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Substation Bay Modeling and Seismic Sensitivity Study

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SUBSTATION BAY MODELING AND SEISMIC SENSITIVITY STUDY

Bonneville Power Administration

Ross Complex 115 kV & 230 kV Substations

Pearl 500 kV Substation

(Using Rigid Bus)

BY

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A research project report submitted in partial fulfillment
of the requirement for the degree of

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ABSTRACT

The performance of high voltage electrical substations during an earthquake significantly contributes to regional resilience by providing electrical power to public entities, businesses and homes following an earthquake. Utilities try to minimize the seismic impact by qualifying individual equipment, but rarely evaluate the interconnected substation bay as a whole. In this study, three detailed numerical models were developed using the seismic qualification reports of individual electrical equipment as basis for the components within 115kV, 230kV, and 500 kV substation bay systems. The substation bays were evaluated without interconnectivity of the components and with rigid bus connectivity between components. The models were subjected to modal and modal time history analyses. Displacement demands, forces at electrical equipment terminal pads, and forces at the base of insulators were compared to one another, as well as to equipment failure criteria provided by the utility. The changes and variability of the results shows that evaluation of the interconnected system is important in understanding the overall seismic performance of a substation.

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Overview

The purpose of this study was to determine the seismic response of electrical equipment in 115, 230, and 500 kV bays as part of a high-voltage substation. Using computer software, each piece of equipment was modeled as a subassembly as well as part of a complete bay system. The equipment and supporting structures were developed based on information such as drawings provided by Bonneville Power Administration (BPA), seismic qualification reports, and data collected during controlled experimental testing. All models were subjected to modal and time history analyses to determine performance during IEEE 693 compliant response spectra, including IEEE 693 compliant acceleration time histories. From the analyses, displacements at electrical equipment terminal pads, member forces at the base of each installation, forces at electrical equipment terminal pads, and forces at the base of insulators and bushings was all collected and tabulated for informational purposes by BPA.

Description of Equipment

In 2007, the American Society of Civil Engineers (ASCE) Substation Structure Design Committee published the "Guide for Design of Substation Structures" [1]. The following equipment descriptions were taken from this document.

Rigid Bus (Figure 1): A tubular metallic conductor typically made of aluminum alloy or copper used to transfer power from one piece of equipment to the other. Rigid bus is typically supported by an insulator connected to the ground via a structural pedestal.

Figure 1: Rigid Bus

Insulator: Porcelain, glass, and composite materials used to electrically isolate the bus from supporting structures. They can be either suspended or post insulators. Suspension insulators only transfer tension forces from the conductor to the structure, whereas station post insulators can transfer tension forces, compression forces, and bending moments to the structure. No suspension type insulators were used in this study, but various types of post insulators were, including cap-and-pin and station post.

Disconnect Switch (Figure 2): Switches are used to electrically isolate a transmission line, circuit breaker, or other electrical equipment from the rest of the system. Disconnect switches can be manual or motor operated, but the circuit must be de-energized before the switch can be opened. Motor operators are applied to disconnect switches when physical operating requirements dictate and when automatic or remote controlled operation of the switches is required. Disconnect switches may be vertical break, center break, single side break, or double side break. Typically, the switches are delivered from the manufacturer as a unit with three insulators isolating the electricity from the supporting structure. The steel truss structure used to support the switches should have adequate rigidity to permit proper switch operation. Each switch support may have a switch operating platform or two operating platforms if the switch has a grounding blade.

Figure 2: Disconnect Switch with Blade Closed

Dead and Live Tank Circuit Breakers (Figures 3, 4, and 5): A chamber that houses an electrical load switching and fault current interrupting mechanism at ground potential. The breaker must be capable of interrupting the fault current of the circuit in which they are applied. While there are oil, compressed air, sulfur hexafluoride (SF_6), and vacuum breakers, only oil and SF_6 breakers were used for this report.

Figure 3: Dead Tank SF_6 Circuit Breaker

Figure 4: Dead Tank Oil Circuit Breaker

Figure 5: Live Tank Circuit Breaker

Surge Arrester (Figure 6): Surge arresters, sometimes called arresters, protect power equipment from over voltages caused by switching surges or lightning. Arresters are typically supported by a single phase support structure, but sometimes could be three phase depending on the voltage. Surge arresters (seen in the 500 kV bay only) were supported on single pedestals anchored directly to the slab on grade.

Figure 6: Surge Arrester

Coupling Capacitor Voltage Transformer (Figure 7): Coupling capacitor voltage transformers or CCVT's, are capacitance voltage dividers used to obtain voltages in the 66V to 120V range for relaying and metering. CCVT's were only considered in the 500 kV bay and are mounted at ground elevation within a fenced area.

Figure 7: CCVT

Current Transformer (Figure 8): Current Transformers or CT's, are instrument transformers that change the magnitude of the primary circuit voltage to a secondary value that is suitable for use with relays, meters, or other measuring devices. The CT is used to measure current. These are typically supported on a single pedestal or lattice structure.

Figure 8: Current Transformer

Failure Criteria

Although a seismic analysis can be performed in the model, results obtained would not be of any use unless a force, deflection, or some other limiting criteria was prescribed for each subassembly and bay system. Individual subassembly models were used to determine deflections at connections between the electrical equipment (terminal pads) and rigid bus. Results were recorded for informational purposes by BPA and were not used to decide failure of the electrical equipment, supporting structure, or subassembly in this report. Although deflection alone would not be used to decide failure, those in excess of six inches in any single direction were noted as possible design concerns.

Bay system model analyses were used to determine electrical equipment terminal pad deflections as well, but member forces at the base of each installation, forces at electrical equipment terminal pads, and forces at the base of insulators and bushings were also obtained. The following failure criteria was collected from standards, BPA drawings, and seismic qualification reports. The results from each time-history analysis were compared to these values to determine the performance of each piece of electrical equipment in response to IEEE 693 compliant ground motion.

1. *Electrical Equipment Terminal Pad Deflections*

   Through discussion with BPA representatives, electrical equipment terminal pad deflections in excess of six inches in any single direction were noted as possible design concerns.

2. *Forces at Electrical Equipment Terminal Pads*

   Allowable loads at electrical equipment terminal pads were obtained from IEEE/ANSI standards for both disconnect switches [2] as well as circuit breakers [3]. However, standards were not provided for other equipment such as insulator pedestals or surge arresters. For these, the disconnect switch allowable loads would be used for determining failure for the miscellaneous electrical equipment in each bay.

