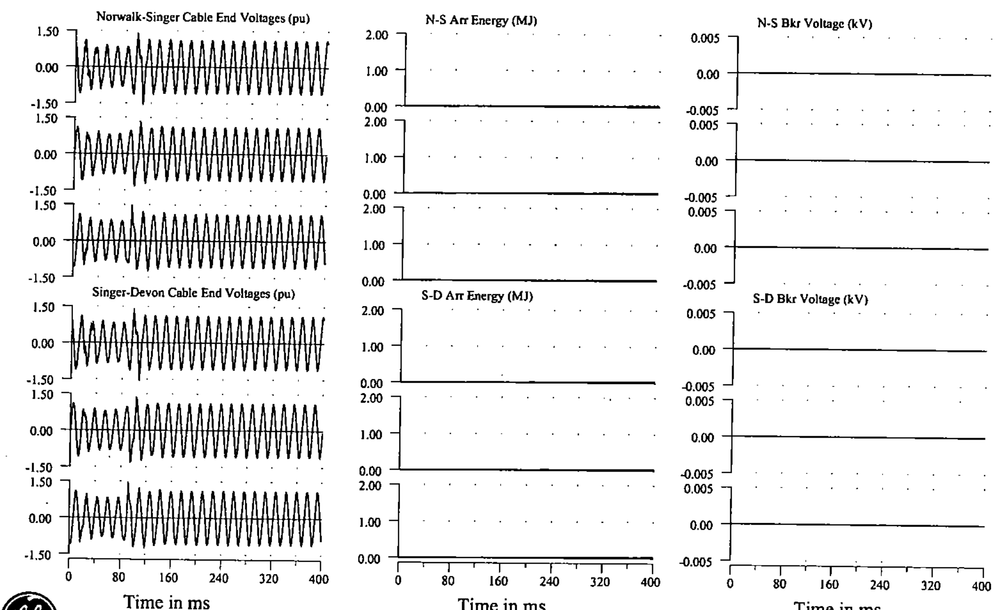
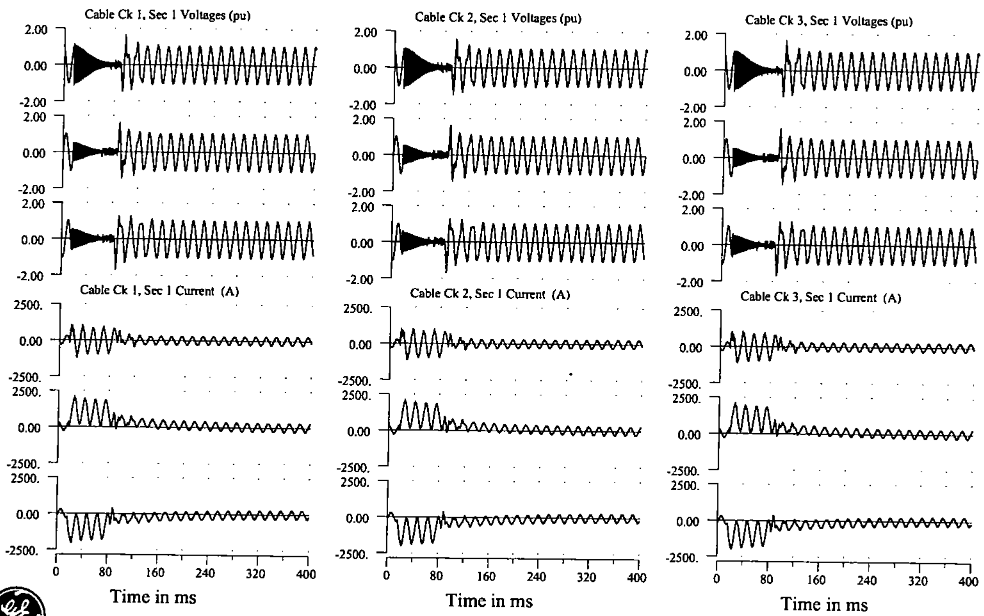
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_90
Devon-Beseck 345 kV Cables



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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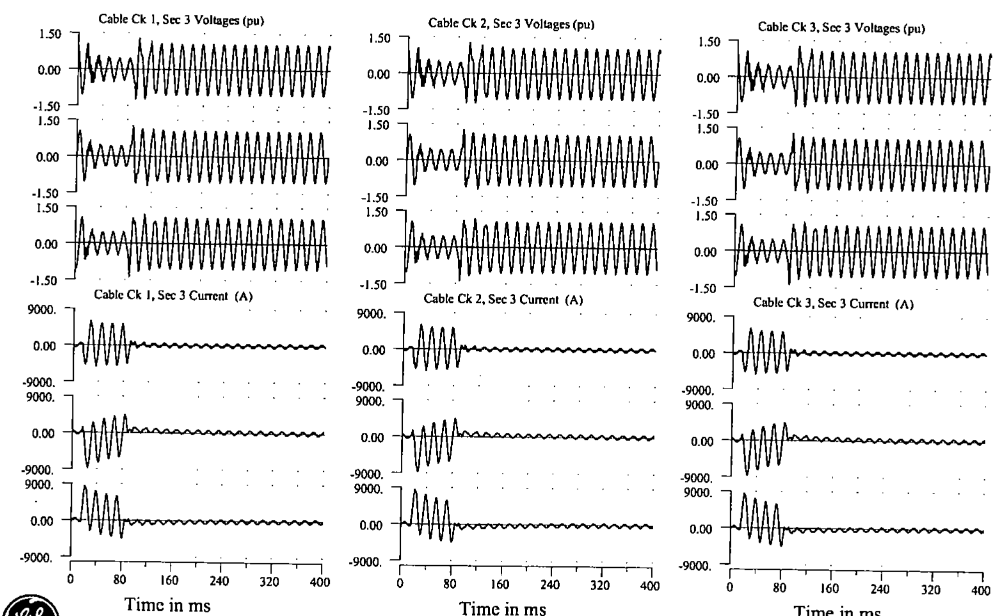
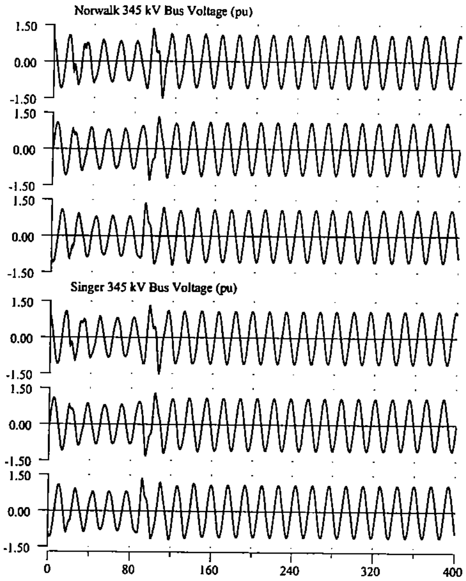
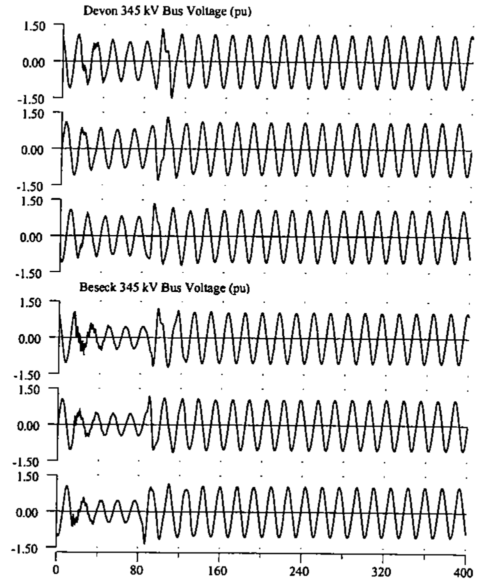
Devon-Beseck 345 kV Cables

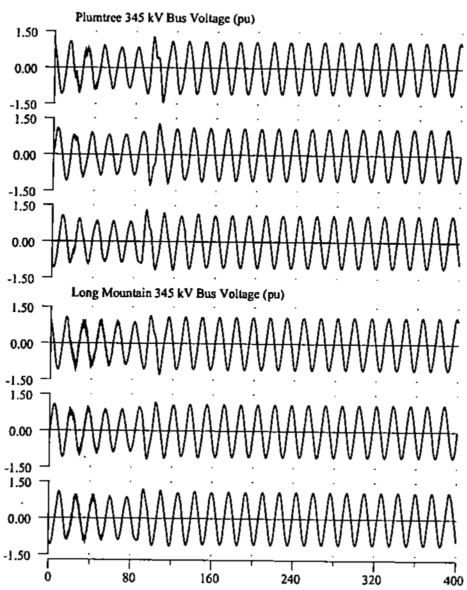


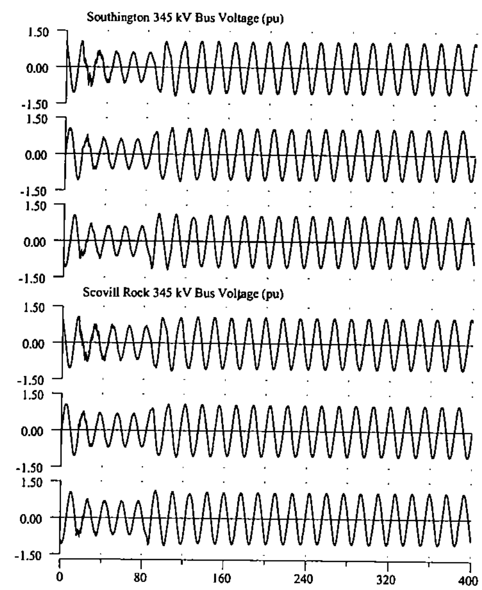
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_90
345 kV Bus Voltages



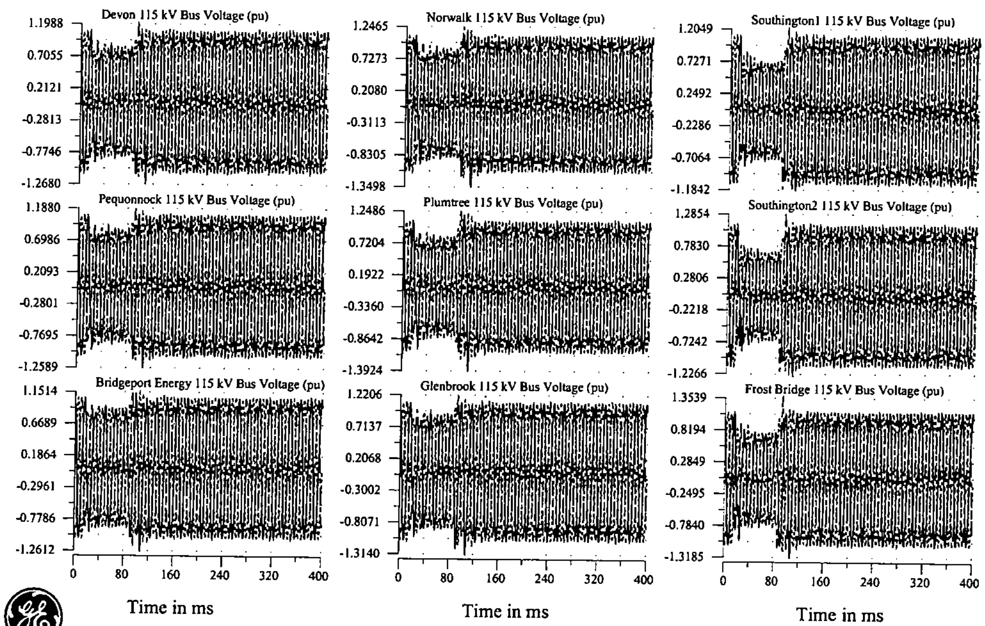


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_90
345 kV Bus Voltages

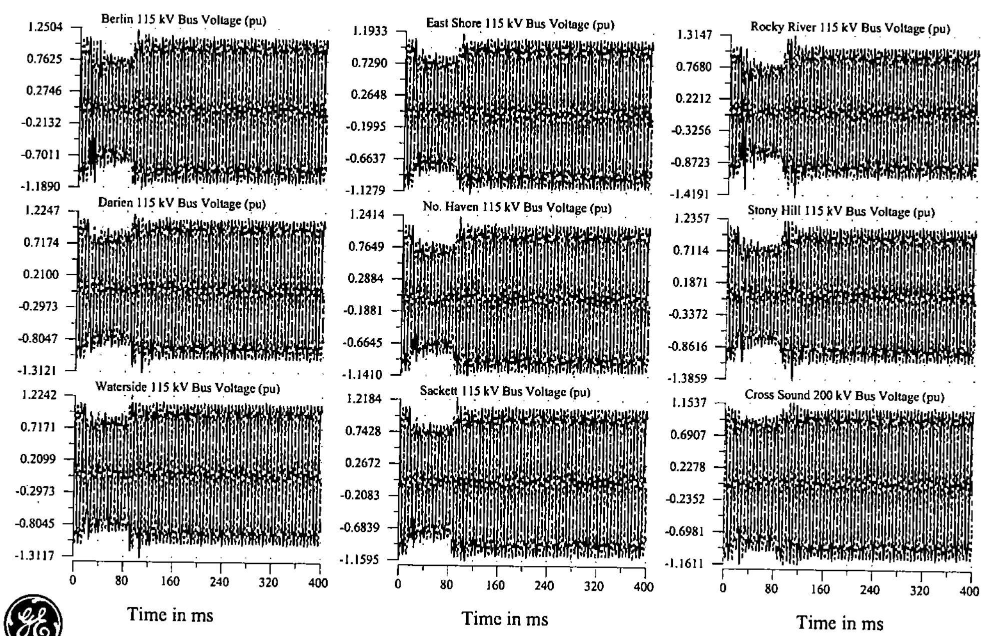




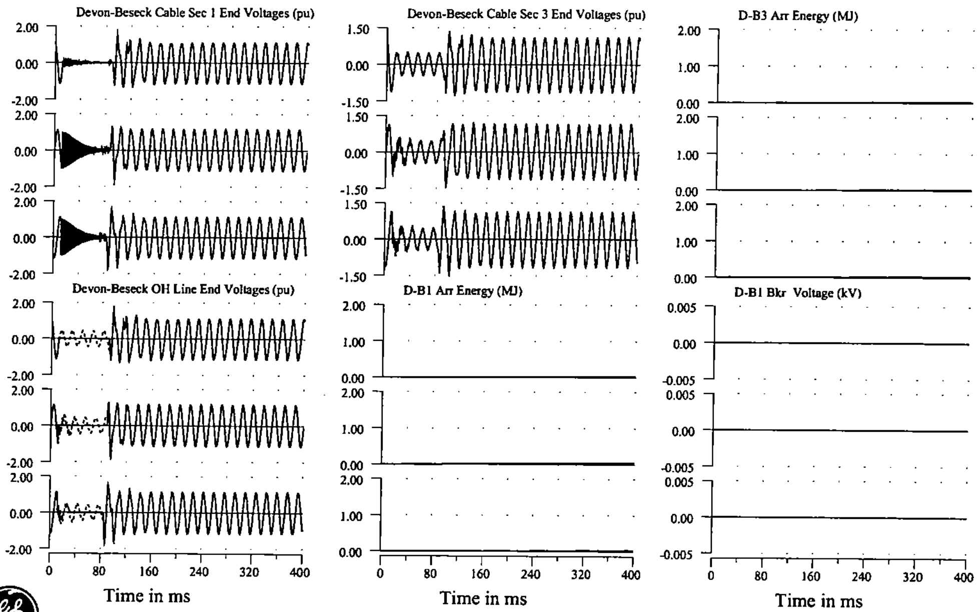
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_16_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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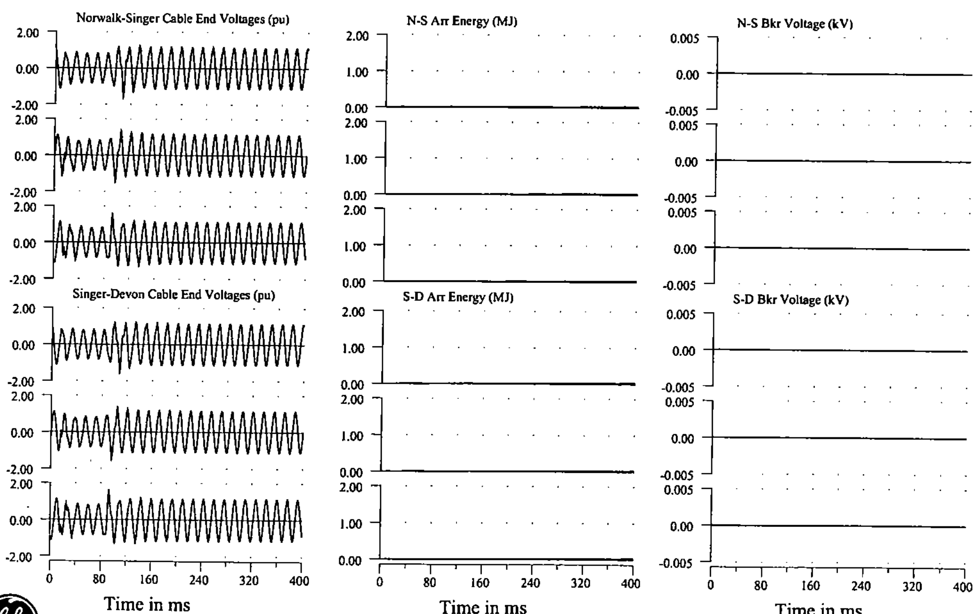
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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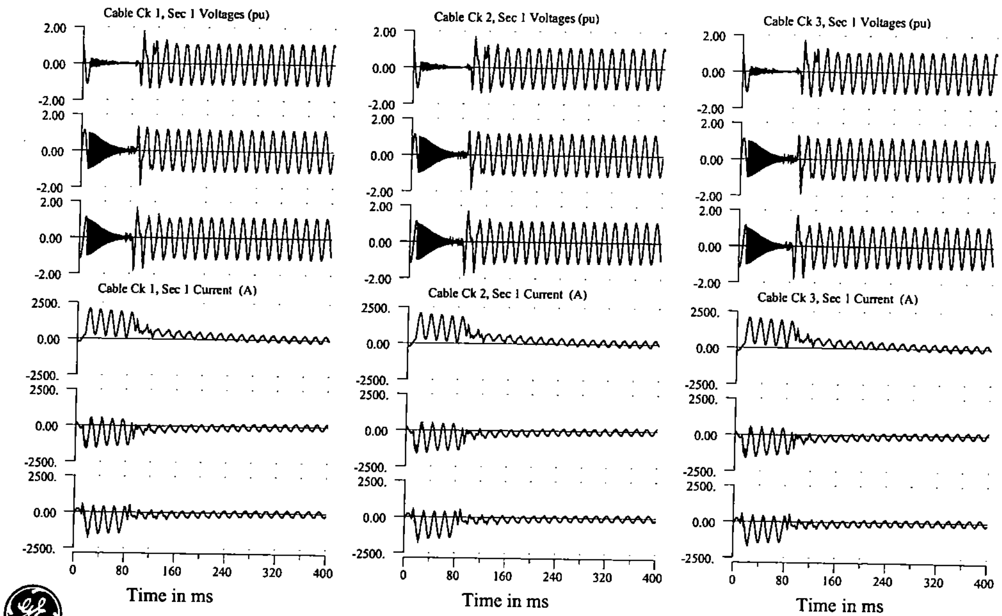
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_0
Devon-Beseck 345 kV Cables



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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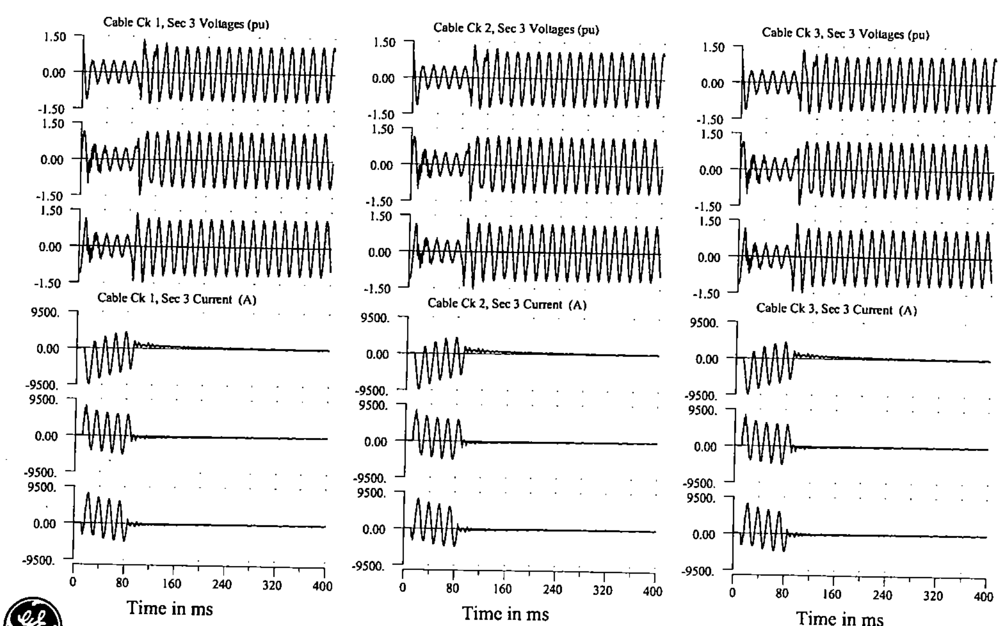
Devon-Beseck 345 kV Cables



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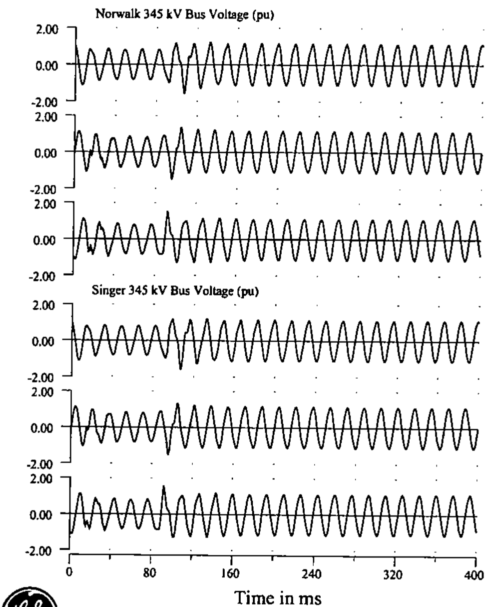
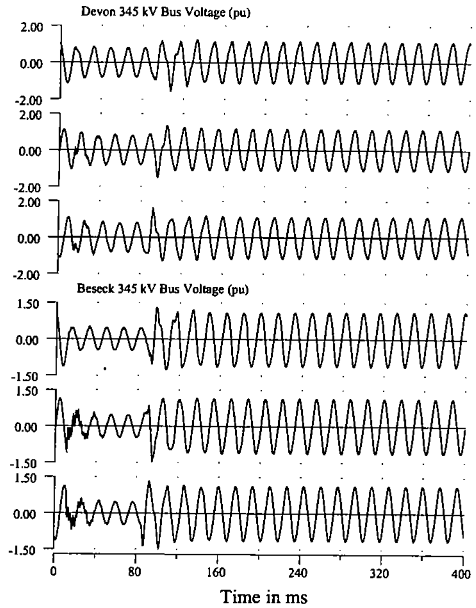
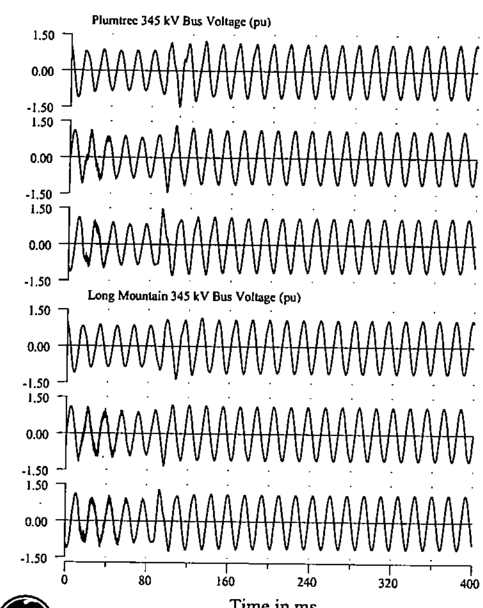
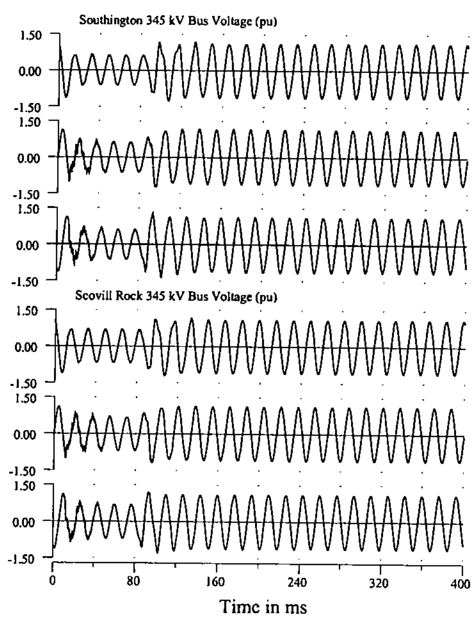
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_0
345 kV Bus Voltages



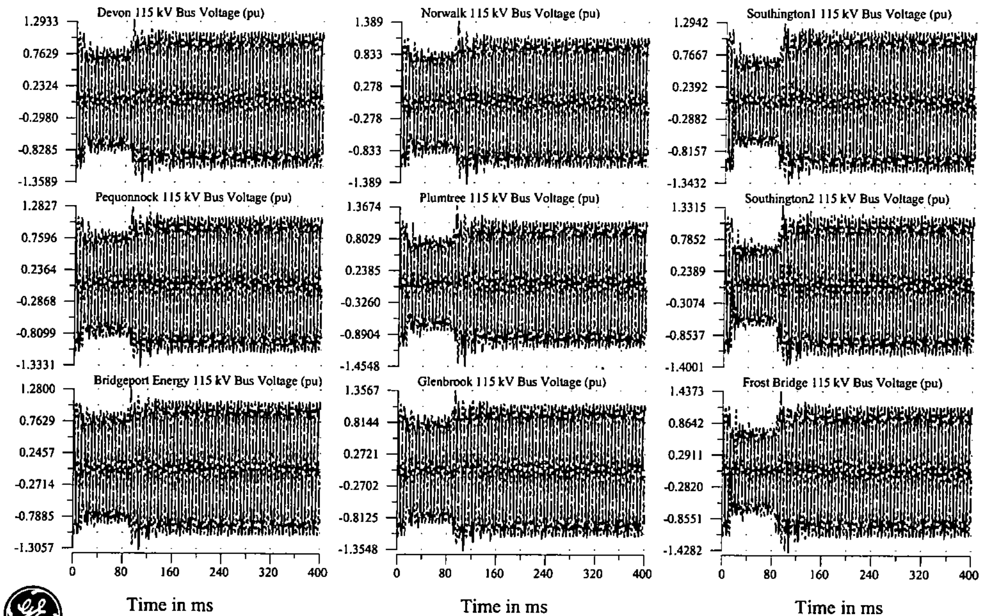


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_0
345 kV Bus Voltages

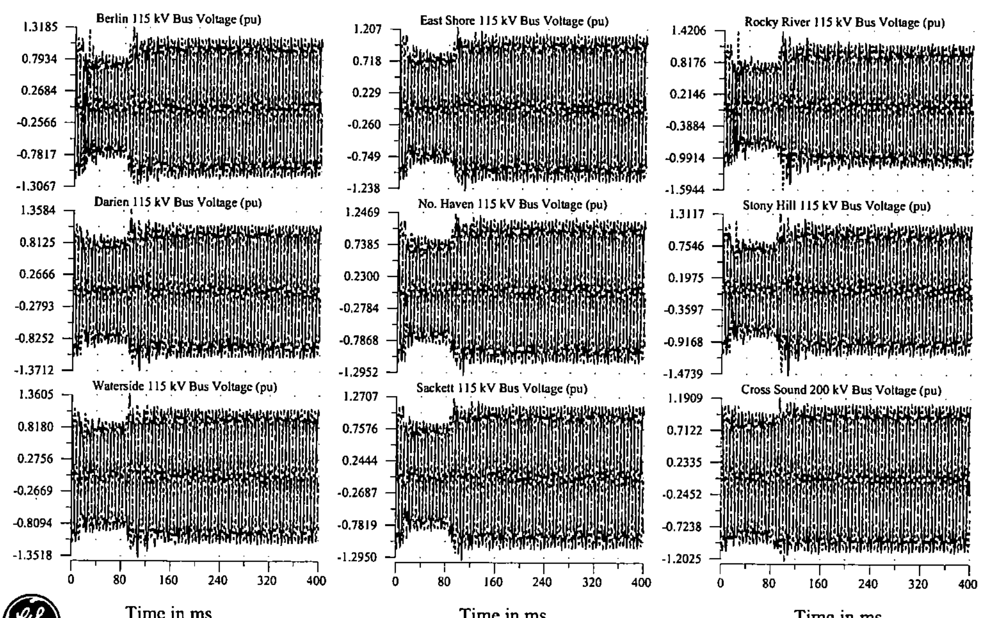




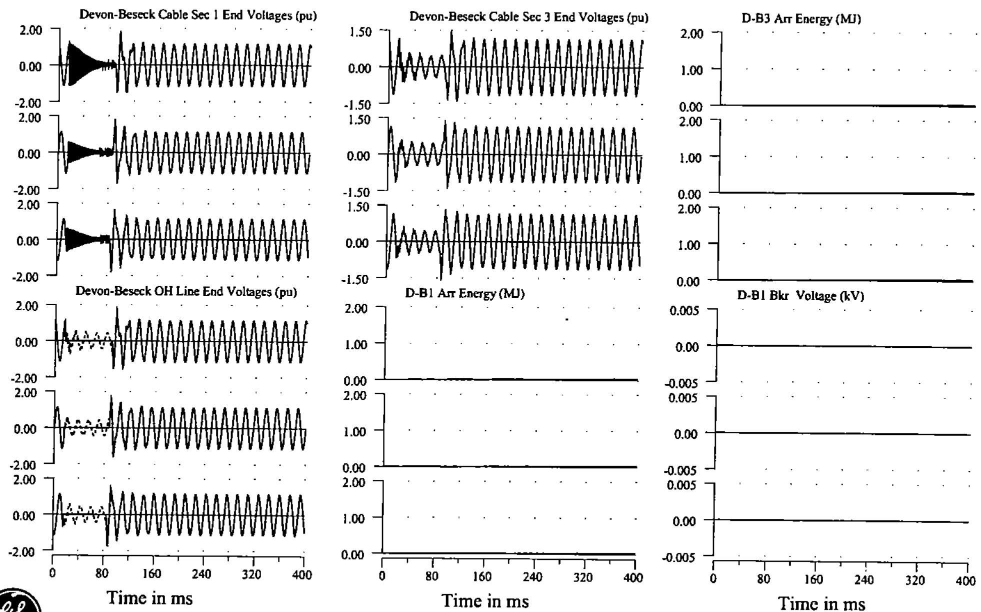
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_90
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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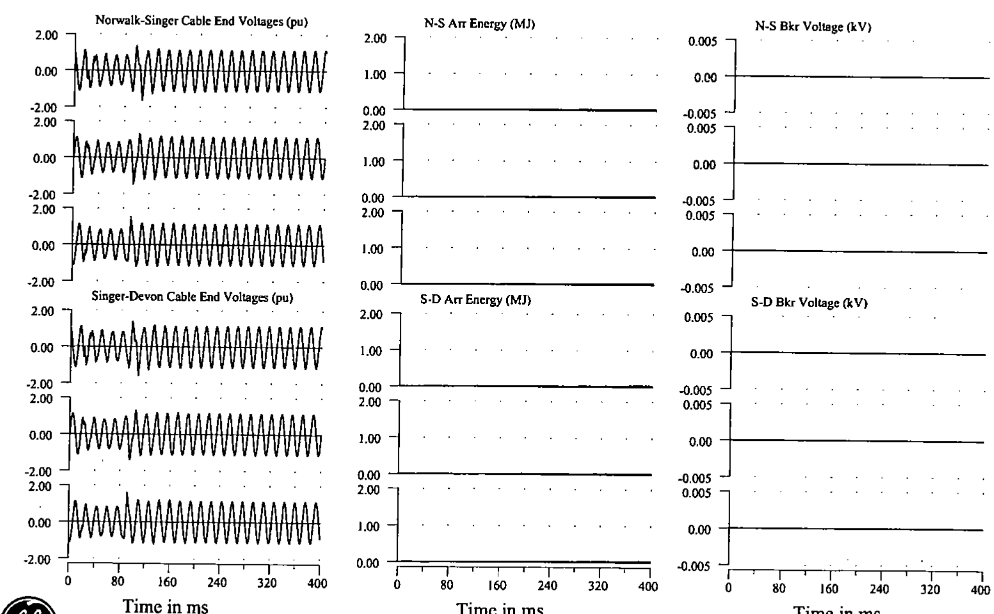
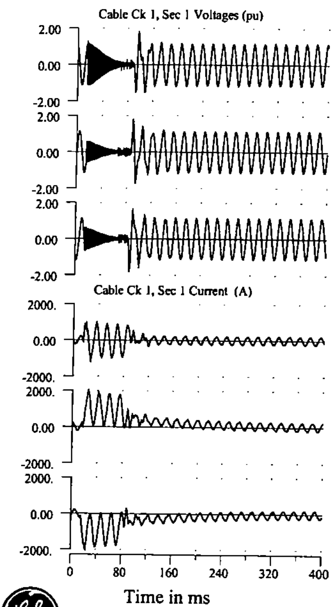
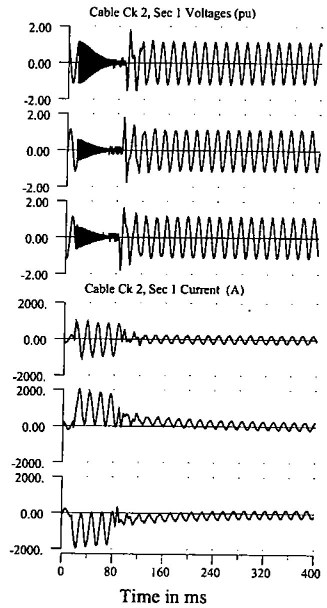
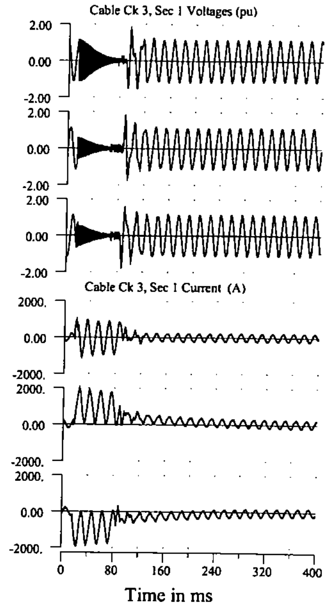
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



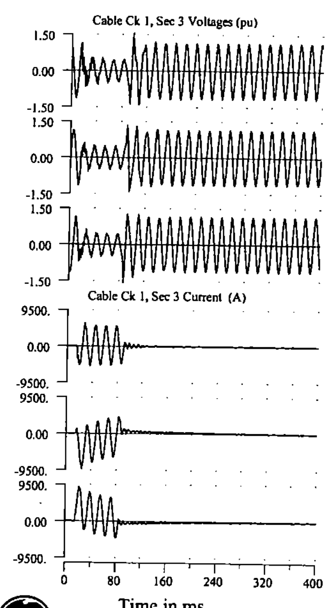
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_90
Devon-Beseck 345 kV Cables

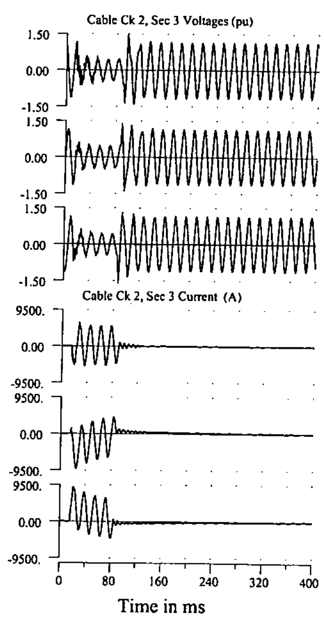


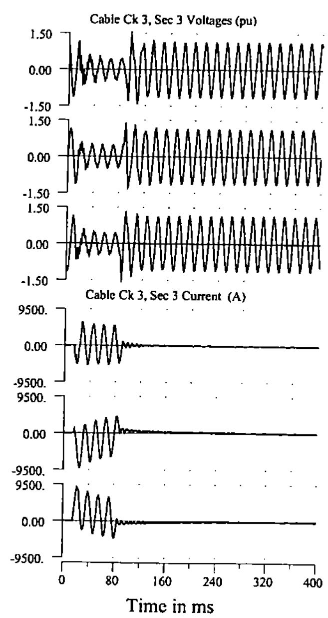




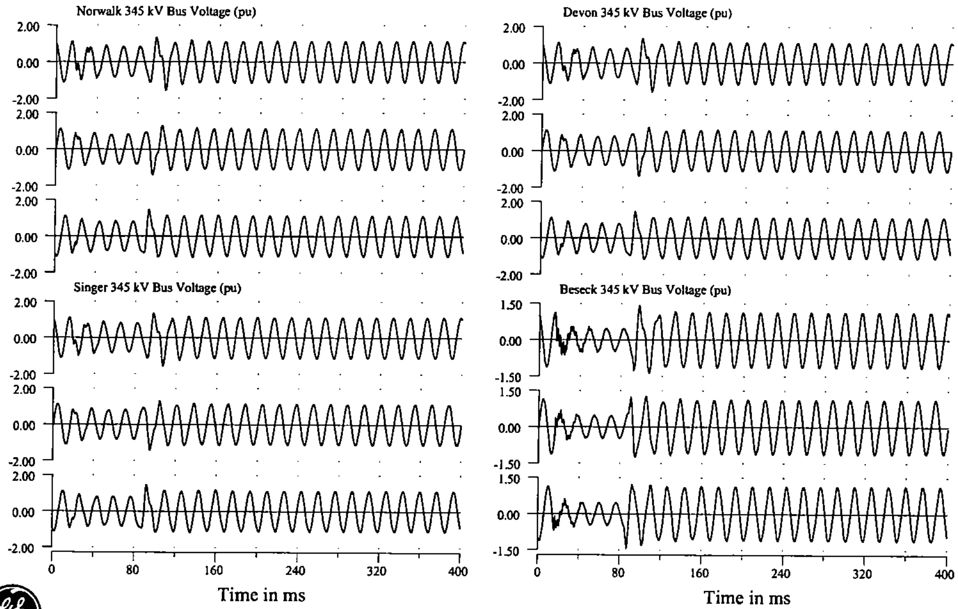
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_90
Devon-Beseck 345 kV Cables



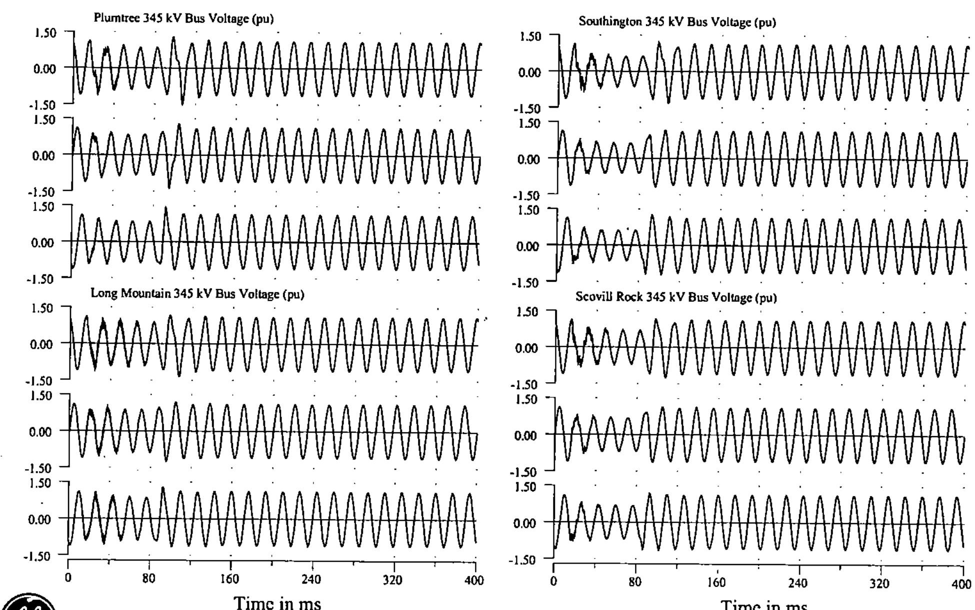




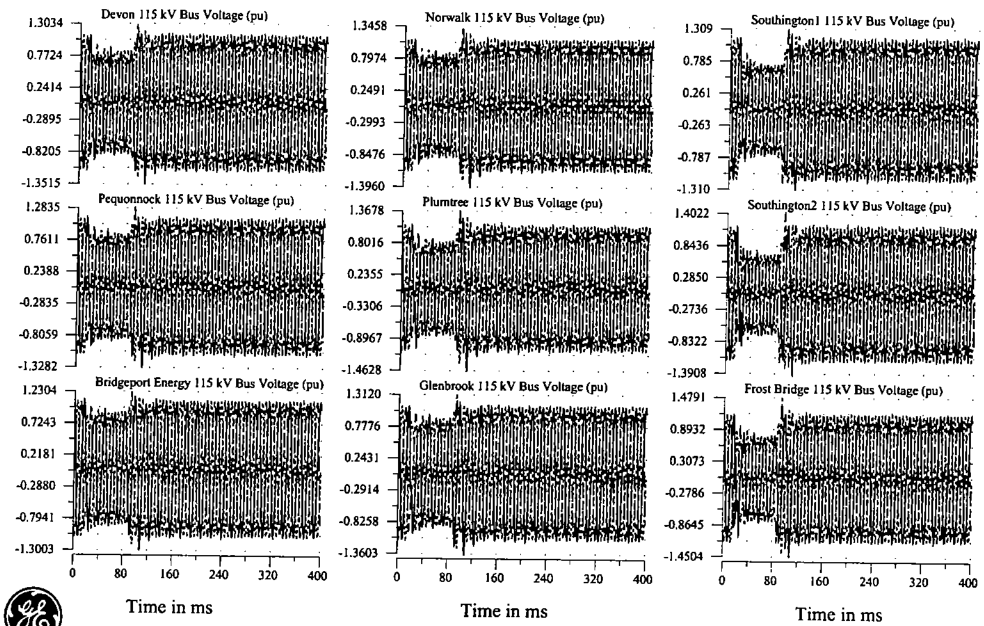
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_90
345 kV Bus Voltages