3. *Forces at the Base of Insulators and Bushings*

   Allowable base moments and/or shears were provided in either seismic qualification reports or BPA drawings. The criteria obtained for each piece of equipment has been summarized below:

   230 kV Bay
   - Insulators
     - Cap-and-Pin: Maximum Cantilever Strength = 0.91 kips (BPA drawing 208911C-DSD-F)
     - Station Post: Maximum Cantilever Strength = 1.45 kips [4]
   - Bushings
     - Porcelain: Allowable Base Moment = 108.00 kip-in [5]
     - Composite: Allowable Base Moment = 66.00 kip-in

   115 kV Bay

- Insulators
    - Cap-and-Pin: Maximum Cantilever Strength = 1.70 kips (BPA drawing 208911C-DSD-F)
    - Station Post: Maximum Cantilever Strength = 4.50 kips [4]
- Bushings
    - Porcelain: Allowable Base Moment = 221.46 kip-in [6]
    - Composite: Allowable Base Moment = 135.00 kip-in

500 kV Bay

- Surge Arrester
    - Allowable Base Moment = 137.50 kip-in [7]
- Coupling Capacitor Voltage Transformer
    - Allowable Base Moment = 324.00 kip-in [8]
- Disconnect Switches
    - Maximum Cantilever Strength = 4.71 kips [9]
- Circuit Breaker
    - Allowable Base Moment = 487.00 kip-in [10]
- Current Transformer
    - The seismic qualification report provided for the current transformer based its performance criteria off a limiting deflection of 4.34" [11]. No allowable forces or base moments could be determined from either BPA drawings or seismic qualification reports. Therefore the allowable deflection would be used to determine performance for the current transformer in this study.

Equipment Modeling – 230 kV Bay

The following sections describe the methodology used to construct a computer model of each piece of equipment, support structure, and subassembly using SAP2000.

4. *Cap-and-Pin Insulators*

    In a typical 230 kV bay there are two variations of insulator pedestals, those that are 9' – 1 ¾" tall and those that are 21' – 1 ¾" tall. Although the height of the supporting structures may be different, the cap-and-pin insulators used to separate the rigid bus from the pedestals are the same. As seen in drawing 220629-1-8, the supporting structures are steel pipe of varying diameter. The material properties of these steel shapes are pre-programmed into SAP2000 and can be assigned to a frame element quite simply. However, the material properties of the cap-and-pin insulators connected to the top of the pedestals must be manually inputted. A representative element must be drawn and the correct material properties may then be assigned to the element.

Testing performed by BPA on August 28, 2013 developed the load vs. displacement curves for three different stacks of five TR140 cap-and-pin insulators. Testing was conducted by selecting a stack of five cap-and-pin type insulators and bolting the stack to a two inch thick steel plate which was then bolted to the concrete floor of the testing facility. A displacement gauge was attached to a rigid steel cantilever near the insulators and then connected to the top of the stack. Load was measured by a device also connected to the top of the stack of insulators. The other side of the load measuring device was attached to a rope, which was run through a pulley and attached to an overhead bridge crane. As the crane was drawn upward, it would pull the rope, which would apply a horizontal force to the stack. A rough sketch of the testing procedure can be seen in Figure 9.

$$k = \frac{f_s}{u} \tag{1}$$

$$f_s = appled\ lateral\ load$$

$$u = displacement\ at\ top\ of\ stack = 1''$$

Load was applied in a stepped manner since it was not possible to apply a constant force with the overhead crane. Load and displacement data was recorded at each step and sorted to obtain the load vs. displacement curves in Figure 10. Best-fit equations showed the relationship of the two and can also be seen in Figure 10. Using a displacement of one inch, the associated loads for each of the three stacks could be calculated. Using equation (1), the stiffness of each stack was determined.