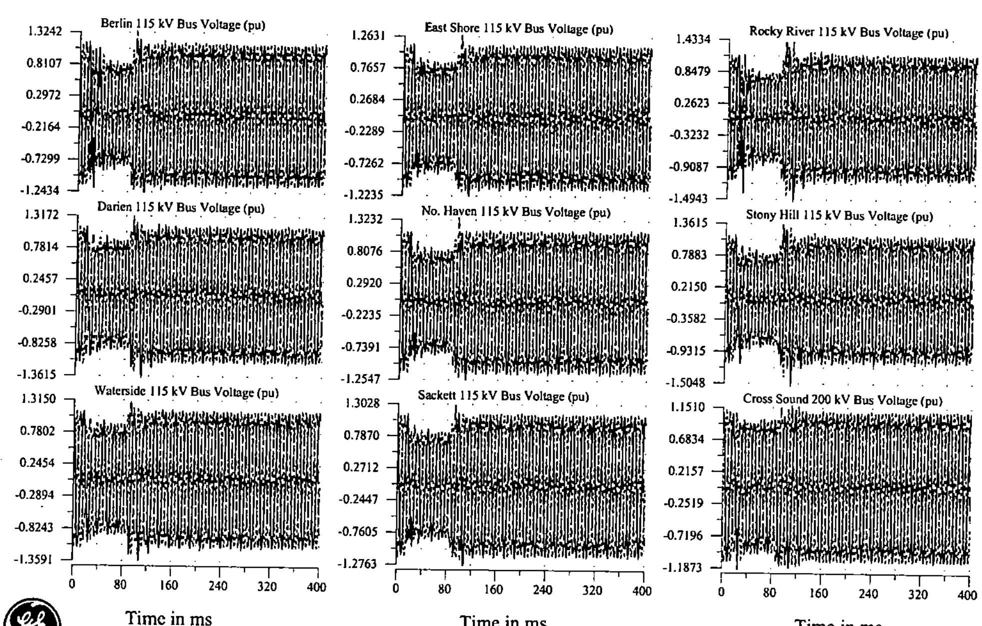
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_90
345 kV Bus Voltages



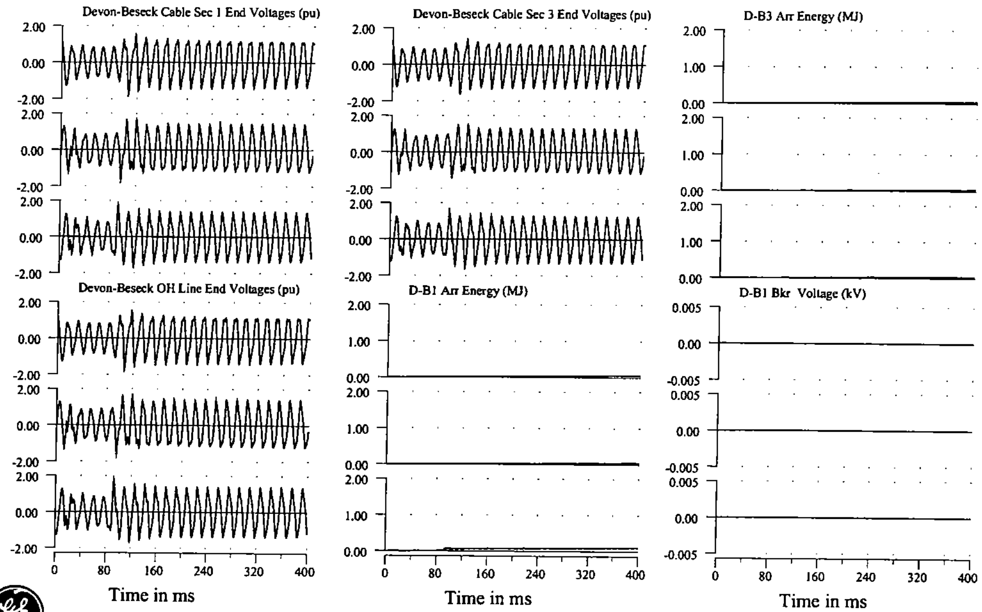
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_17_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_18_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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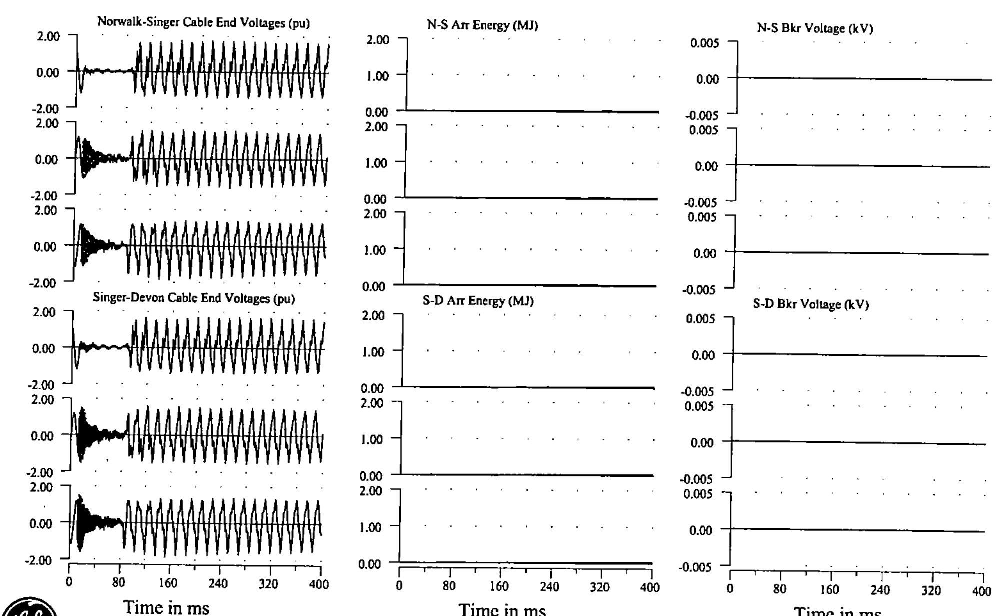
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_18_0
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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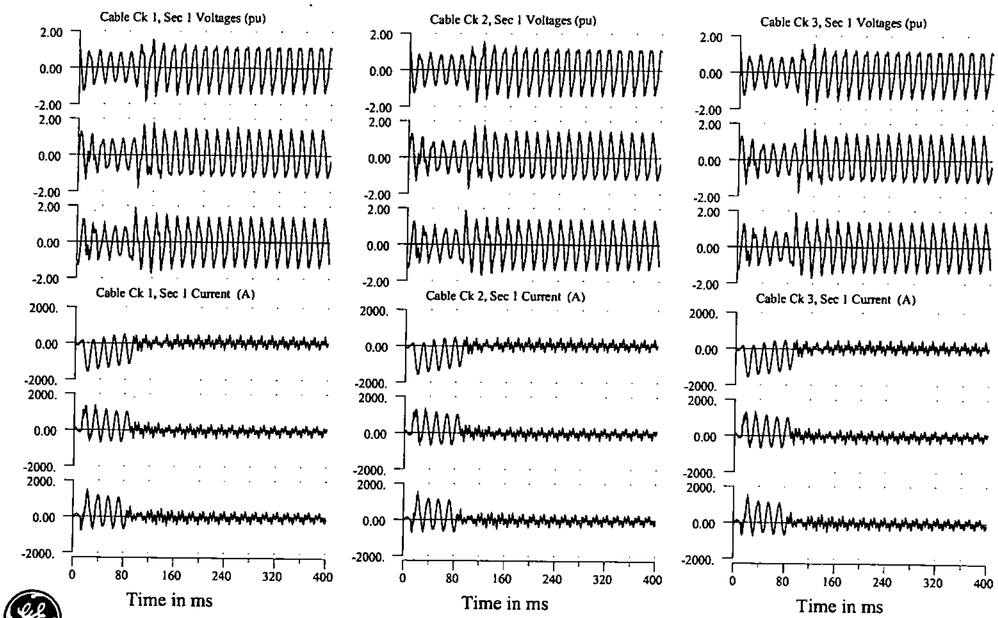
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_18_0
Devon-Beseck 345 kV Cables



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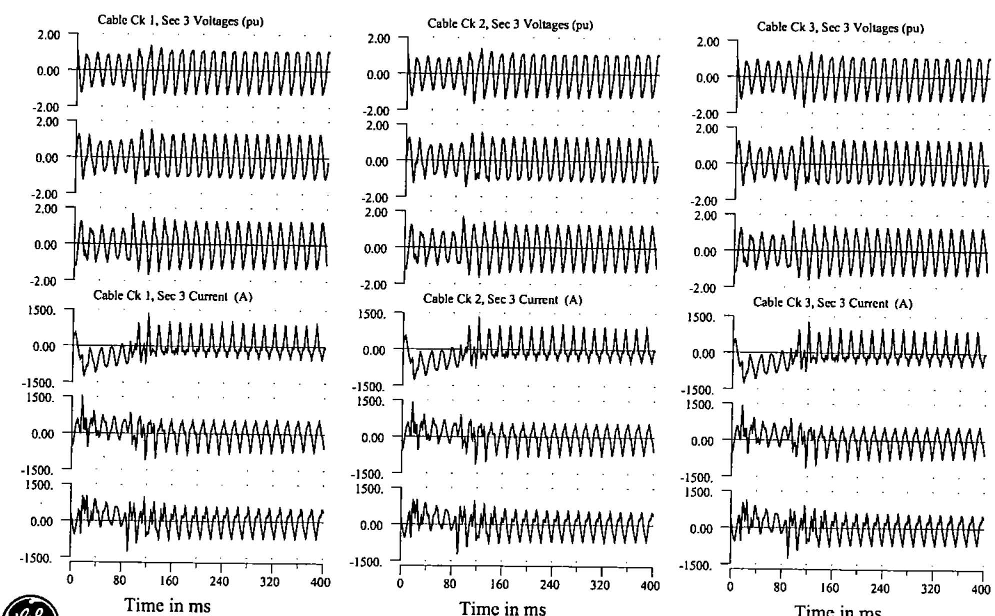
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_18_0
Devon-Beseck 345 kV Cables



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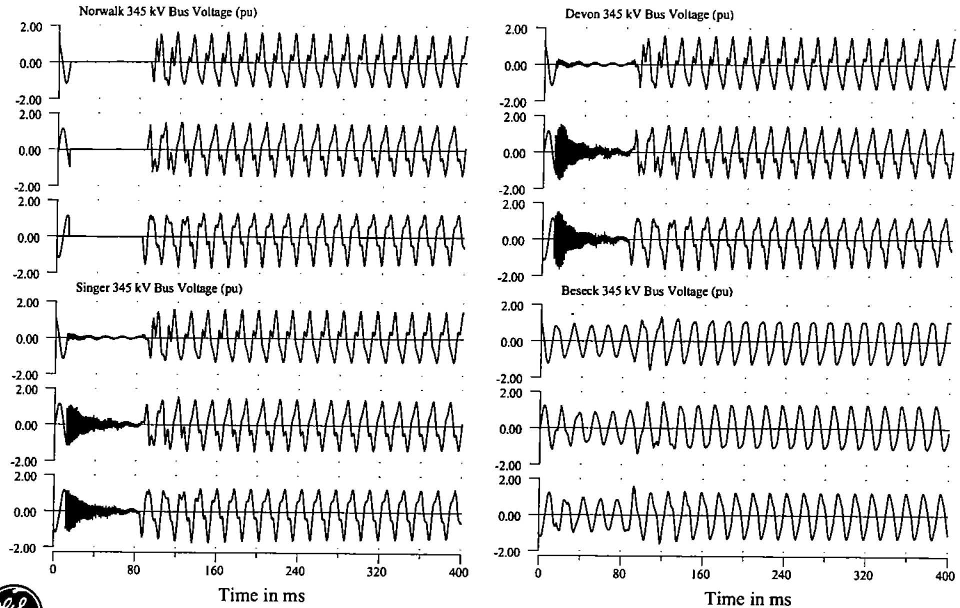
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_18_0
345 kV Bus Voltages



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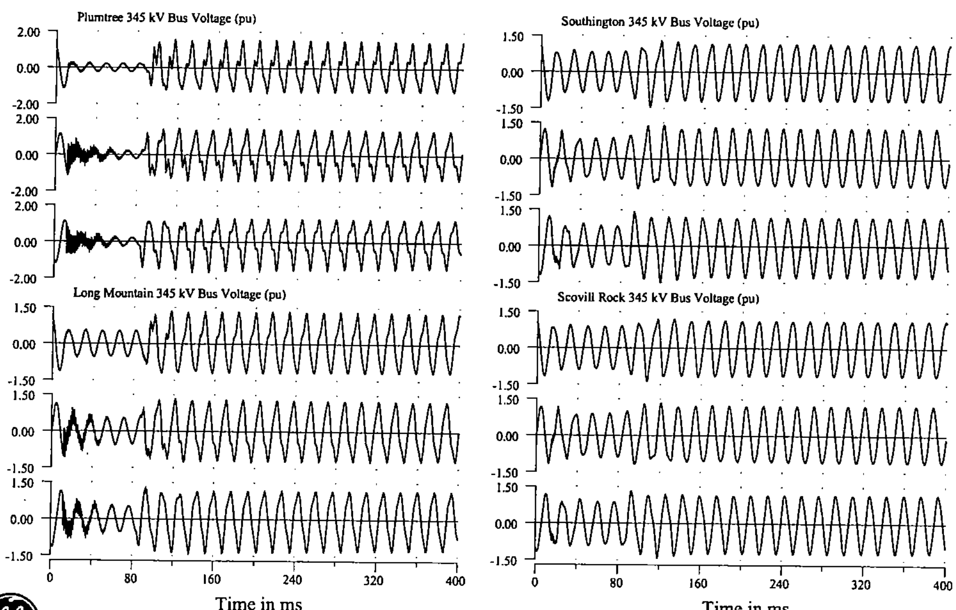
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_18_0
345 kV Bus Voltages



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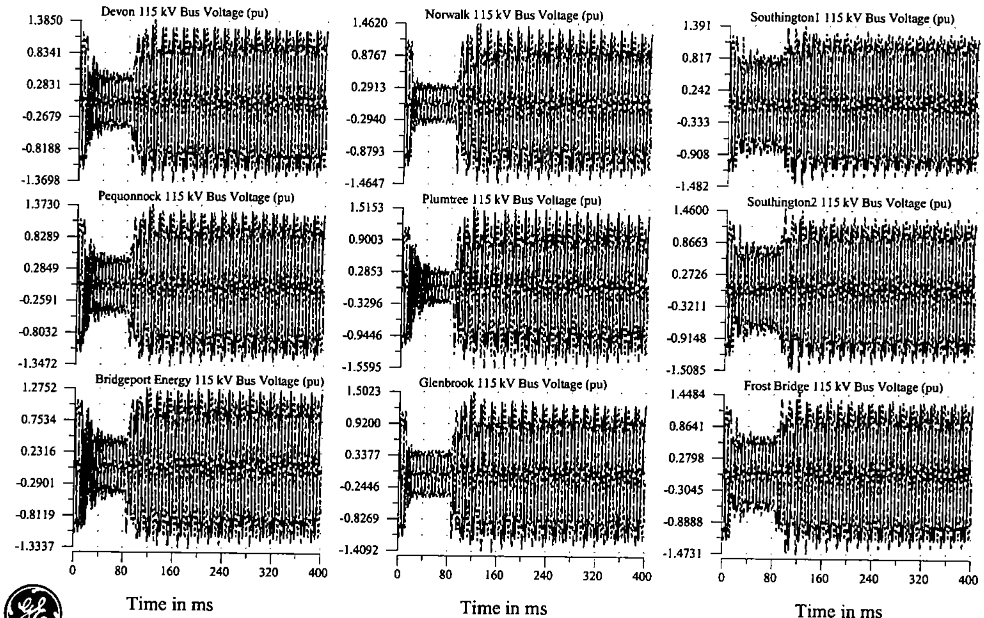
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_18_0

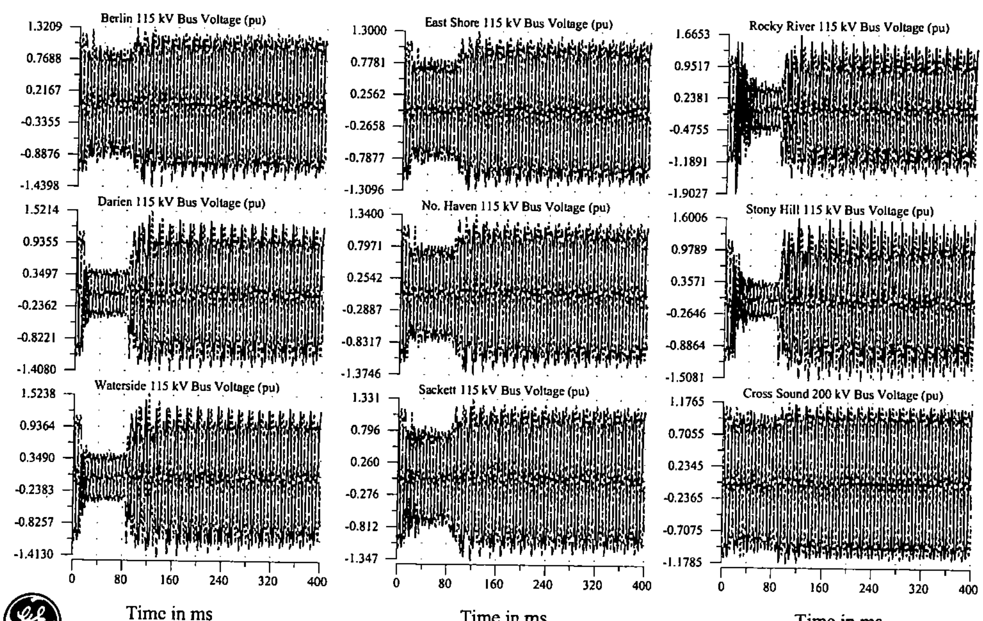
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_18_0

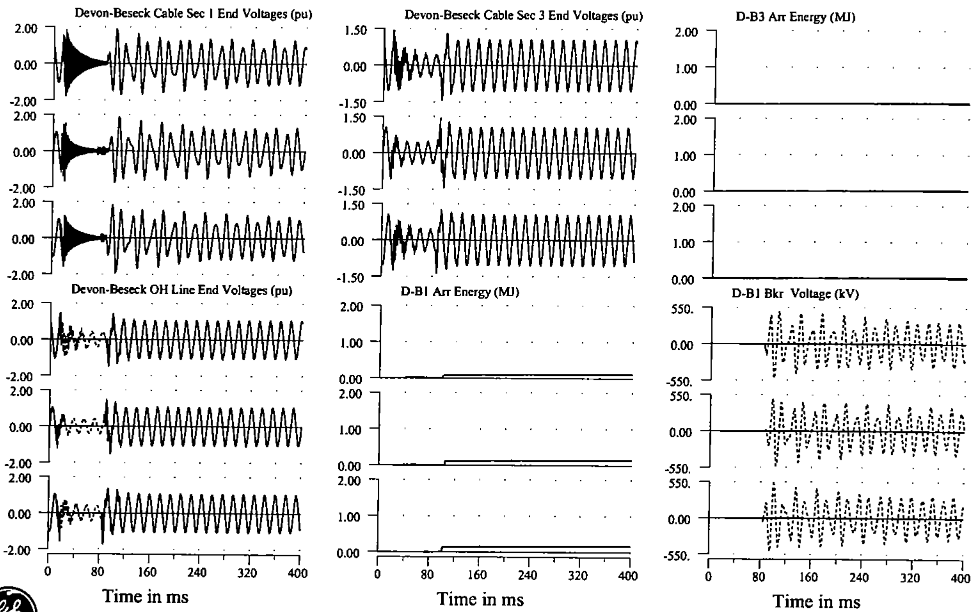
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

DBF_19_0

Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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Northeast Utilities: Middletown to Norwalk P2 Project Transient Study