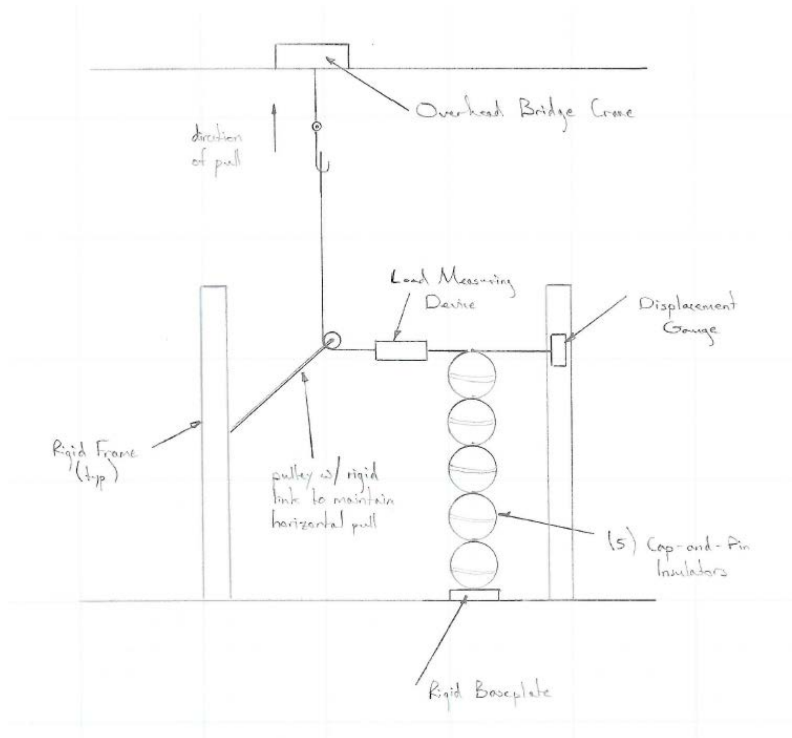

Figure 9: Cap-and-Pin Insulator Testing Setup

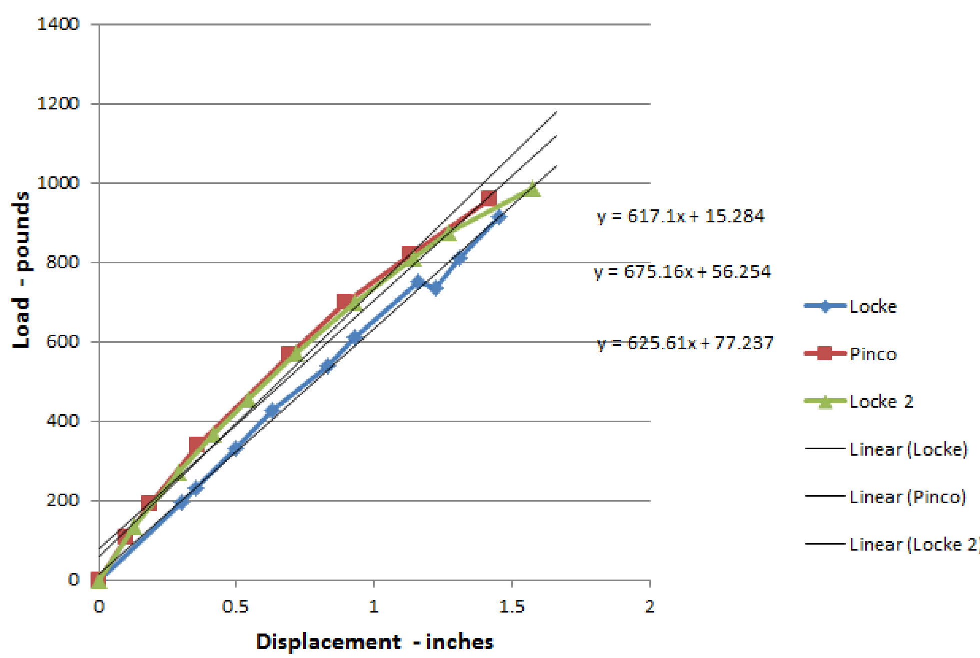

Figure 10: Load vs. Displacement Curves

Once the stiffness of each insulator stack was determined, an average value of applied force was calculated. Still utilizing the one inch of displacement and the newly acquired average force value, the average stiffness was then obtained.

A seismic qualification report was completed by W. E. Gundy & Associates, Inc. in 1992 and 1995 for a Pascor disconnect switch [12]. The report contained material property data for the porcelain insulators contained within the disconnect switch assembly. Through discussion with BPA associates and the aforementioned seismic qualification reports, the modulus of elasticity (E), shear modulus (G), and unit weight of the insulator porcelain were determined to be $10x10^6$ psi, $4.3x10^6$ psi, and 150 pcf respectively. Although the insulators used in the disconnect switch were not the same TR140 cap-and-pin insulators that were tested, it was assumed the porcelain in both had the same material properties. Once the porcelain's modulus of elasticity was known, the moment of inertia of a single TR140 insulator could be determined using Equation (2).

$$I = \frac{k_{avg} h^3}{3E} = 8.75\ in^4 \tag{2}$$

$$k_{avg} = average\ stiffness\ of\ TR140\ stack = 689\ \frac{lbs}{in}$$

$$h = height\ of\ a\ single\ TR140\ insulator = 14\frac{1}{2}"$$

$$E = modulus\ of\ elasticity\ of\ porcelain = 10x10^6\ psi$$

Once the porcelain's modulus of elasticity was known, the moment of inertia of a single TR140 insulator could be determined using Equation (2).

As stated previously, porcelain was not a material that was already programed into SAP2000, but it could be created as long as the modulus of elasticity, shear modulus, and unit weight were known. Because it was not feasible to construct an exact replica of the cap-and-pin insulators in the model, a tubular frame element was assigned to the stack of five insulators and modified to correctly represent them. Since the insulators theoretically have the same stiffness in each lateral direction, a circular tube represents them well since it also possesses this property. Knowing the insulator's modulus of elasticity, the radius and cross-sectional area of the tube could be determined. Because the mass of the stack is important in determining the fundamental periods of the structure, a modifier had to be added to the area in order for the correct mass to be represented. Equation (3) shows how the area modifier was determined.

$$Area\ Modifier = \frac{w}{V\gamma} = 6.44 \qquad (3)$$

$$w = weight\ of\ a\ single\ TR140\ insulator = 85\ lbs$$

$$V = volume\ of\ representative\ tube = 0.44\ ft^3$$

$$\gamma = unit\ weight\ of\ porcelain = 150\ pcf$$

Now that the cap-and-pin insulators were properly represented, the same average lateral force experienced during testing was applied to the stack in the model and an analysis was run to determine the displacement. By comparing the SAP2000 displacement results at the top of the insulator stack with the experimental data (Figure 11), it could be seen that the model was representative of the field condition. The SAP2000 representation of the TR140 insulator stack can be seen in Figure 12.

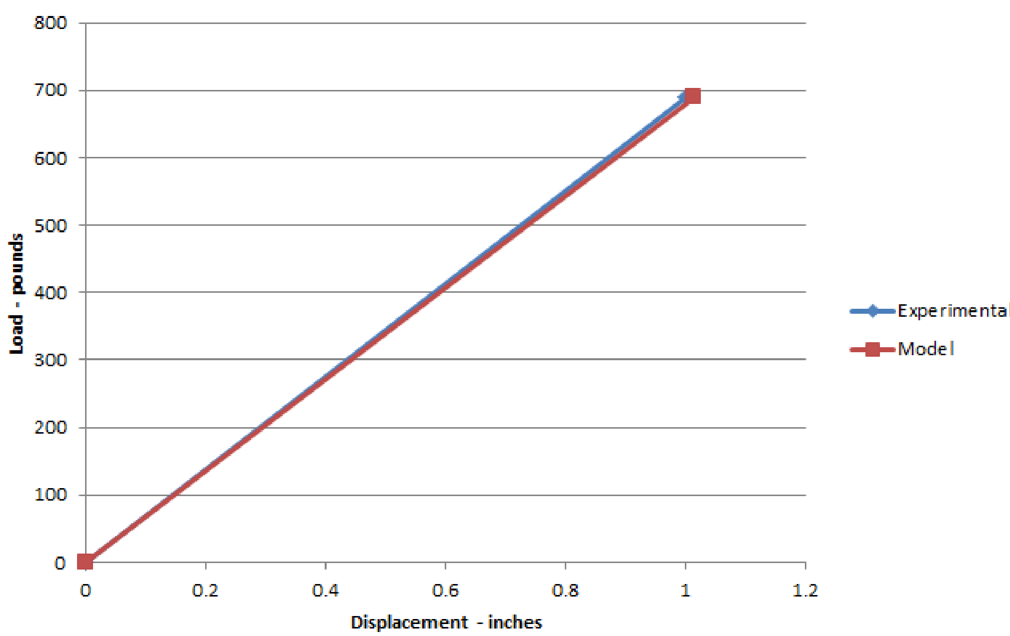

Figure 11: Experimental Data vs. SAP2000 Cap-and-Pin Insulators

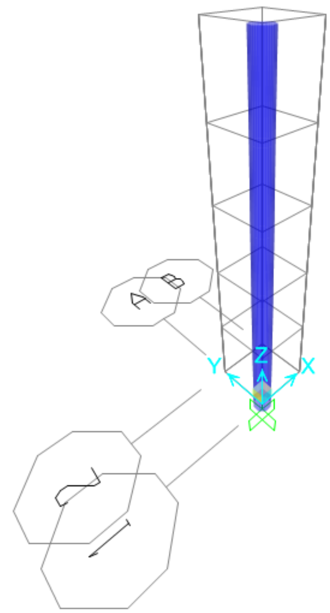

Figure 12: Stack of (5) TR 140 Insulators – 230 kV Bay

5. *Insulator Pedestals*

In a typical 230 kV bay there were two variations of insulator pedestals, those that are 9' – 1 ¾" tall and those that are 21' – 1 ¾" tall. Although the height of the supporting structures may be different, the cap-and-pin insulators used to separate the rigid bus from the pedestals was the same. As seen in drawing 220629-1-8, the supporting structures were steel pipe of varying diameter. The material properties of these steel shapes were pre-programmed into SAP and could be assigned to a frame element quite simply. However, the material properties of the cap-and-pin insulators connected to the top of the pedestals had to be manually inputted as discussed earlier.

For each of the two insulator pedestals, the model was drawn to generate a computer representation of the actual equipment. Using material properties specified in BPA drawing 220629-DSD-D, the equipment was drawn using schedule 20, 8.625" outer diameter pipe for the shorter pedestal, and schedule 20, 10.75" outer diameter pipe for the taller pedestal (Figure 13).

In order to check the validity of the computer model, a simple analysis was run to determine the stiffness of the pedestals in each direction (x, y, and z). For each case, a load of 1.0 kip was applied at the top of the pedestal and the displacement was recorded. Stiffness in each direction was calculated by dividing the 1.0 kip force by the displacement observed. Assuming a fixed base, the stiffness of the pedestals in the x and y directions could be calculated by hand. Because these supports are cantilevers, equation (1) could be manipulated to solve for the stiffness. By comparing the hand calculated values for stiffness in the x and y directions to those determined through SAP2000 (Table 1), it can be stated that the model was within 1.0% of the hand-calculated value, and is therefore representative of the field condition.

Table 1: Comparison of Insulator Pedestal Stiffness

TABLE: Pedestal Stiffness Comparison		
Pedestal	Source	Stiffness (lbs/in)
9' - 1 3/4"	PSU Model	3538
	Hand Calculations	3560
21' - 1 3/4"	PSU Model	563
	Hand Calculations	564

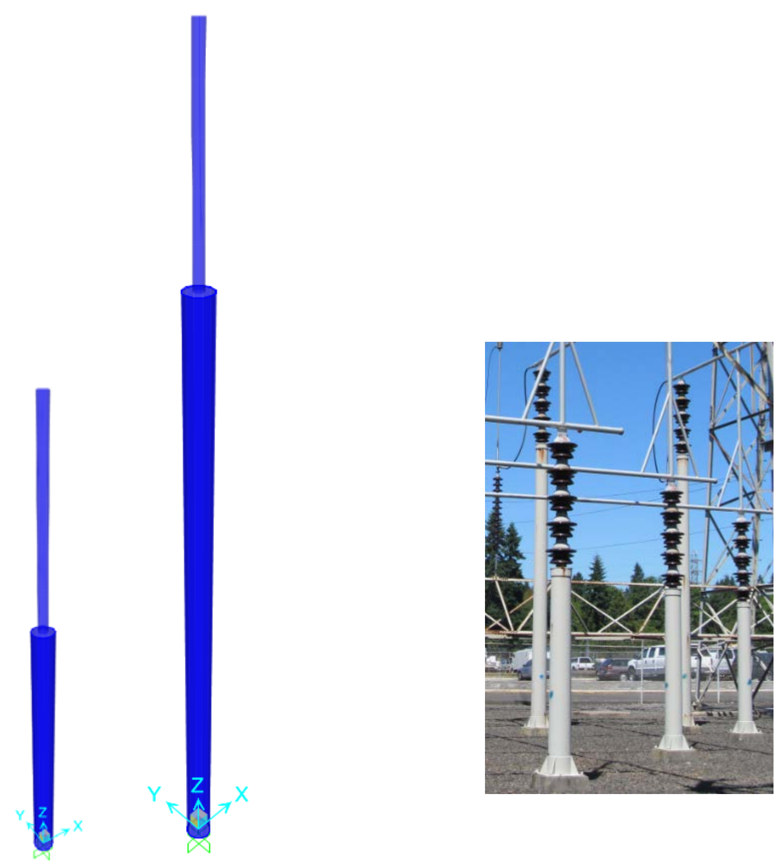

Figure 13: 9’-1 ¾” and 21’-1 ¾” Insulator Pedestals – 230 kV Bay

6. *2000 Amp Disconnect Switch Assembly*

As stated previously, a seismic qualification report was completed by W. E. Gundy & Associates, Inc. in 1992 and 1995 for a Pascor disconnect switch [12]. The report used the modeling software SAP90 to determine if a Type VBPA 230 kV 2000 amp disconnect switch with station post insulators would be able to withstand the effects of seismic loading conditions specified by IEEE 693-1984. Although the switch seen in the seismic qualification report is slightly different than the switches considered in this report, a model of the Type VBPA 230 kV 2000 amp switch was constructed to determine if the results could be duplicated and therefore the correct modeling process verified.

Because the SAP program has been updated since the issuing of the seismic qualification report, it proved difficult to replicate all aspects of the switch. The newer version of the program requires additional input (shear area, section and plastic modulus, radius of gyration, etc.) not specified in the seismic qualification report in order to define material and section properties. Because of this, an exact copy of the 1992 or 1995 models was not feasible, but a close approximation was expected. Once the model was completed, the total weight and mass of the equipment determined through the past model was compared to the output from the present model (Table 2). Based on this comparison, it can be stated that the disconnect switch was modeled adequately and could now be modified to fit the dimensions of the Pascor D-13391 230 kV 2000 amp disconnect switch used in this report. The SAP2000 replica model of the Type VBPA disconnect switch can be seen in Figure 14.

Table 2: Comparison of Qualification Report Switch to Replica Model

TABLE: Disconnect Switch Model Comparison			
Switch	Source	Weight (lbs)	Mass ($lb\text{-}sec^2/ft$)
Pascor Type VBPA	SQR Model	1305.8	40.6
Pascor D-13391	PSU Model	1297.0	40.3

In the 230 kV bay under consideration, two variations of disconnect switch assemblies were used. The first variation was the replica model using station post insulators. These disconnect switches were placed on the first pair of disconnect switch subassemblies in the bay system (ref. Figure 2 and items C and E Figure A22). The second variation was identical to the first, except the station post insulators were replaced by a stack of five cap-and-pin insulators. These modified switches were placed on the second pair of disconnect switch subassemblies in the bay system (ref. Figure 15 and items H and J Figure A22).