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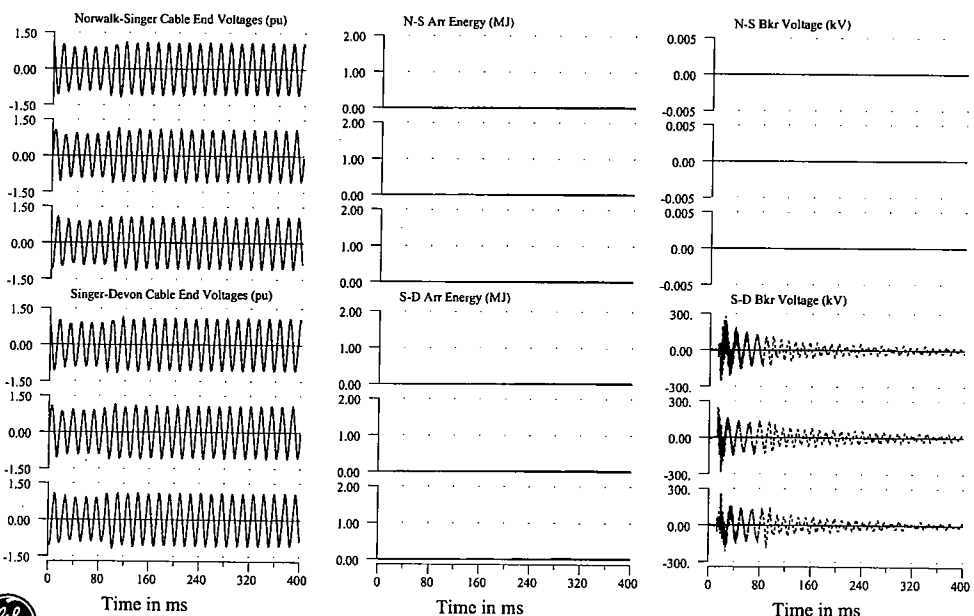
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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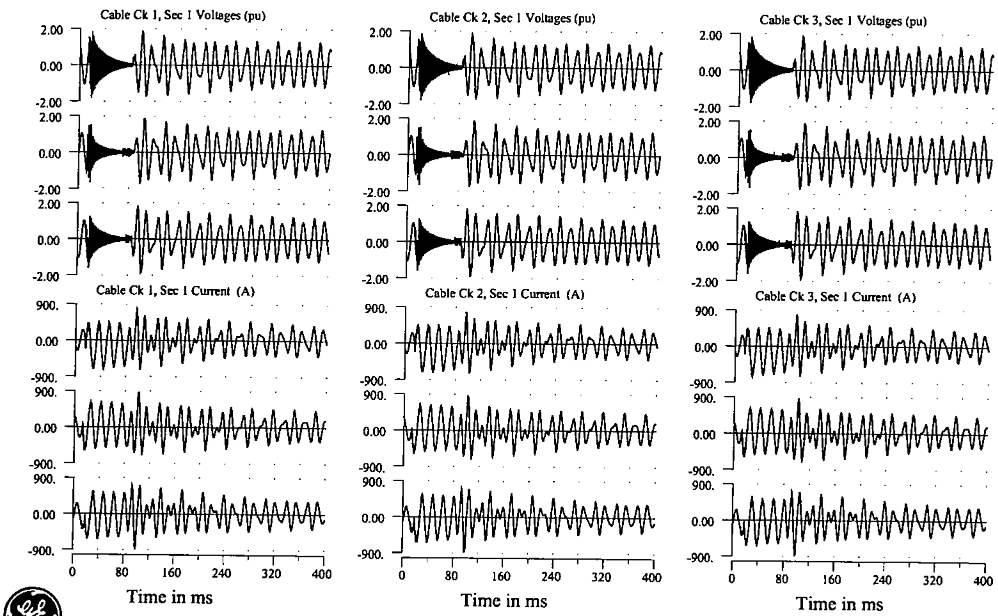
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_19_0
Devon-Beseck 345 kV Cables



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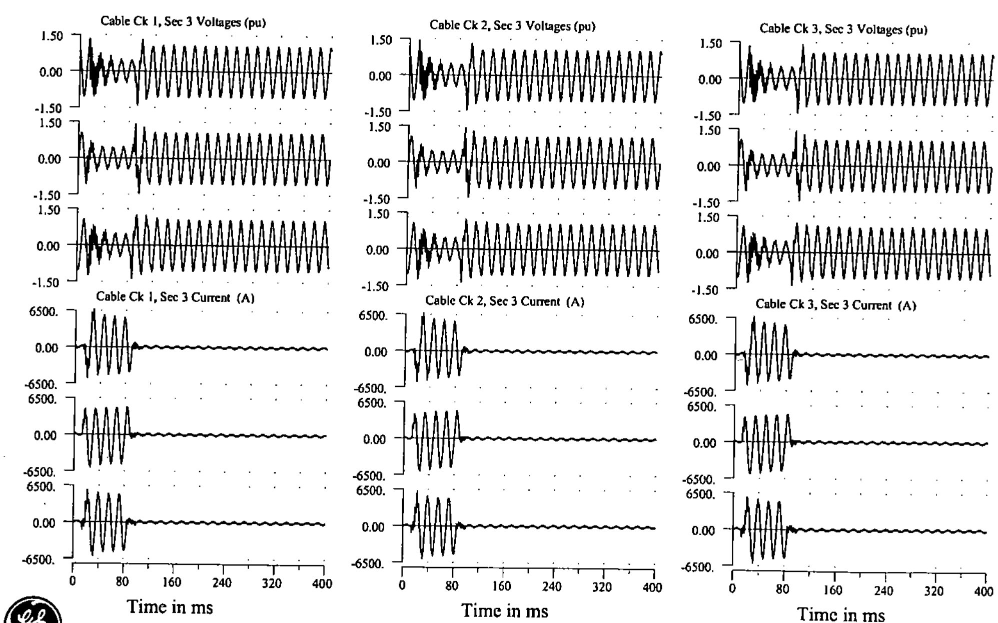
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_19_0
Devon-Beseck 345 kV Cables



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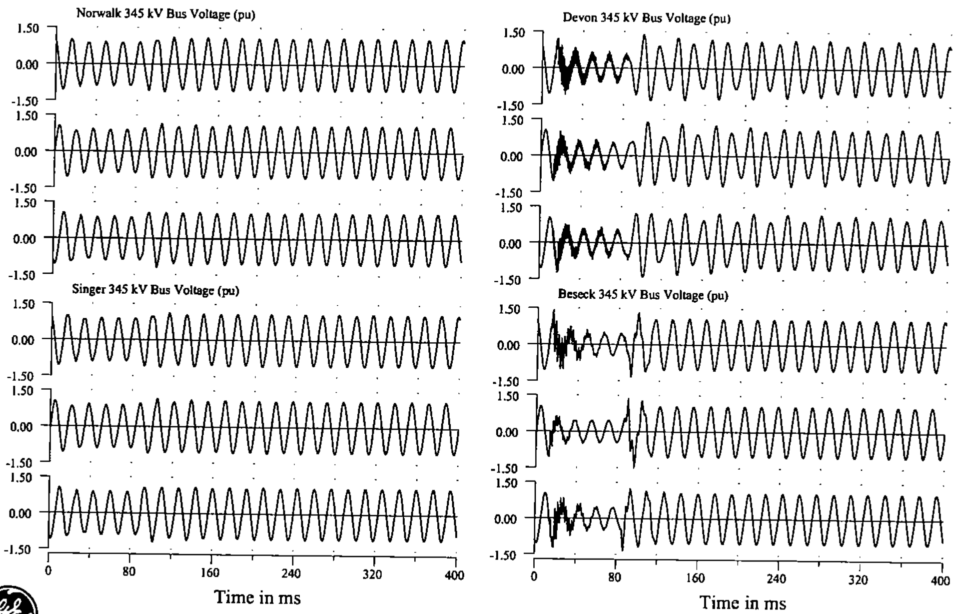
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_19_0
345 kV Bus Voltages



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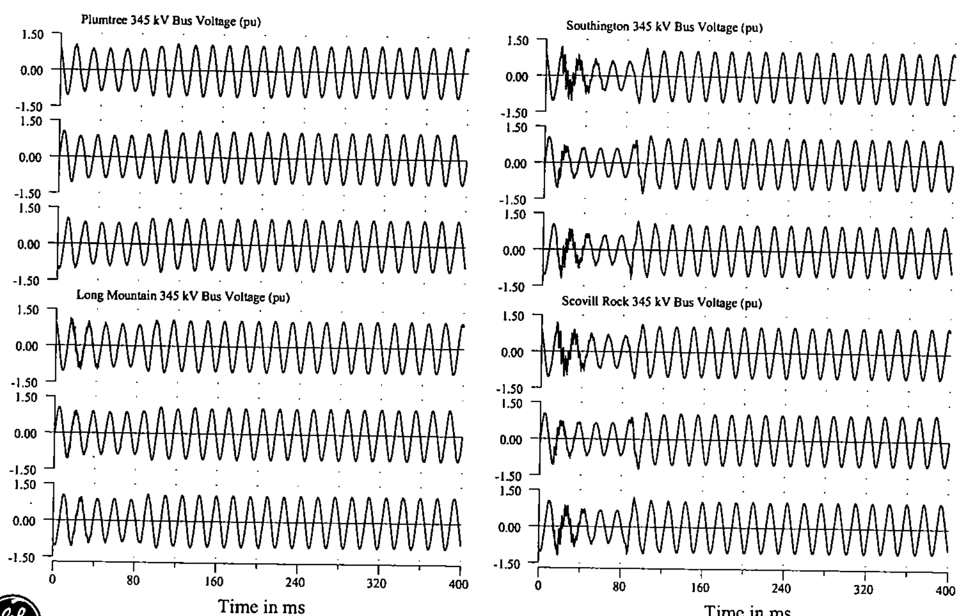
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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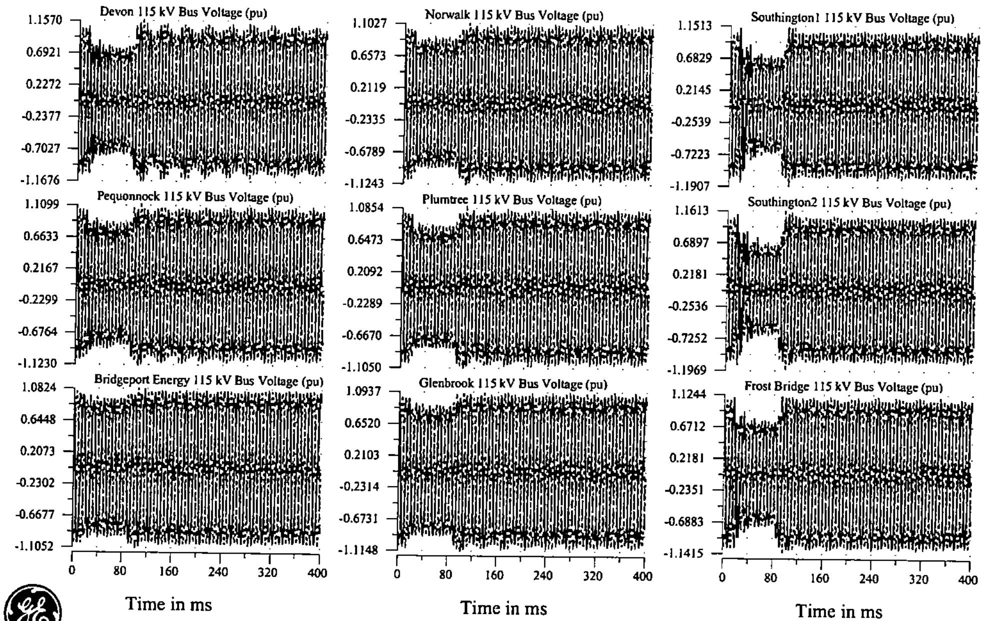
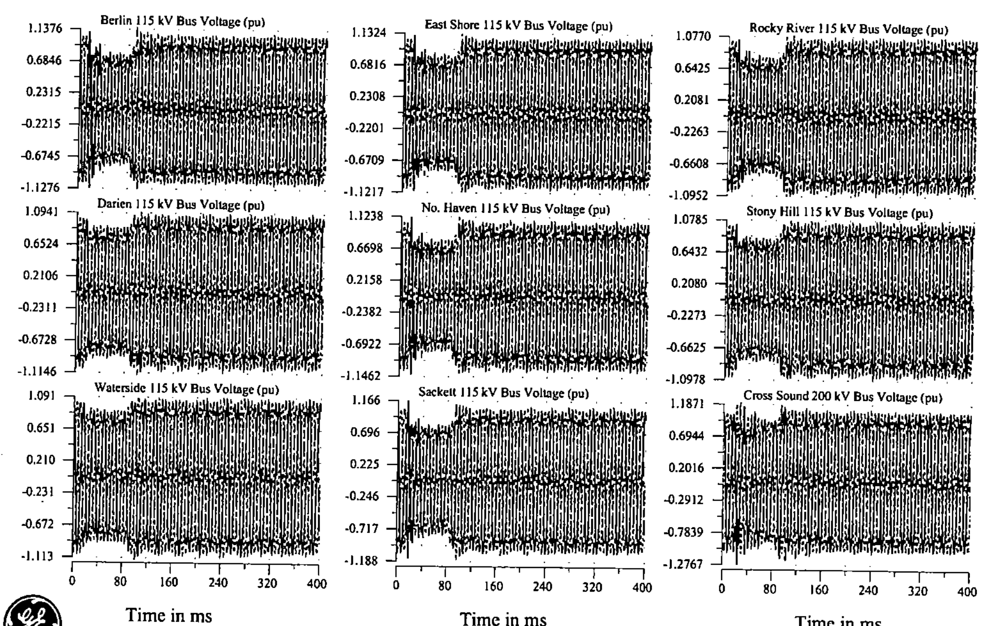
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_19_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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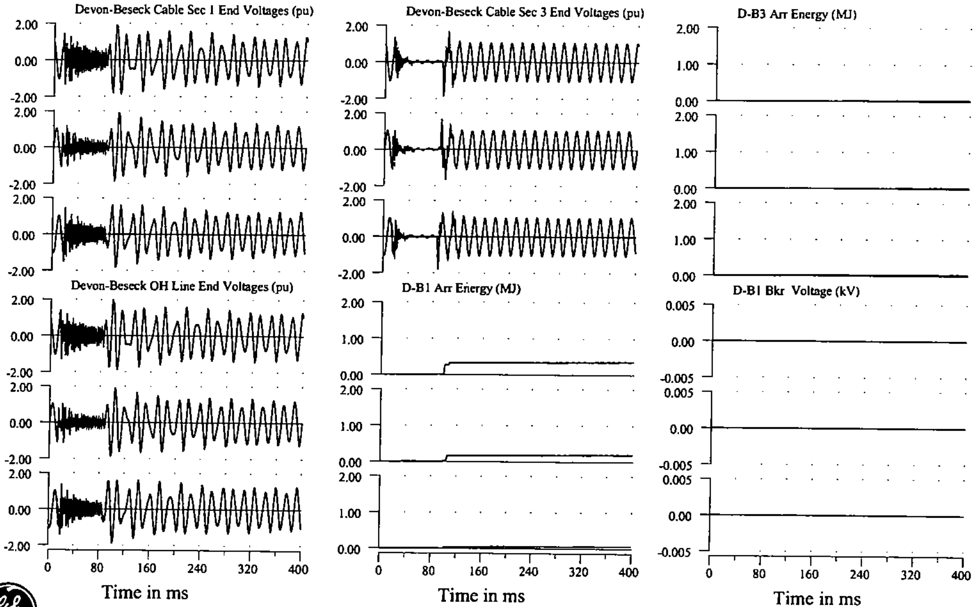
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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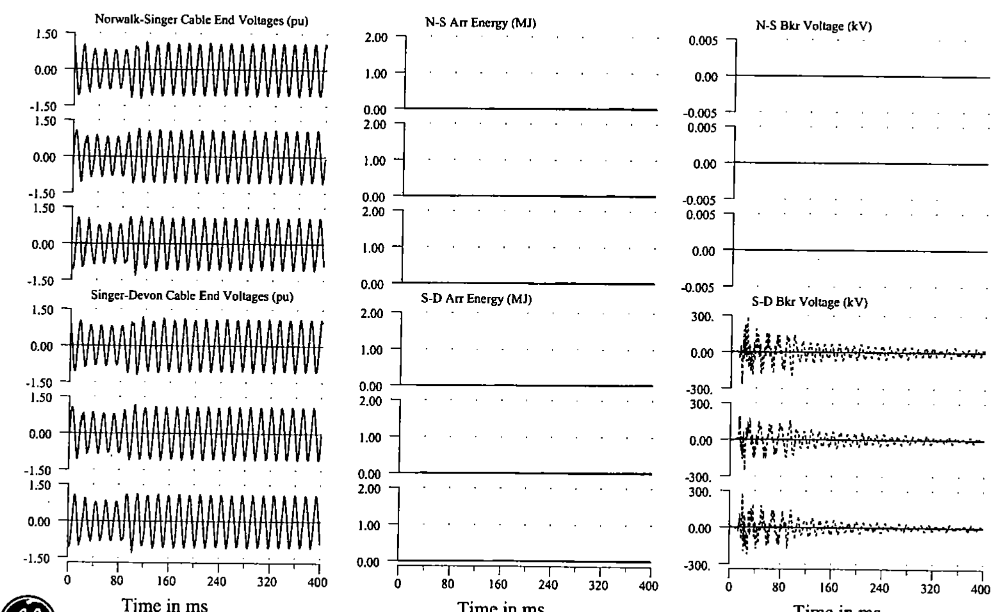
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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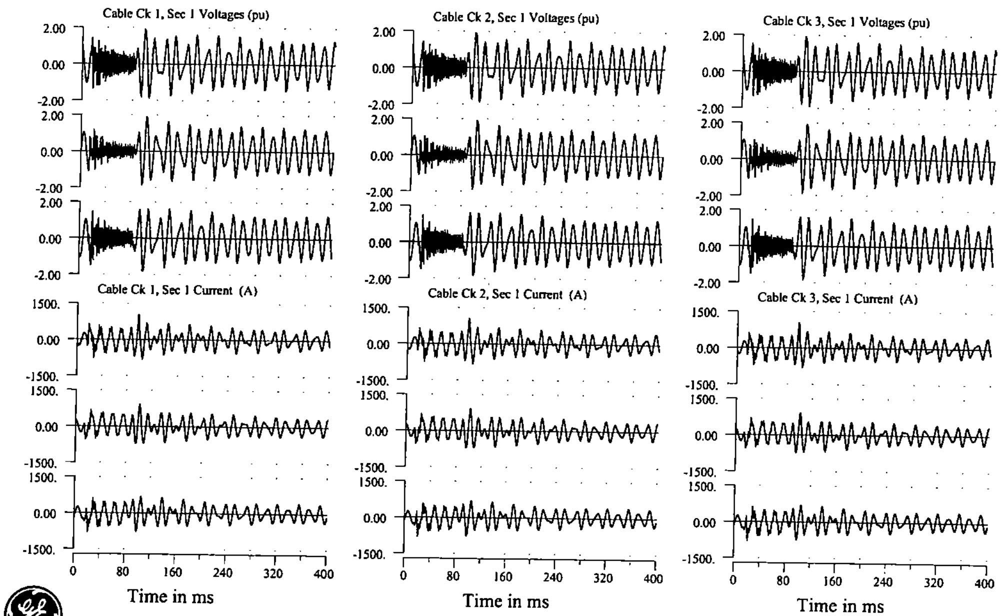
Devon-Beseck 345 kV Cables



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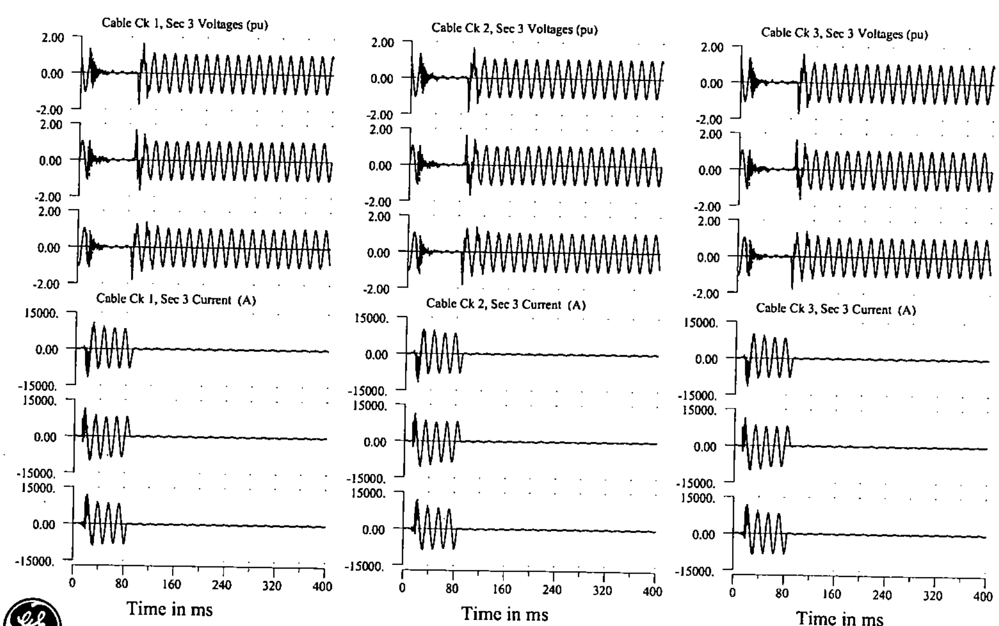
Devon-Beseck 345 kV Cables