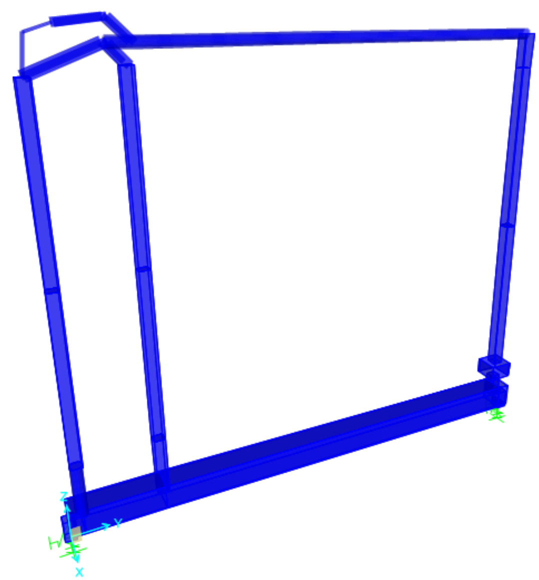

Figure 14: Disconnect Switch (1995 Seismic Qualification Report Replica) – 230 kV Bay

Figure 15: 2000 Amp Subassembly with Cap and Pin Insulators – 230 kV Bay

7. *2000 Amp Disconnect Switch Subassembly*

The 230 kV bay under consideration included a total of four disconnect switch supports designed for 1600 Amp Pascor switches. After discussion with BPA representatives, it was decided to analyze the bay using the heavier 2000 Amp Pascor switches, as this would demonstrate the worst case scenario. Using information provided on the BPA supplied drawing 124168-DSD-D for a Type "C" 230 kV disconnect switch support, a model with proper dimensions and member orientation was constructed. The base supports were assumed to be pinned and all members had pinned connections.

Because a separate model of the switch assembly was already constructed, a copy of the switch assembly model was exported into an Excel format. This file was then imported into the support model, and then moved to the proper location atop the support structure. A rigid link with zero mass was used to connect the switch to the support structure below. The SAP2000 representation of the disconnect switch subassembly can be seen in Figure 16.

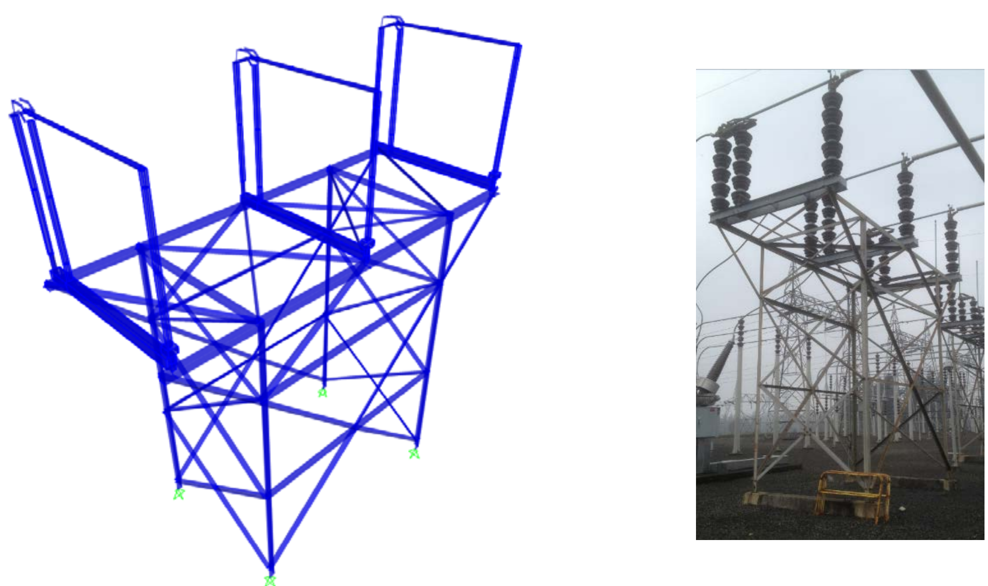

Figure 16: 2000 Amp Disconnect Switch Subassembly – 230 kV Bay

8. *Circuit Breaker Subassembly*

There were two dead tank circuit breakers within the 230 kV bay, one which had porcelain bushings and one with composite bushings. The first variation was the circuit breaker with porcelain bushings (item D Figure A22). A seismic qualification report was completed by W. E. Gundy & Associates, Inc. in 1995 for the 230 kV SF6 circuit breaker with porcelain bushings [5]. No information on the size of members or dimensions of the support structure was provided on the BPA supplied drawings, therefore the required information was gathered by measuring a support in the storage area at the BPA Ross Complex. The base supports were assumed to be pinned and all members had pinned connections.

The breaker and bushings were modeled using dimensions provided on BPA drawing 106D827. Porcelain bushing properties were the same as those used in the insulators, except cross sectional area and stiffness properties were altered to match the bushings size and weight. The composite bushings were modeled using the same frame section properties as the porcelain bushings, but the composite material was defined with a lower modulus of elasticity (2.321×10^6 psi), shear modulus (0.013×10^6 psi), and unit weight (125 pcf). The resulting composite bushings were therefore less stiff than the porcelain bushings, but were also much lighter. Breakers were modeled as hollow stainless steel tubes as suggested by BPA representatives. The connection between the breakers and substructure was made by using rigid links. These links were assumed to be infinitely rigid while contributing zero mass to the subassembly. The SAP2000 representation of the 230 kV dead tank circuit breakers can be seen in Figure 17.

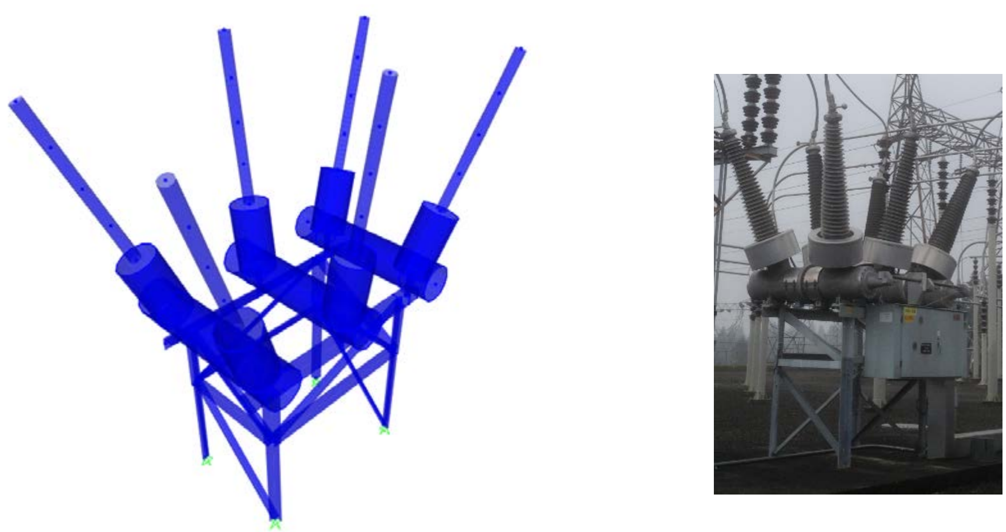

Figure 17: Circuit Breaker Subassembly – 230 kV Bay

9. *Insulator Lattice Subassembly*

Similar to the disconnect switch support model, the insulator lattice support structure was modeled following specifications provided on the BPA supplied drawing 142-DSD-D. The base supports were assumed to be pinned and all members had pinned connections.

Following procedures similar to importing the disconnect switch assembly into the support structure model, the model of five TR140 cap-and-pin insulators was exported to an Excel file and then imported into the lattice support model. The coordinates of the insulator stacks were then manipulated to place them in the correct positions atop the support structure. Because the insulator stacks were bolted directly to the channel on the support structure, no rigid link was used to connect the insulators to the supporting structure. The SAP2000 representation of the insulator lattice subassembly can be seen in Figure 18.

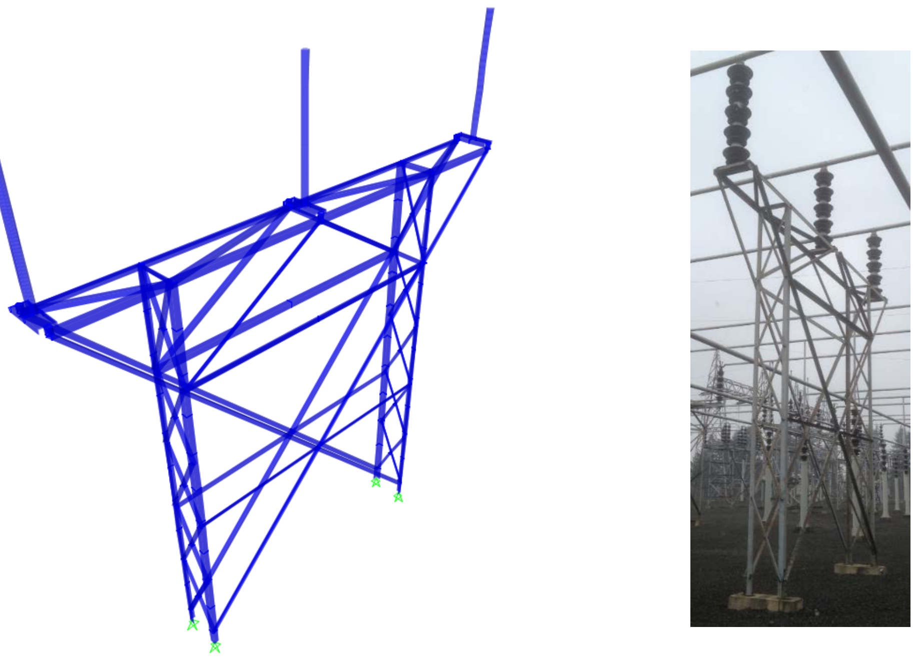

Figure 18: Insulator Lattice Subassembly – 230 kV Bay

Equipment Modeling – 115 kV Bay

1. *Insulator Pedestals*

Conveniently, the cap-and-pin insulators used in the 115 kV bay were the same as those in the 230 kV bay, with the only difference being that instead of a stack of five insulators, the 115 kV bay used a stack of three.

The 115 kV bay had both 9' - 7" and 17' - 7" variations of insulator pedestals. The size of the steel support column varied according to the height of the structure, but each variation had a stack of three cap-and-pin insulators at the top of the column. For each of the two insulator pedestals, the model was drawn to generate a computer representation of the actual equipment. Using material properties specified in BPA drawing 220629-DSD-D, both supports were drawn using schedule 40, 6 5/8" outer diameter steel pipe (Figure 19).

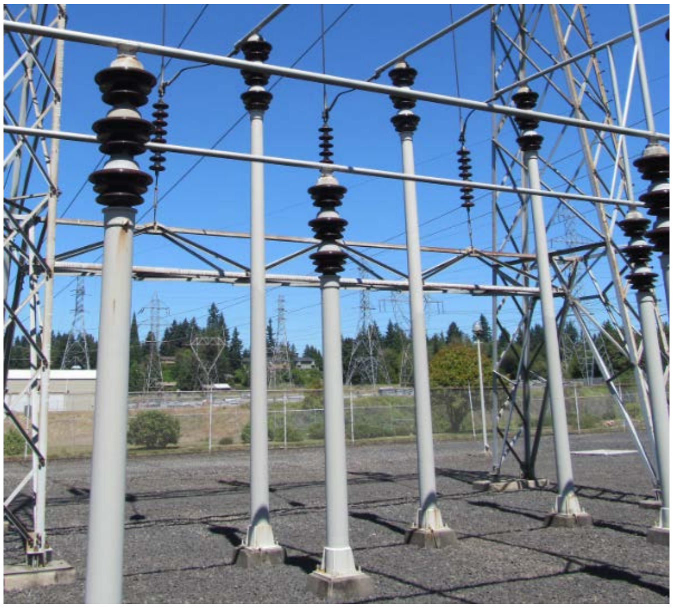

Figure 19: Insulator Pedestals – 115 kV Bay

2. *2000 Amp Disconnect Switch Assembly*

   Similar to the insulator pedestals, the disconnect switches used in the 115 kV bay used a shorter stack of insulators than their 230 kV counterparts. Due to a lack of formal information regarding the 115 kV disconnect switch, it was decided to use the same switch model drawn for the 230 kV models, but to modify the overall height of the switch to reflect the shorter insulator stack seen in the 115 kV bay.

3. *2000 Amp Disconnect Switch Subassembly*

   The 115 kV bay under consideration included a total of four disconnect switch supports designed for 1600 Amp Pascor switches. Using information provided on the BPA supplied drawing 38187-DSD-D for a Type "A" 115 kV disconnect switch support, a model with proper dimensions and member orientation was constructed. The base supports were assumed to be pinned and all members had pinned connections.