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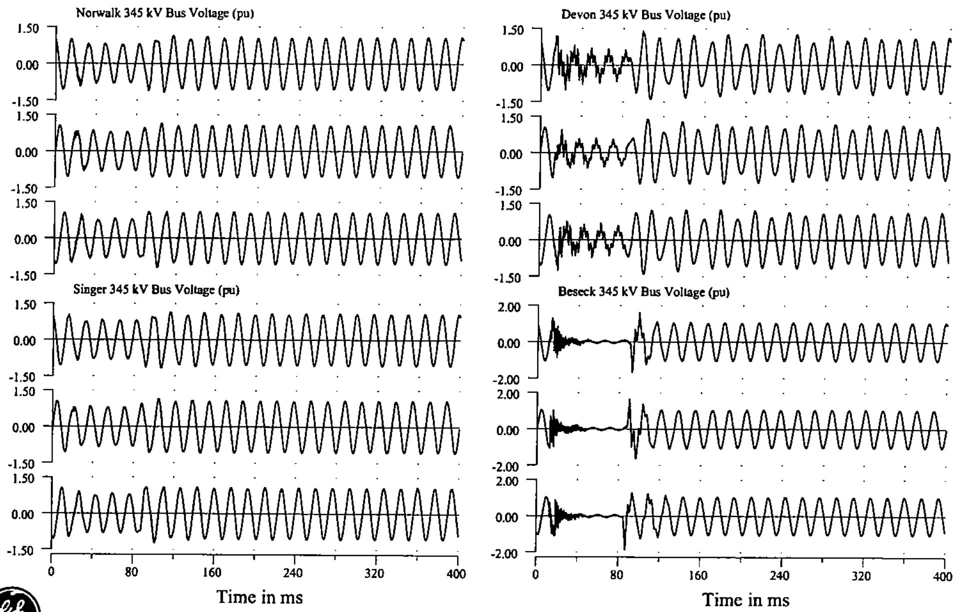
DBF_20_90
345 kV Bus Voltages



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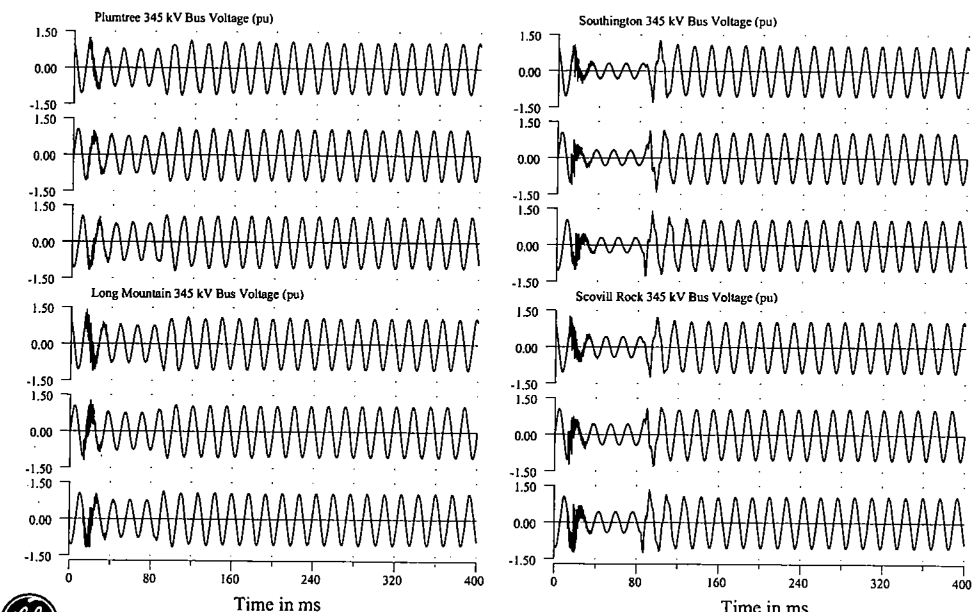
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_20_90
345 kV Bus Voltages



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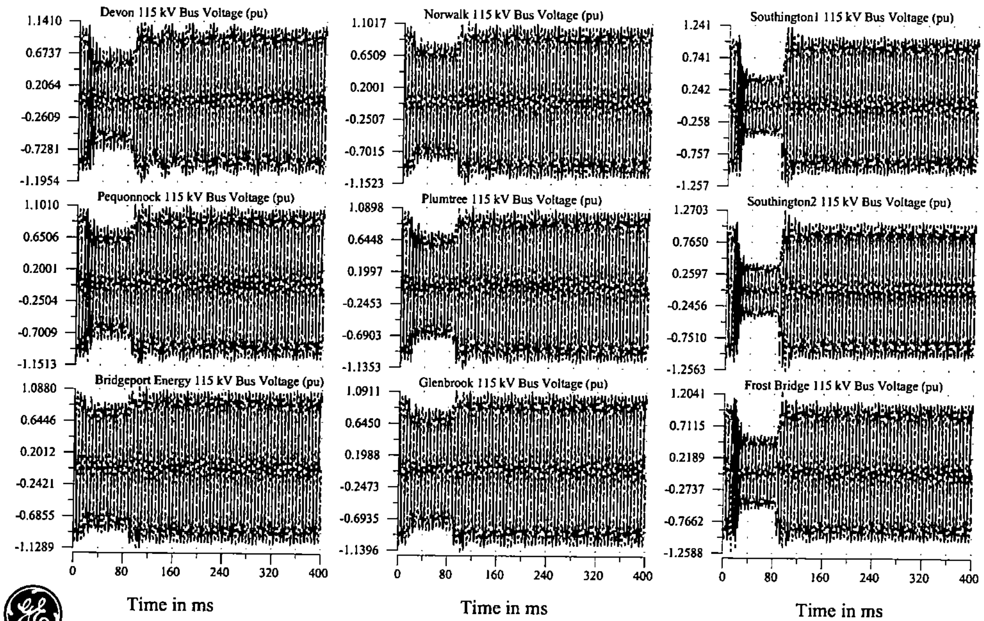
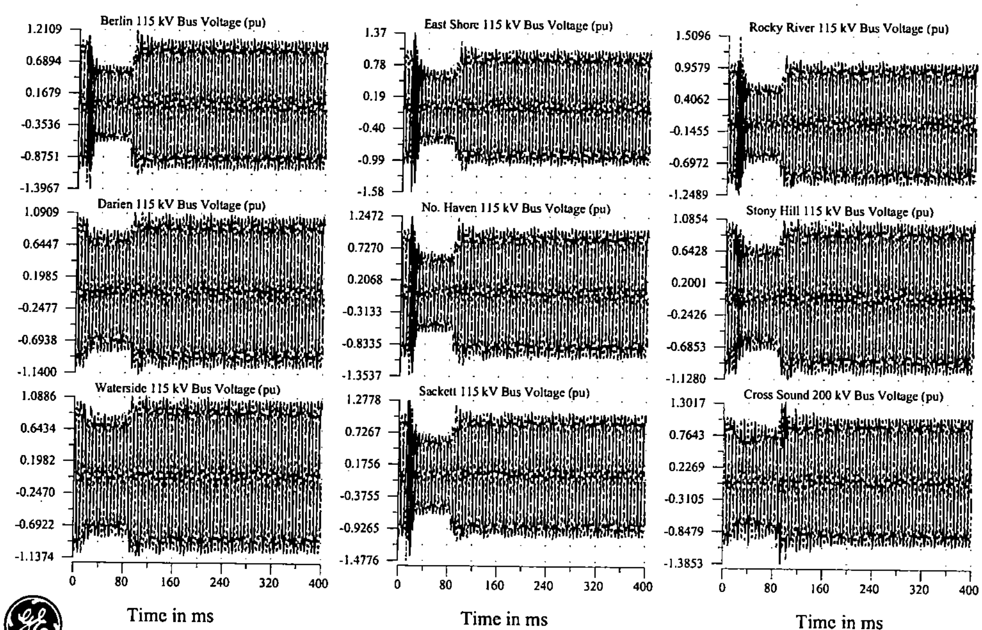
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_20_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_20_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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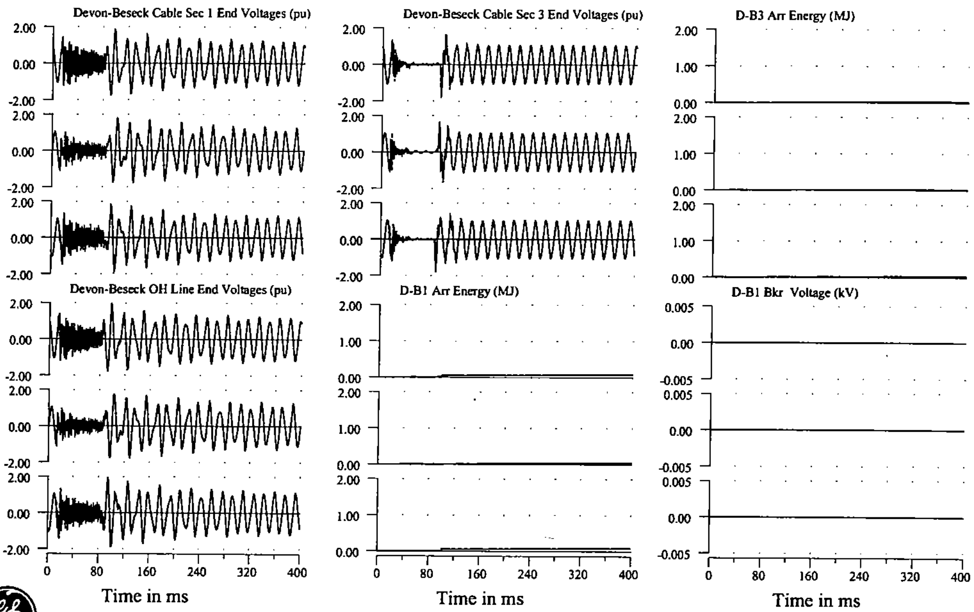
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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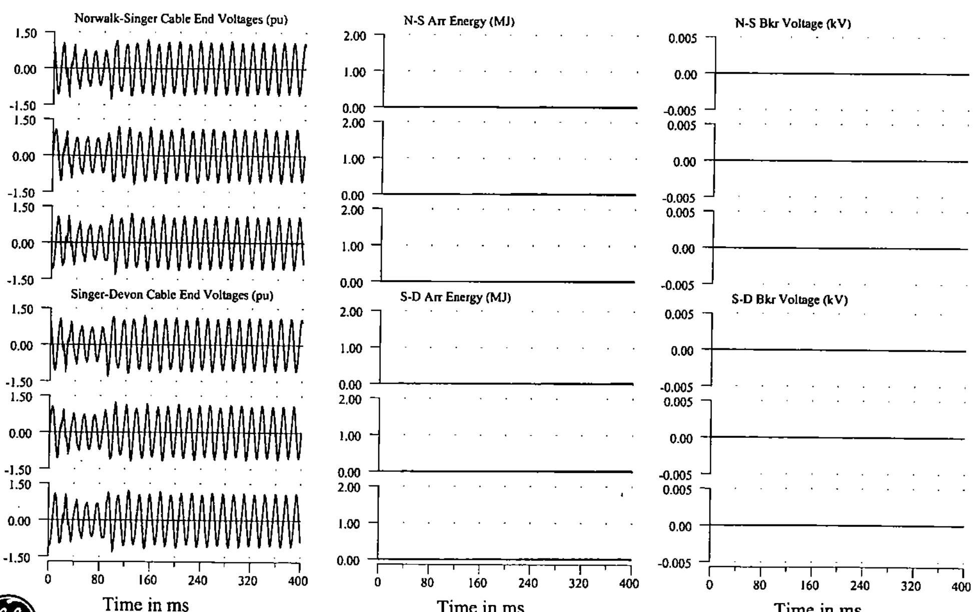
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_21_90
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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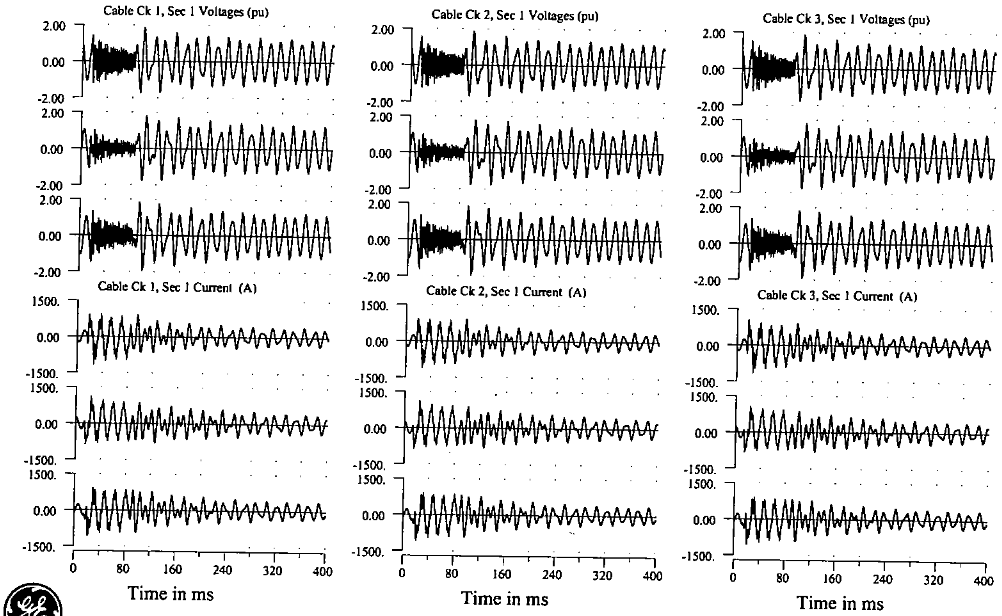
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_21_90
Devon-Beseck 345 kV Cables



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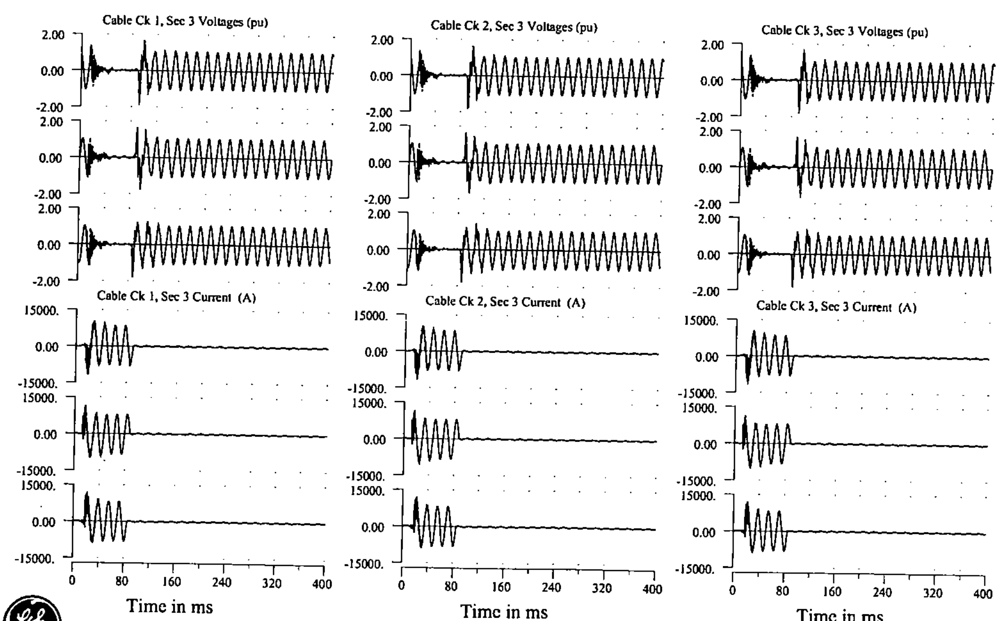
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_21_90
Devon-Beseck 345 kV Cables



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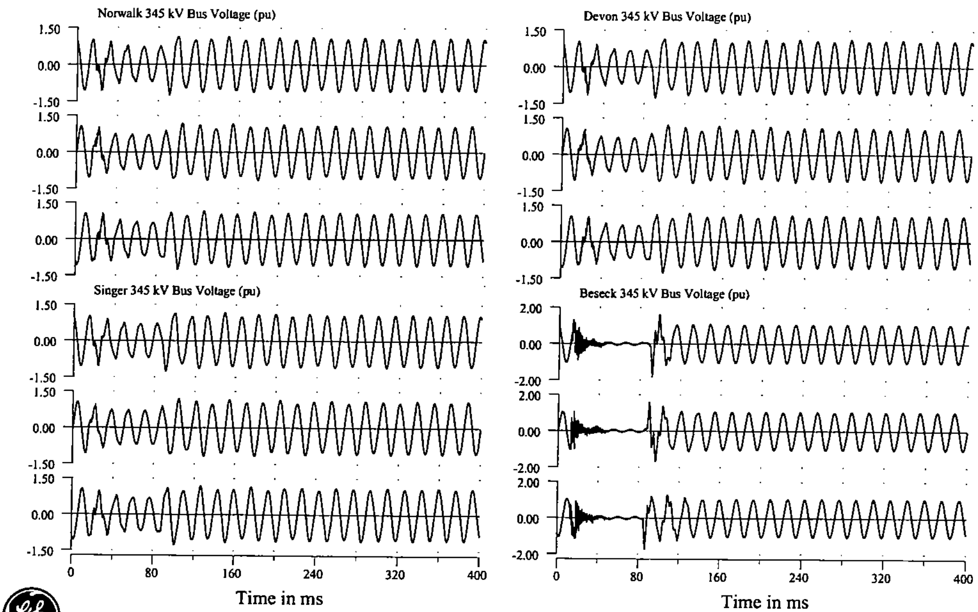
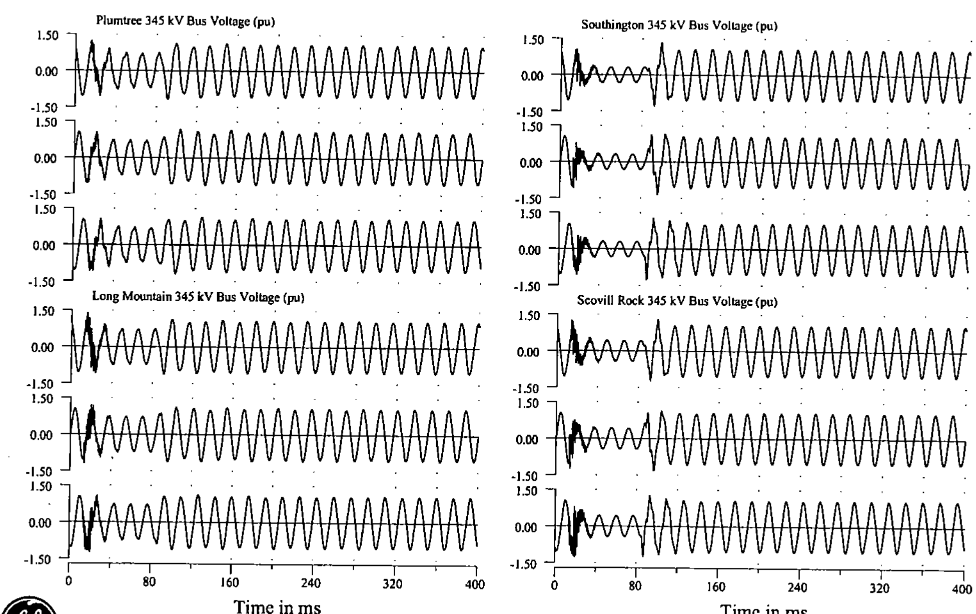
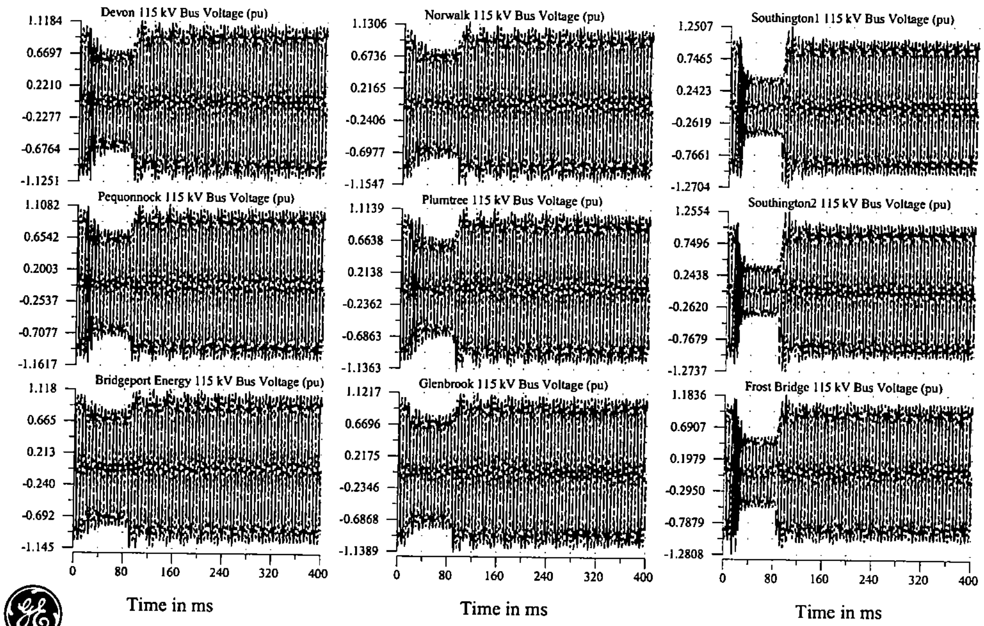
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_21_90
345 kV Bus Voltages