Because a separate model of the switch assembly was already constructed, a copy of the switch assembly model was exported into an Excel format. This file was then imported into the support model, and then moved to the proper location atop the support structure. A rigid link with zero mass was used to connect the switch to the support structure below. The SAP2000 representation of the disconnect switch subassembly can be seen in Figure 20.

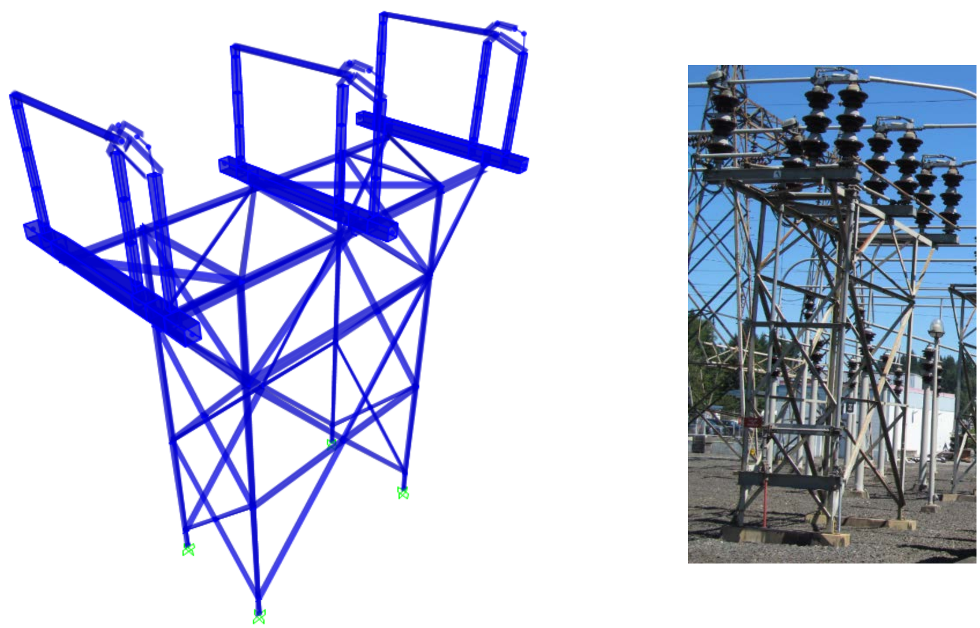

Figure 20: 2000 Amp Disconnect Switch Subassembly – 115 kV Bay

Similar to the 230 kV bay, two variations of disconnect switch assemblies were used. The first variation was the replica model using a stack of three cap-and-pin insulators. These disconnect switches were placed on the first pair of disconnect switch subassemblies in the bay system (items C and E Figure B19). The second variation was identical to the first, except the cap-and-pin insulators were replaced by station post insulators. These modified switches were placed on the second pair of disconnect switch subassemblies in the bay system (items H and J Figure B19).

4. *Circuit Breaker Subassembly*

There were two variations of dead tank circuit breakers within the 115 kV bay. The first being an oil dead tank circuit breaker and the second being an SF6 circuit breaker. A seismic qualification report was provided for the SF6 version, but BPA supplied drawing 72-210-275 was used to generate a model for the oil breaker.

Due to the structure's wide footprint and large mass, it was decided that the oil circuit breaker would act as a rigid mass with motion from the bushings being the primary modes of frequency. To reflect this in the model, the tank was assumed to be rigid with a density high enough to acknowledge the 90000 pound total structure weight. The base supports were assumed to be pinned and all members had pinned connections.

A seismic qualification report was completed by W. E. Gundy & Associates, Inc. in 2001 for the 115 kV SF6 circuit breaker [6]. The report used the modeling software SAP90 to determine if a 145 kV breaker would be able to withstand the effects of seismic loading conditions specified by IEEE 693-1997. As with previous attempts to duplicate the seismic qualification report models, it proved difficult to replicate all aspects of the breaker since the newer version of the program required additional input not specified in the seismic qualification report in order to define material properties. Because of this, an exact copy of the 2001 model was not feasible, but a close approximation was expected. Once the model was completed, the total weight and mass of the equipment determined through the past model was compared to the output from the present model (Table 3). Based on this comparison, it could be stated that the circuit breaker was modeled adequately. The SAP2000 replica model of the 145 kV circuit breaker can be seen in Figure 21.

Table 3: Comparison of Qualification Report Breaker to Replica Model

TABLE: SF6 Circuit Breaker Model Comparison			
Breaker	Source	Weight (lbs)	Mass (lb-sec^2/ft)
145 kV	SQR Model	2790.6	86.7
115 kV	PSU Model	2777.1	86.2

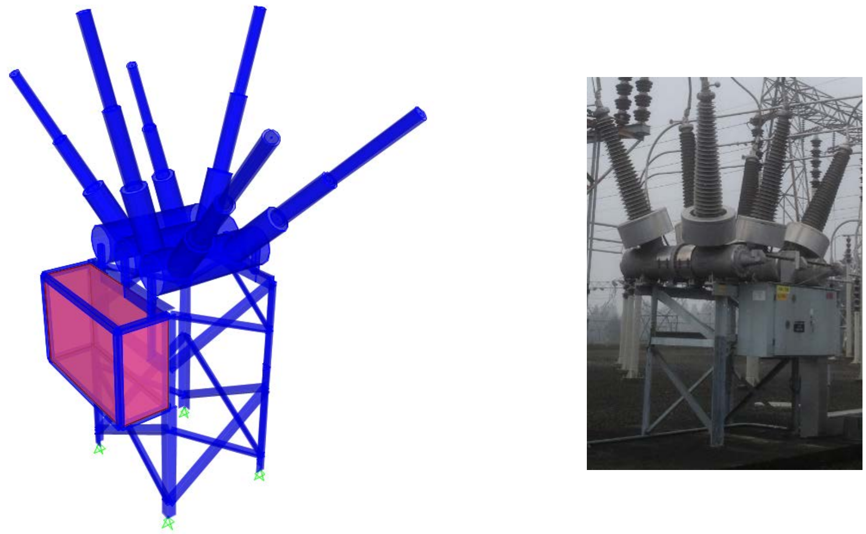

Figure 21: SF6 Circuit Breaker Subassembly – 115 kV Bay

Equipment Modeling – 500 kV Bay

The following sections describe the methodology used to construct a computer model of each piece of equipment, support structure, and subassembly using SAP2000.