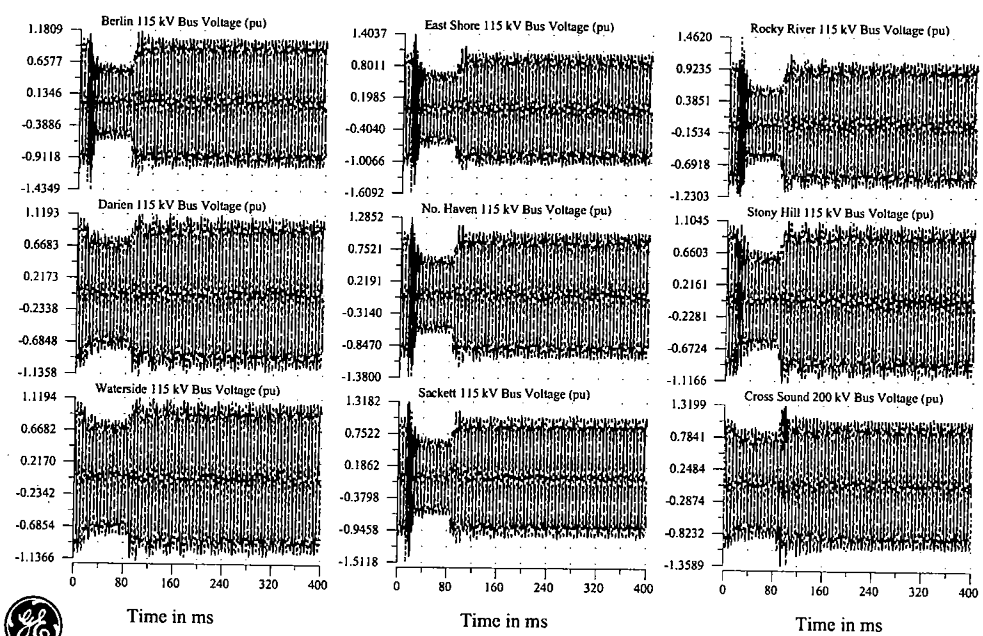
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_21_90
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_21_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_21_90
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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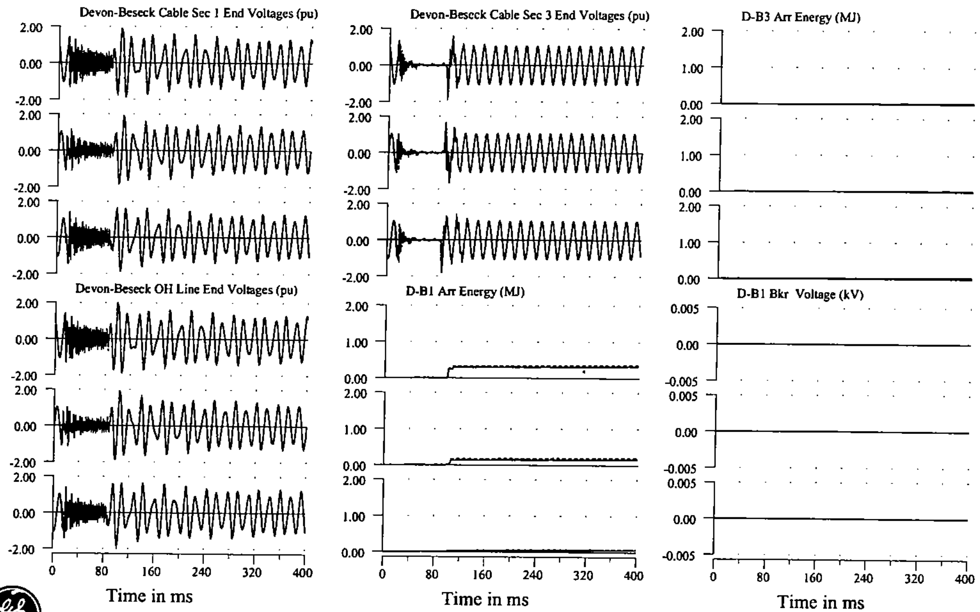
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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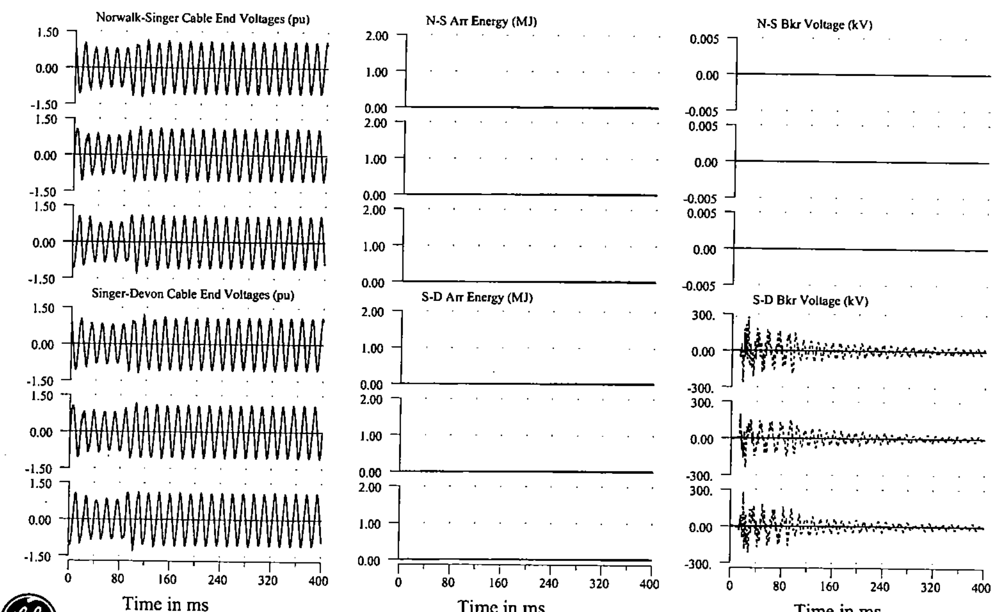
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_22_90
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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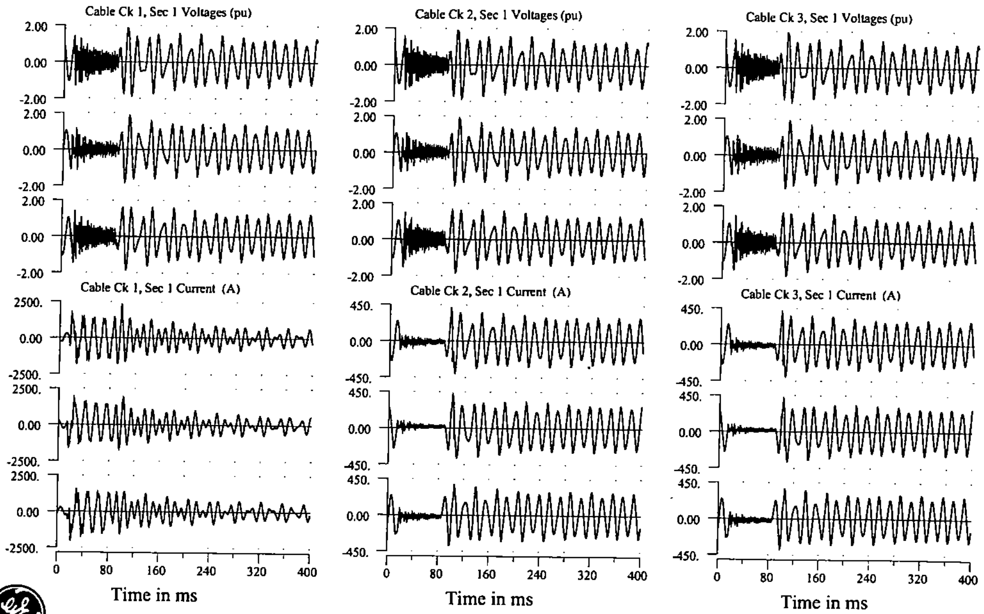
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_22_90
Devon-Beseck 345 kV Cables



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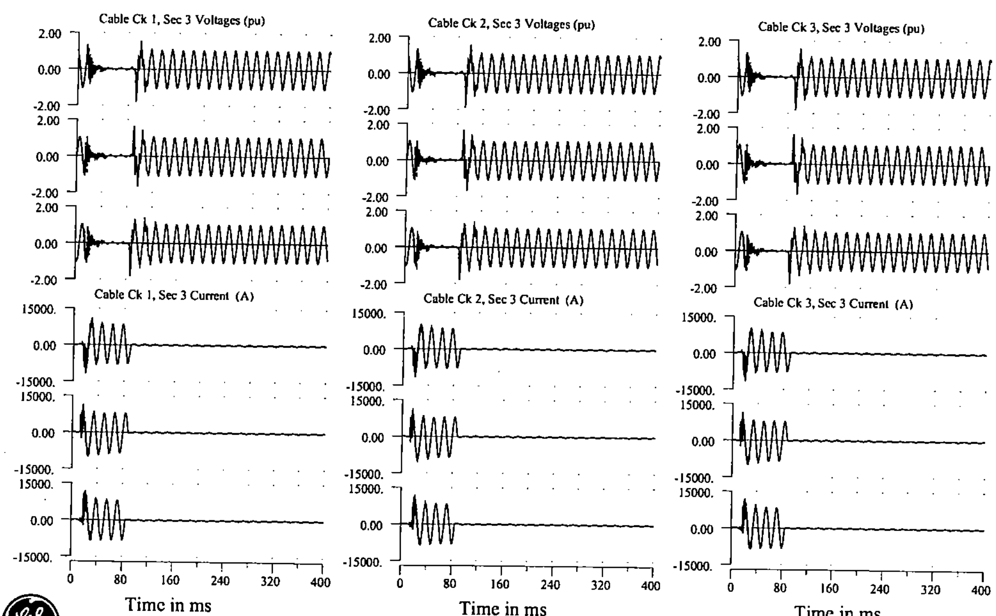
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_22_90
Devon-Beseck 345 kV Cables



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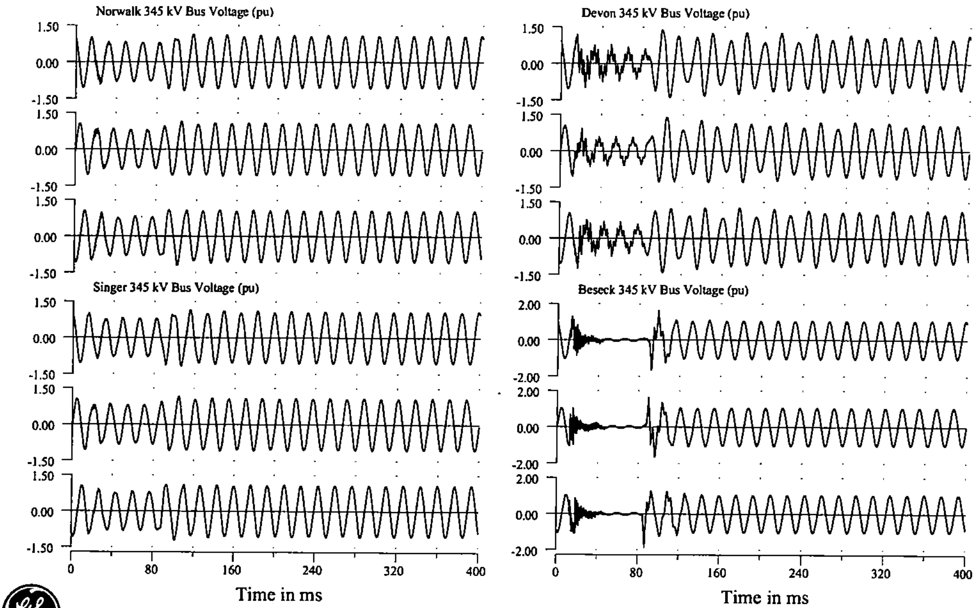
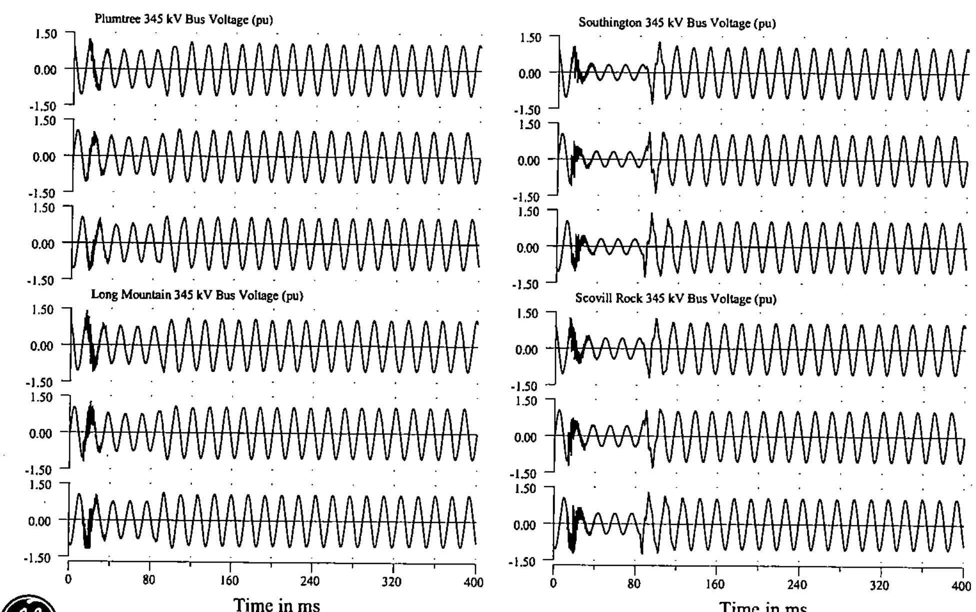
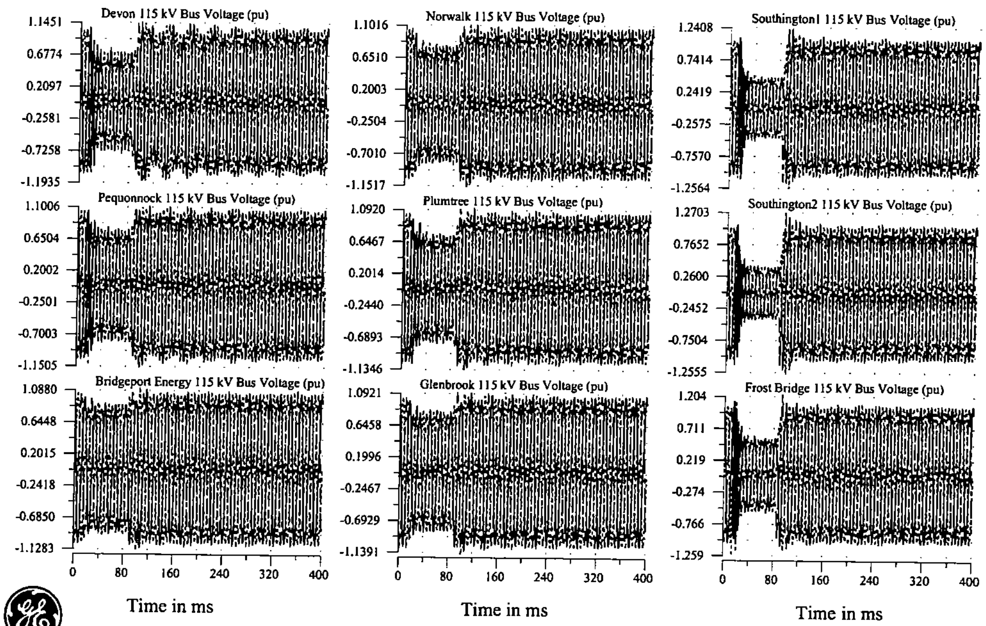
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_22_90
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_22_90
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_22_90
115 kV Bus Voltages and Capacitor Bank Locations



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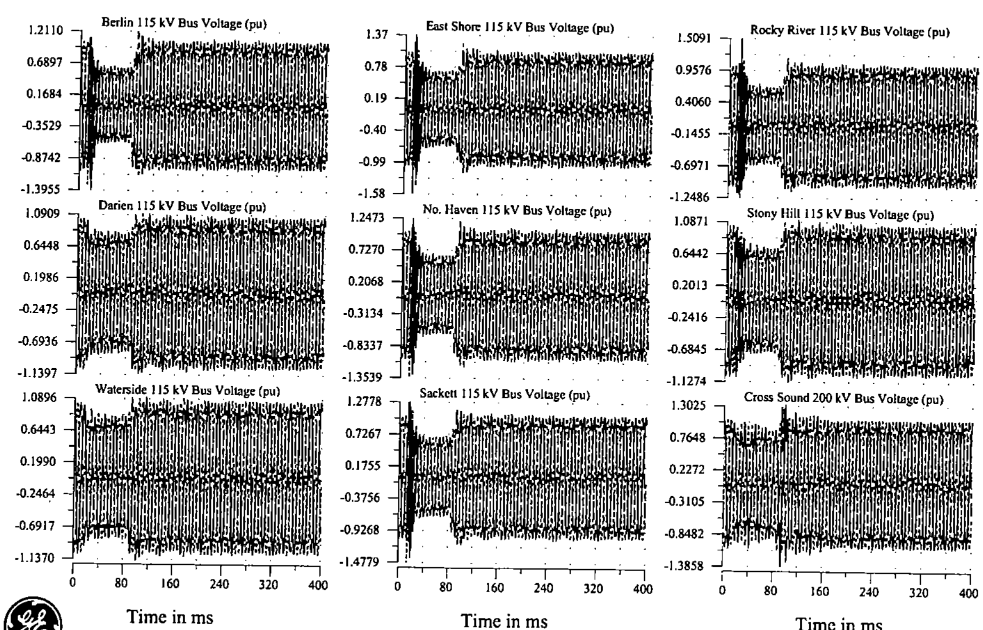
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_22_90
115 kV Bus Voltages and Capacitor Bank Locations



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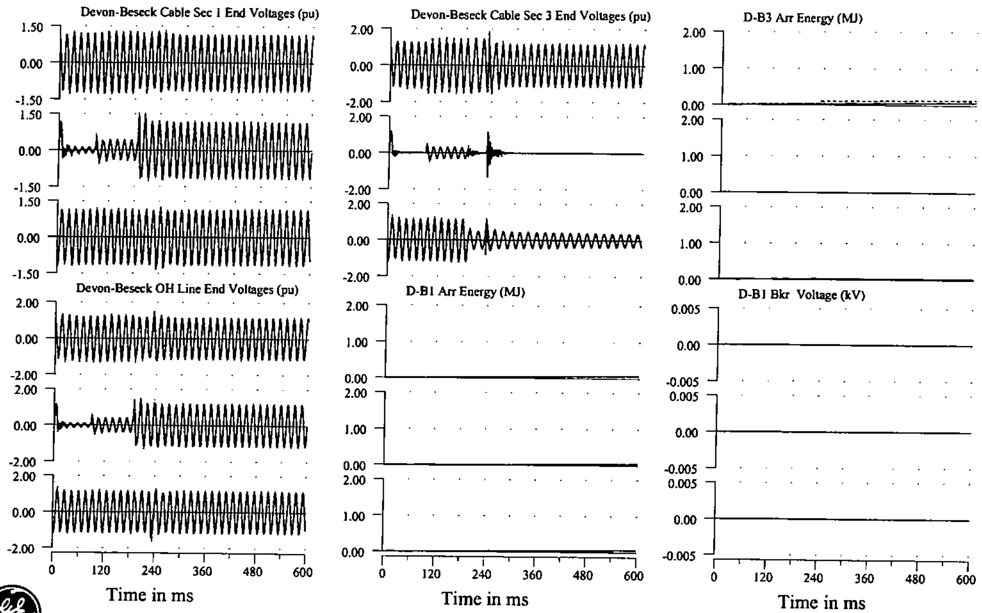
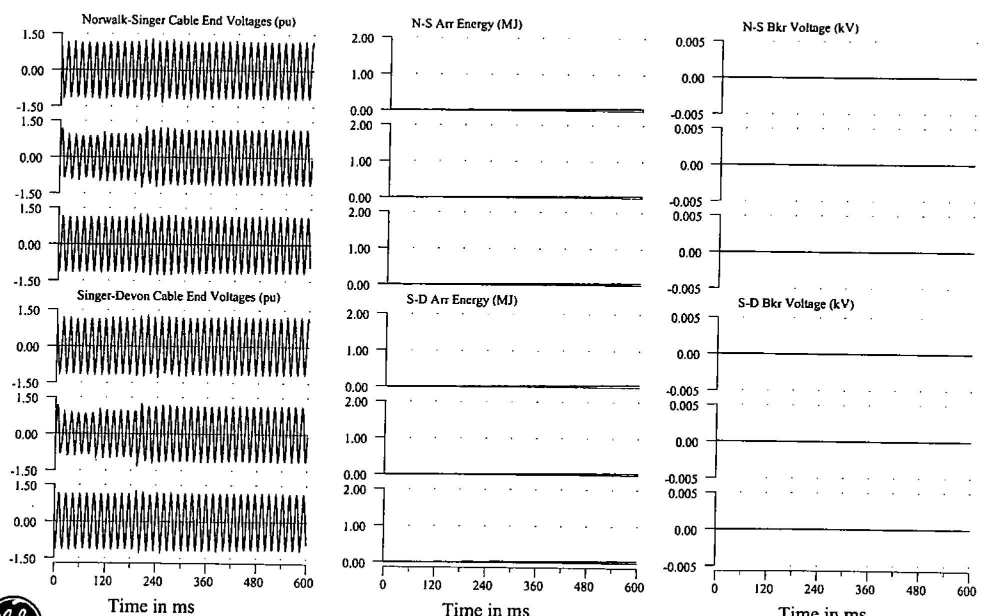
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_23_0
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_23_0
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
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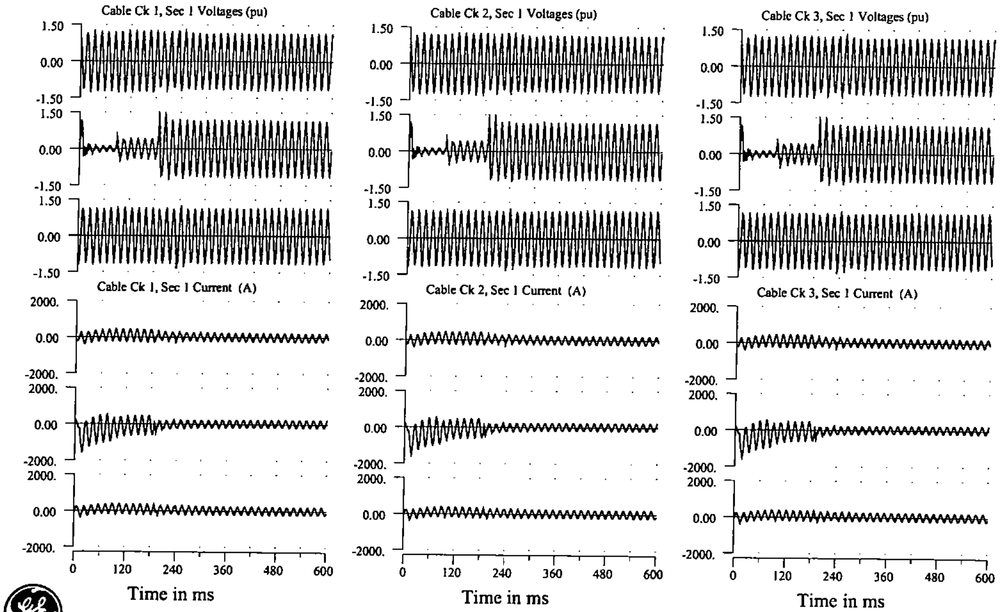
Devon-Beseck 345 kV Cables



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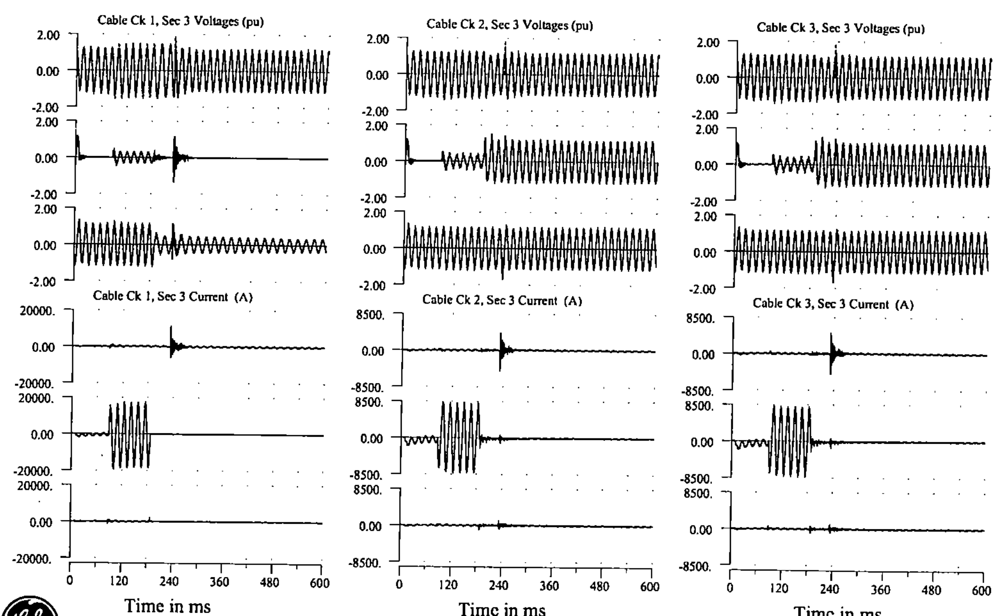
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_23_0
Devon-Beseck 345 kV Cables



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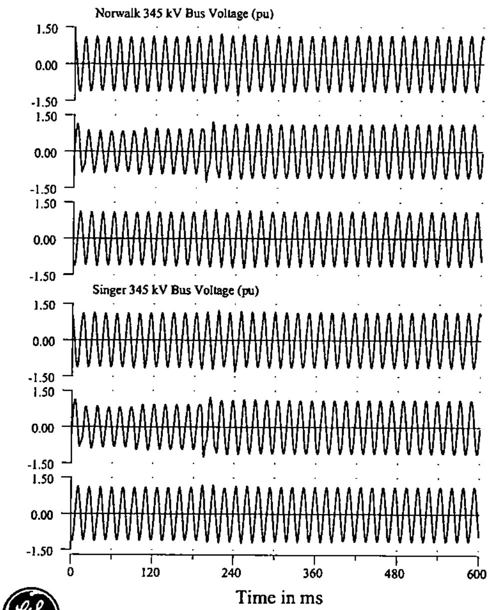
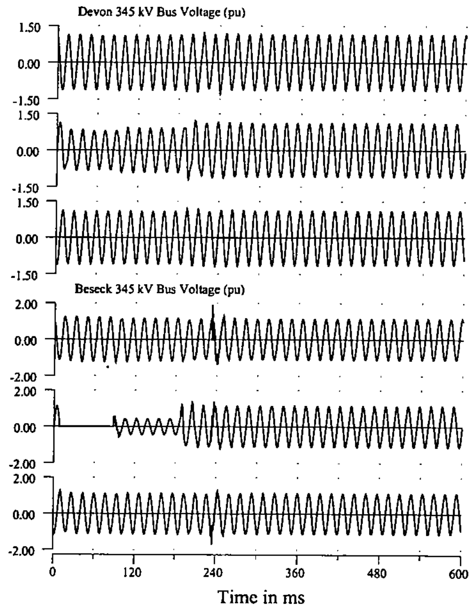
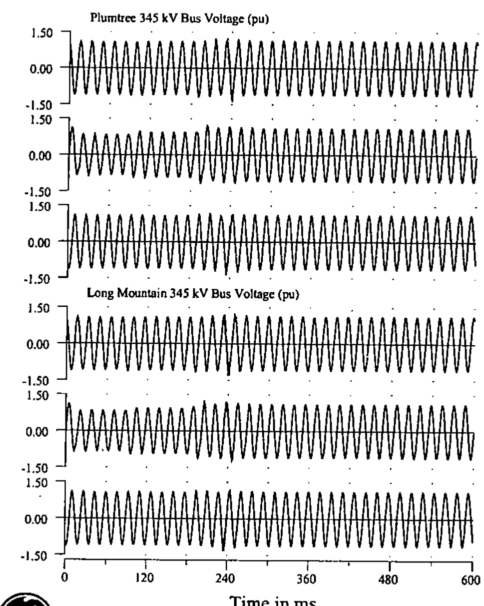
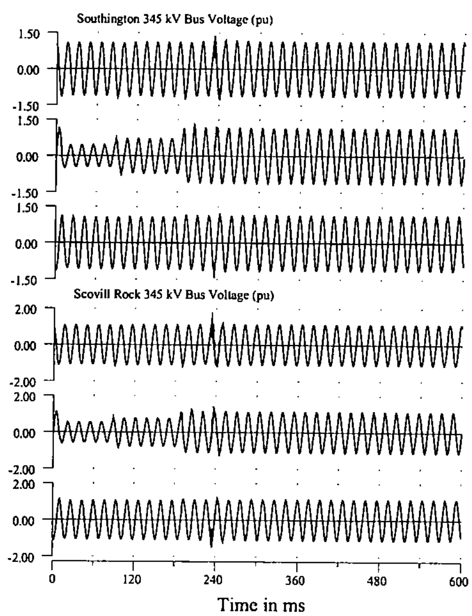
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_23_0
345 kV Bus Voltages



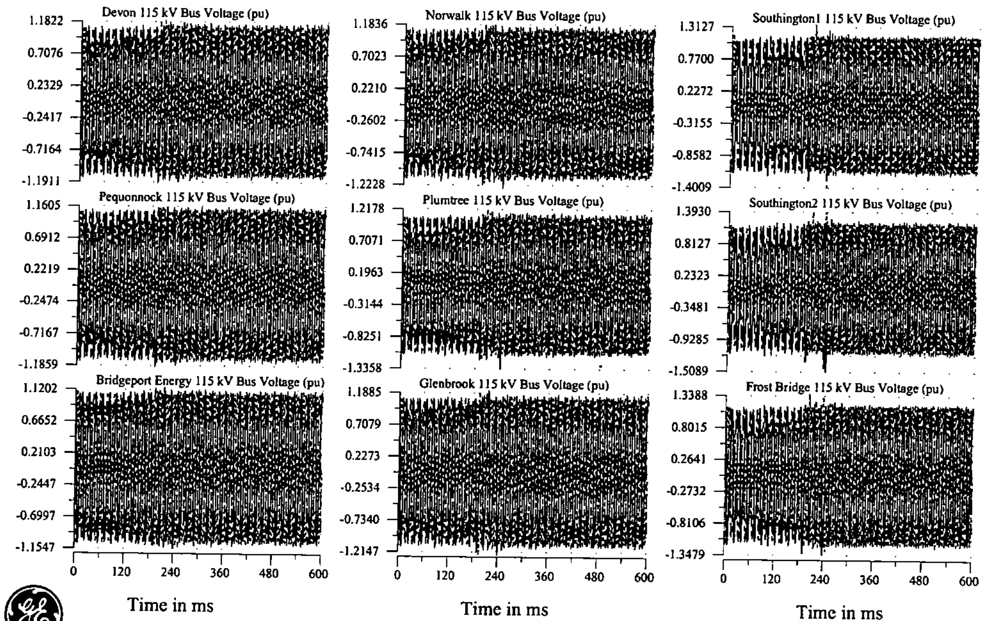


Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_23_0
345 kV Bus Voltages

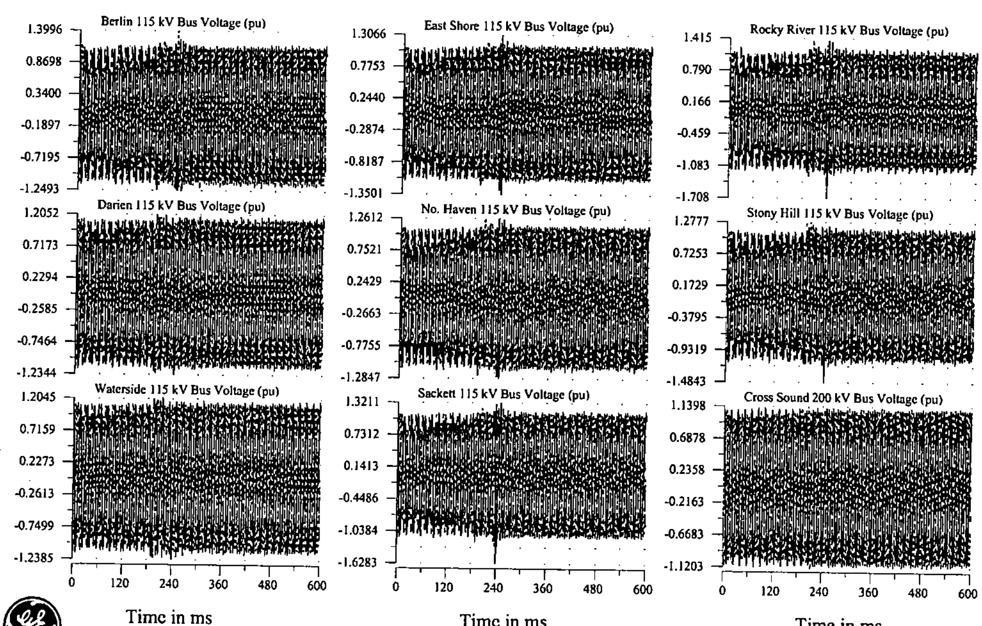




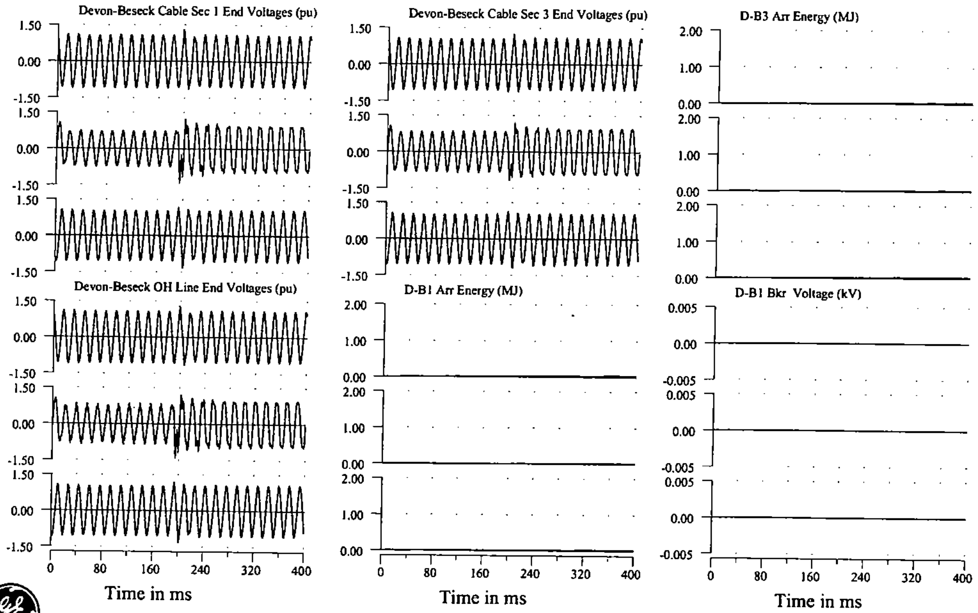
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_23_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
DBF_23_0
115 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
NSF_01
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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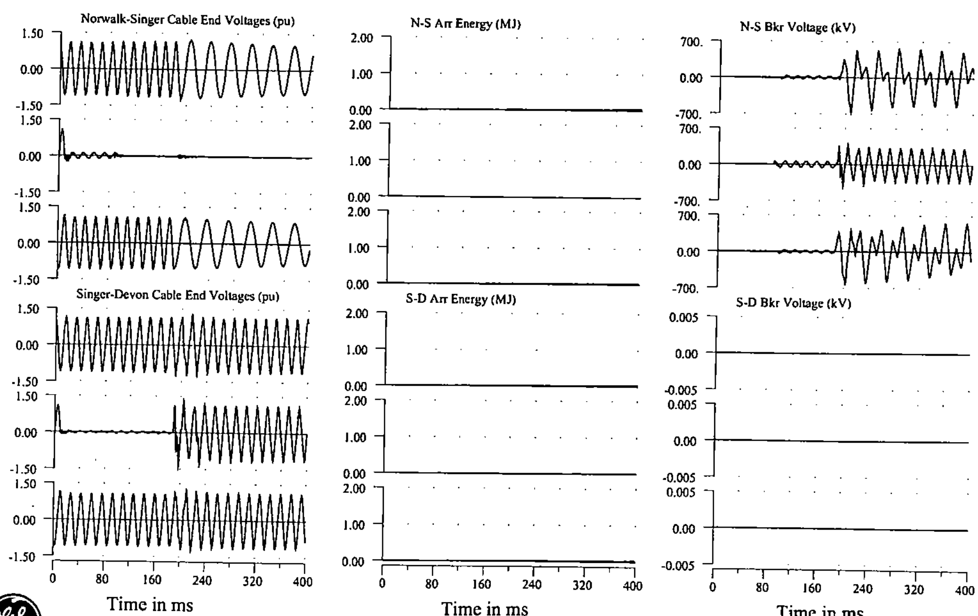
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
NSF_01
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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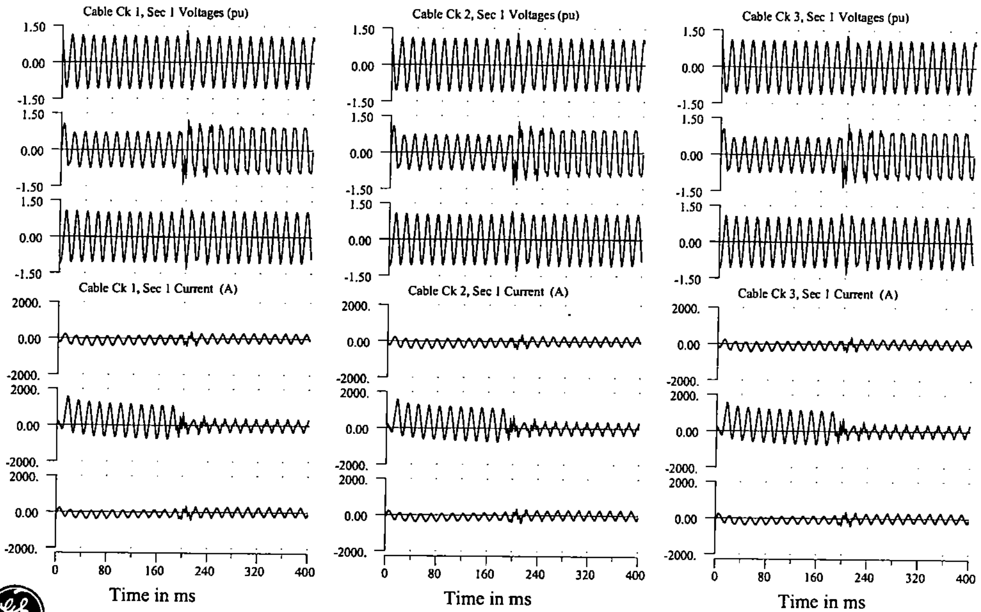
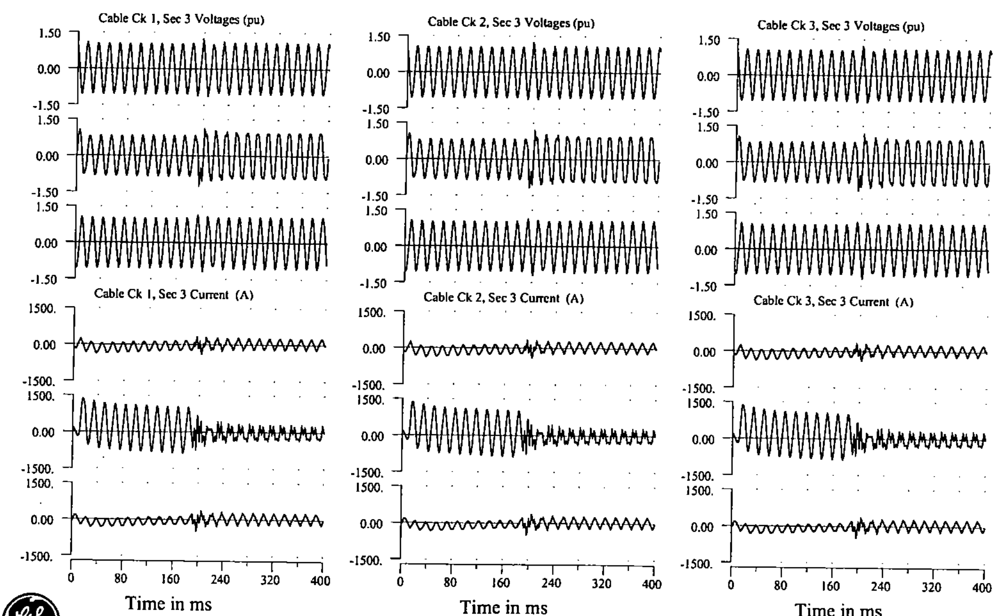
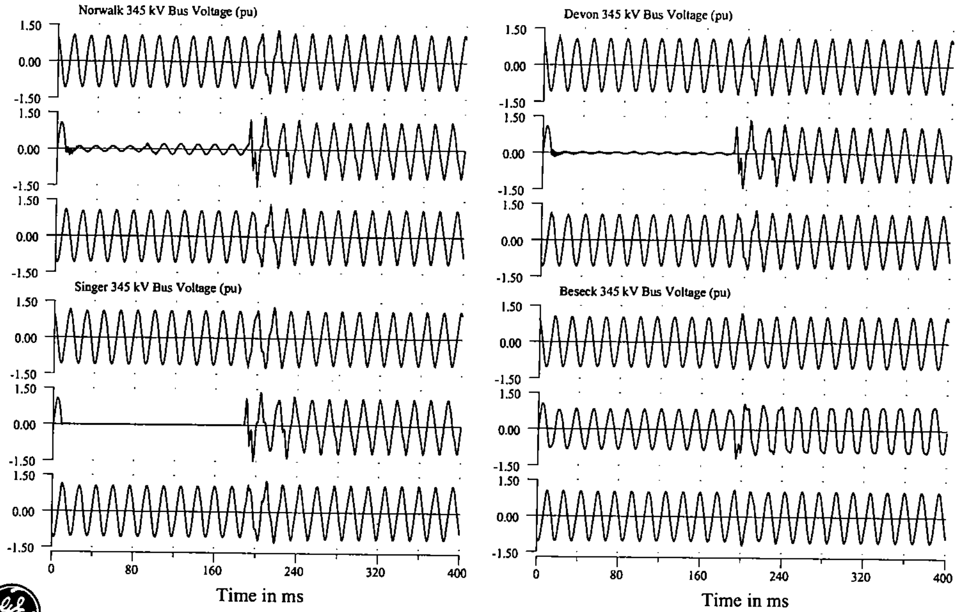
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
NSF_01
Devon-Beseck 345 kV Cables



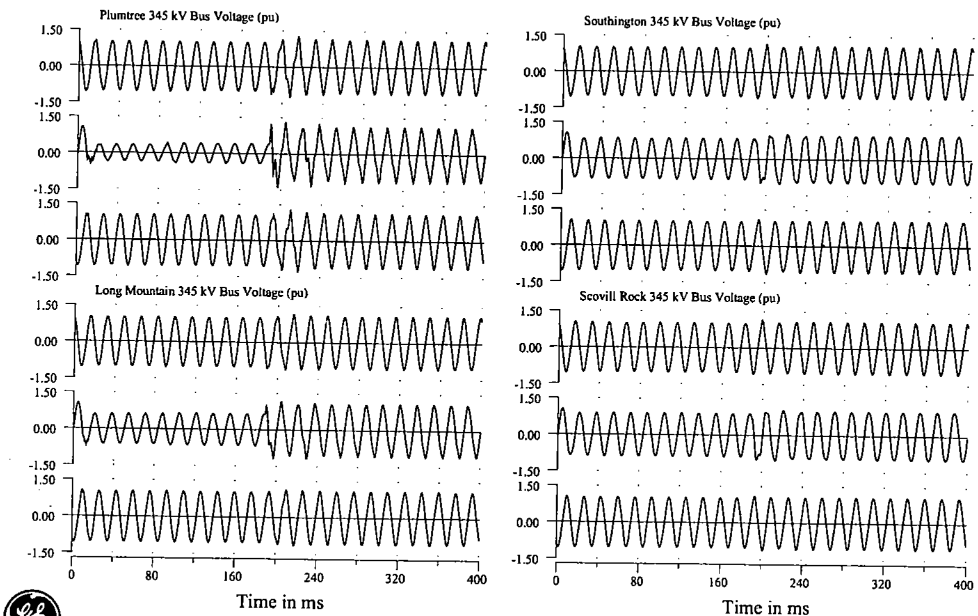
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
NSF_01
Devon-Beseck 345 kV Cables



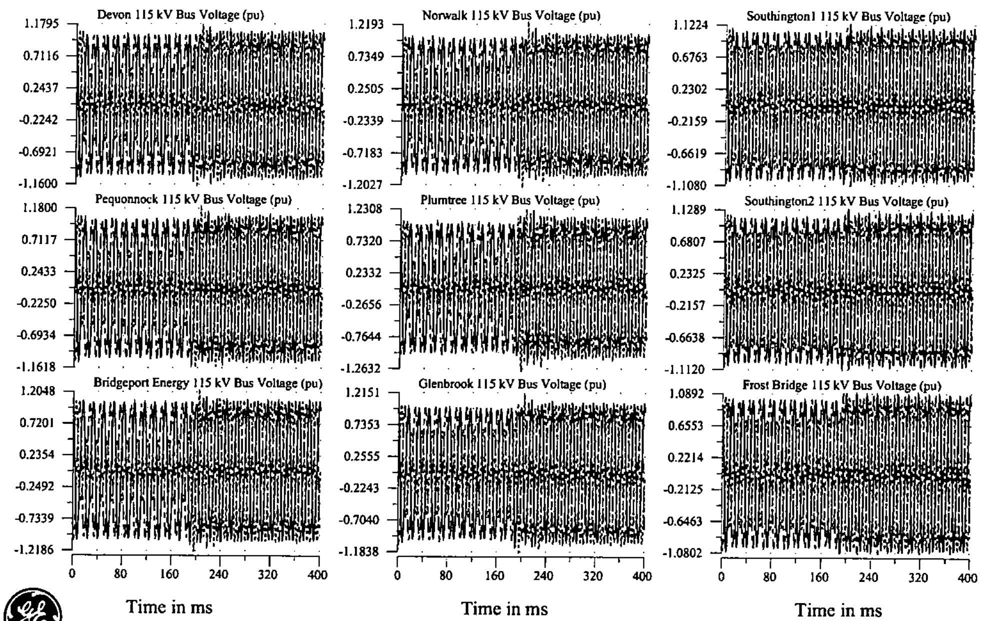
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
NSF_01
345 kV Bus Voltages



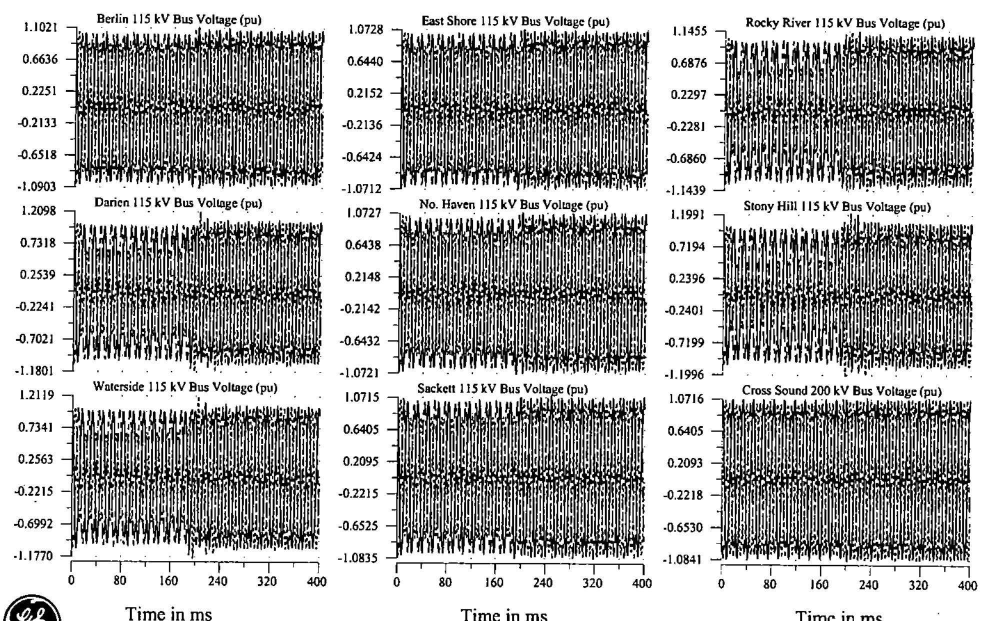
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
NSF_01
345 kV Bus Voltages



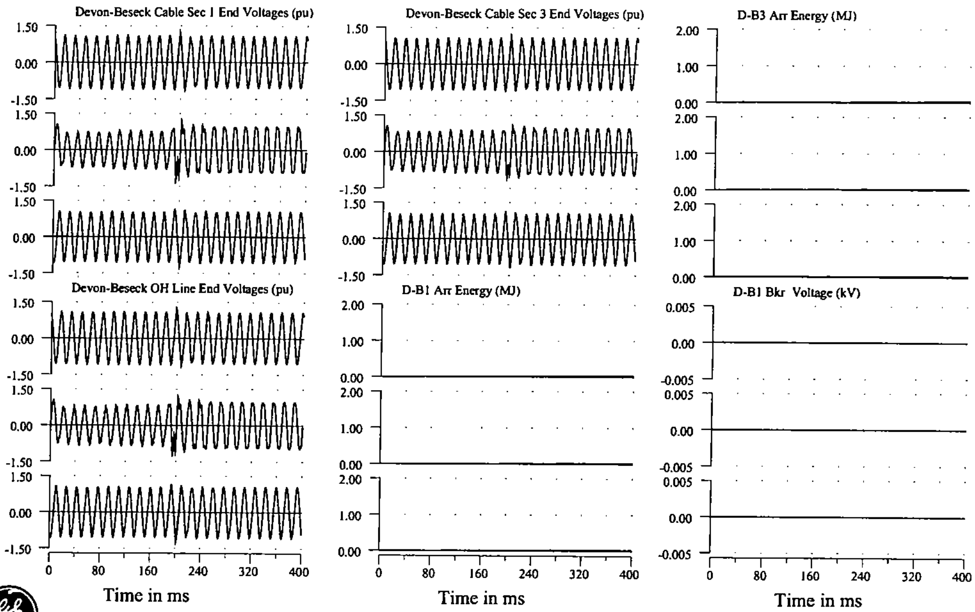
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
NSF_01
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
NSF_01
11A5 kV Bus Voltages and Capacitor Bank Locations



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
SDF_01
Case Summary Plots for MN P2 Project 345 kV Cables and OH Line (Ck 1)



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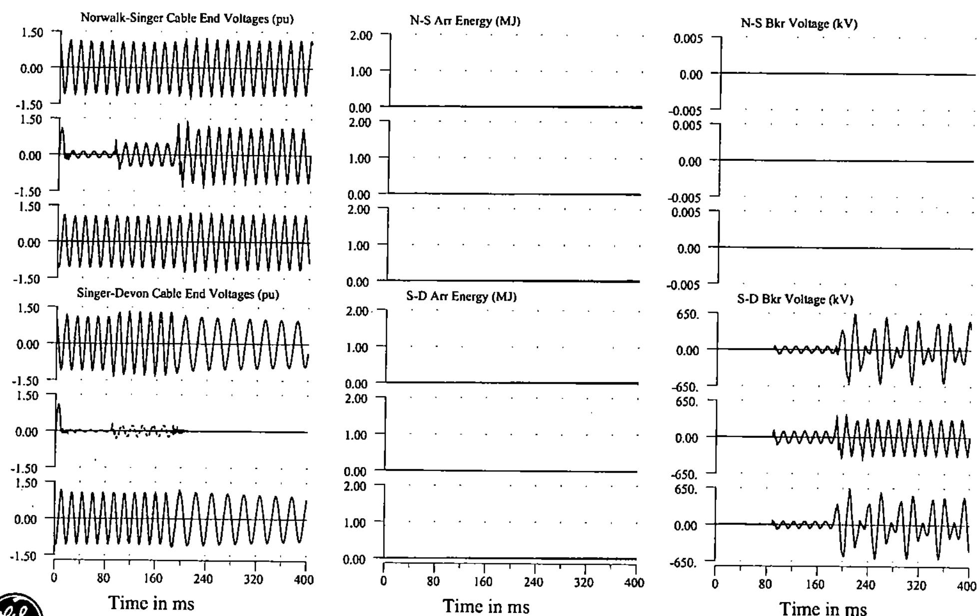
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
SDF_01
Case Summary Plots for MN P1 Project 345 kV Cables (Ck 1)



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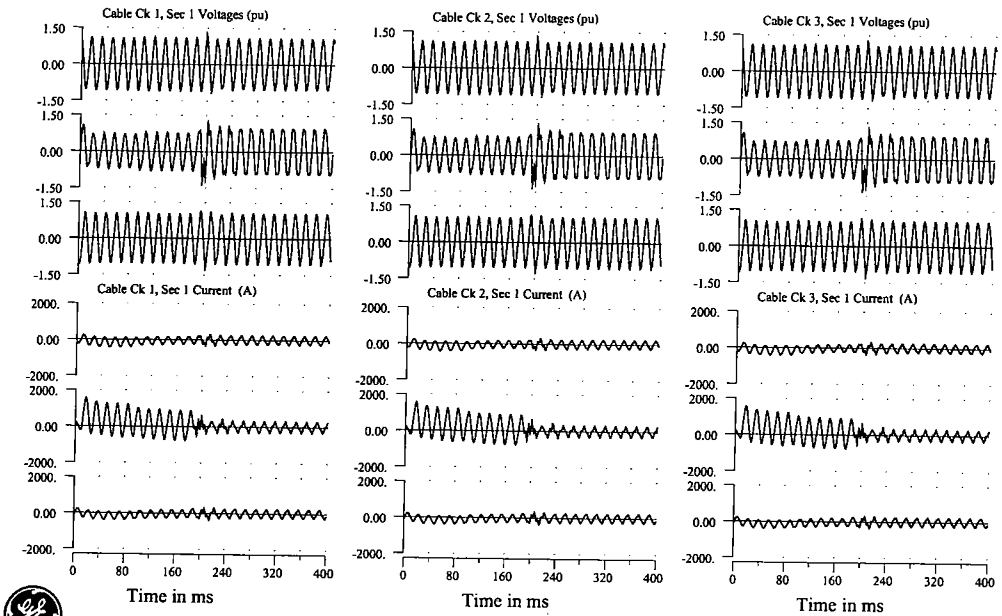
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
SDF_01
Devon-Beseck 345 kV Cables



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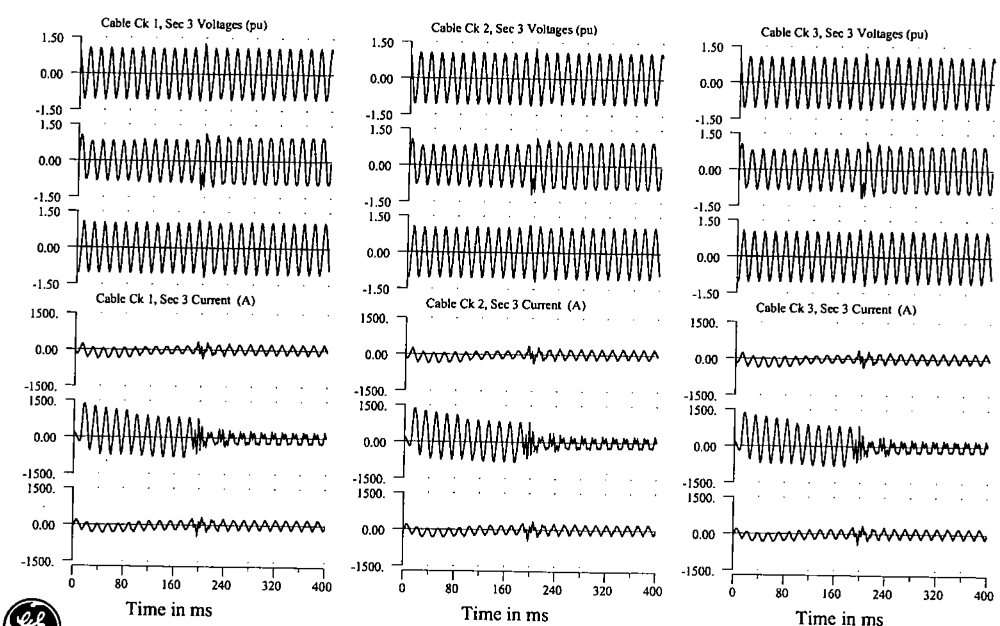
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
SDF_01
Devon-Beseck 345 kV Cables



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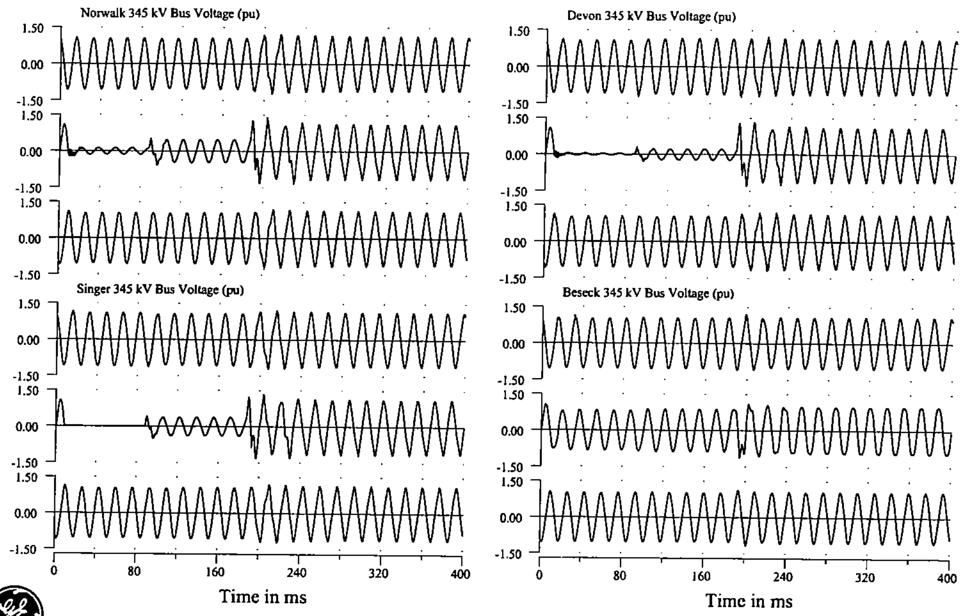
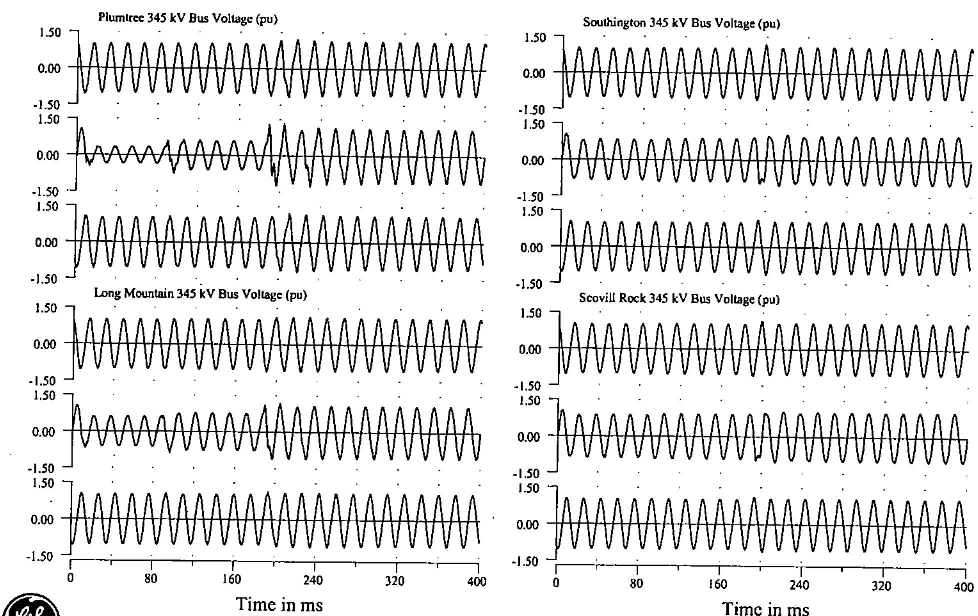
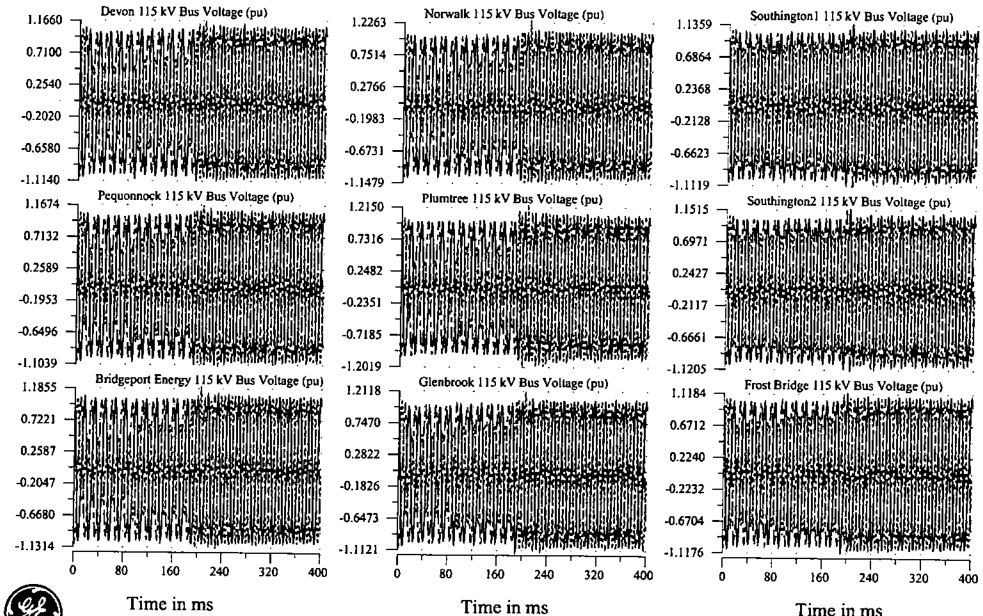
Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
SDF_01
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
SDF_01
345 kV Bus Voltages



Northeast Utilities: Middletown to Norwalk P2 Project Transient Study
SDF_01
11A5 kV Bus Voltages and Capacitor Bank Locations



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SDF_01
11A5 kV Bus Voltages and Capacitor Bank Locations