1. *Insulator Pedestals*

   The insulator pedestals in the 500 kV bay were all 12' tall. The size of the steel support column was taken off BPA drawing 220629-DSD-D. The drawing specified the column as a schedule 10, 14" outer diameter steel pipe. Each column supported a stack of insulators as specified on BPA drawing 208911D-DSD-F. Because this drawing did not contain any information regarding the weight or stiffness properties of the insulators, the approximate weight of 815 lbs was taken from a Lapp 318059 A Series insulator. Stiffness properties were obtained by utilizing force-displacement information taken from the BPA Post Insulator Cantilever Test, report number TNSE 04-41, dated November 29, 2004 [13]. The report outlined tests performed on 11 - 500 kV station post insulators and listed displacements caused by placing a 3500-pound horizontal load at the top of the insulator. These measurements were used to approximate the displacement that would be expected at the top of a complete stack. By following a process similar to the one used to develop the stiffness of the cap-and-pin insulators in the 230 kV bay, the section properties of the station post insulators for the 500 kV bay were found.

   Now that the insulator properties were adequately represented, the same average lateral force experienced during testing was applied to the model stack and an analysis was run to determine the displacement. By comparing the SAP2000 displacement results at the top of the insulator stack with the experimental data, it could be noted that the model was representative of the field condition. The stack was then placed on top of the 12’ insulator pedestal to complete the subassembly model (Figure 22).

Figure 22: Insulator Pedestals – 500 kV Bay

2. *Surge Arrester*

The surge arrester model was created by duplicating the SAP90 model constructed as part of the Seismic Analysis of Arrester 9L16GNM396TA performed by Gundy and Associates in April of 1998 [7]. The report outlined the section and material properties of the equipment, similar to other seismic qualification reports by Gundy previously discussed.

The report used the modeling software SAP90 to determine if a 500 kV arrester would be able to withstand the effects of seismic loading conditions specified by IEEE 693-1997. The report provided all the necessary dimensions and support data to accurately recreate the model using the current version of the program. Once the model was completed, the total weight and mass of the equipment determined through the past model was compared to the output from the present model (Table 4). Based on this comparison, it can be stated that the surge arrester model was representative of the field condition. The SAP2000 replica model of the 500 kV Arrester can be seen in Figure 23.

Table 4: Comparison of Qualification Report Arrester to Replica Model

TABLE: Surge Arrester Model Comparison			
Arrester	Source	Weight (lbs)	Mass (lb-sec^2/ft)
9L16GNM396TA	SQR Model	2670.0	82.9
A-6098	PSU Model	2670.0	82.9

Figure 23: Surge Arrester – 500 kV Bay

3. *Capacitor Voltage Transformer (CCVT)*

A model of the CCVT was made by recreating the model used as part of the seismic qualification report titled Seismic and Wind Qualification of Trench Electric TEIMF 500 Capacitor Voltage Transformer, prepared for BPA by Trench Electric in 1992 [8]. The report provided section and material properties, details of the model, and analysis procedures for the three dimensional finite element analysis performed using the NISA computer program.

To duplicate all aspects of the previous model, the equipment was modeled in SAP2000 as a cantilever with lumped masses to represent the insulators, basebox, and pedestal. Once the model was completed, a modal analysis was performed to compare the fundamental frequencies of the new model to those listed in the seismic qualification report (Table 5). Based on this comparison, it could be stated that the CCVT model was representative of the field condition. The SAP2000 replica model of the 500 kV CCVT can be seen in Figure 24.

Table 5: Comparison of Qualification Report CCVT to Replica Model

TABLE: CCVT Model Comparison			
CCVT	Source	Frequency X (Hz)	Frequency Y (Hz)
500 kV	SQR Model	2.45	2.45
	PSU Model	2.46	2.48

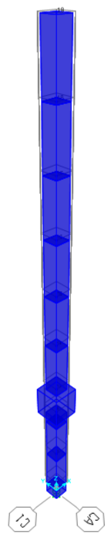

Figure 24: CCVT – 500 kV Bay

4. *3000 Amp Disconnect Switch Subassembly*

Two variations of disconnect switches were used in the 500 kV bay. The first was a 3000 amp disconnect switch on a single phase steel support (item E Figure C21), while the second was a 3000 amp disconnect switch on a three phase concrete support with lateral bracing (item H Figure C21). The switch subassembly sitting on steel supports was previously modeled in SAP90 as part of the Seismic Analysis of a Type TTR-6 Disconnect Switch with Ground Switch and Lapp 318059-70 (Series A) Insulators qualification report performed by Gundy and Associates in July of 2002 [9].

The report outlined the procedures used to create a finite element model of a Pascor disconnect switch and its support structure for both open and closed positions. For the purpose of this report, only the closed position was utilized. Using the section and material properties, as well as the dimensions and restraints outlined in the report, the model was recreated using the current version of the program. Although the total weight of the subassembly could be duplicated, the fundamental frequencies were slightly off.

Because the current version of SAP limits the Poisson Ratio of all materials to 0.5, it was assumed the slight variation in weight was caused by this limit. Multiple materials in the seismic qualification report had ratios close to 1.0, but this could not be duplicated. Through discussion with BPA representatives, it was assumed that frequencies within 10% of those listed in the seismic qualification report were acceptable. Table 6 shows the comparison of the frequencies listed in the seismic qualification report to those from the new SAP model. The SAP2000 replica model of the disconnect switch on steel supports can be seen in Figure 25.

Table 6: Comparison of Seismic Qualification Report Disconnect Switch to Replica Model

TABLE: Disconnect Switch on Steel Supports Model Comparison			
Switch	Source	Frequency X (Hz)	Frequency Y (Hz)
500 kV	SQR Model	3.77	5.81
500 kV	PSU Model	3.49	5.52

Once this model was finalized, the model was modified to create the concrete supported version. BPA drawing 411-718 provided the dimensions for the concrete supports and lateral bracing, but the member sizes could not be determined from the drawing. It was assumed that C6x10.5 channels were used for the horizontal beams between each phase, and L5x5x1/2 angles were used for the cross bracing. To complete the second variation, the original steel columns were replaced with 24" diameter concrete columns with the SAP2000 default reinforcement. The SAP2000 replica model of the disconnect switch on concrete supports can be seen in Figure 26.

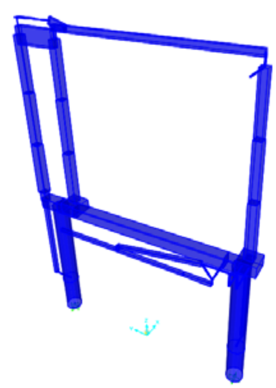

Figure 25: Disconnect Switch on Steel Supports – 500 kV Bay

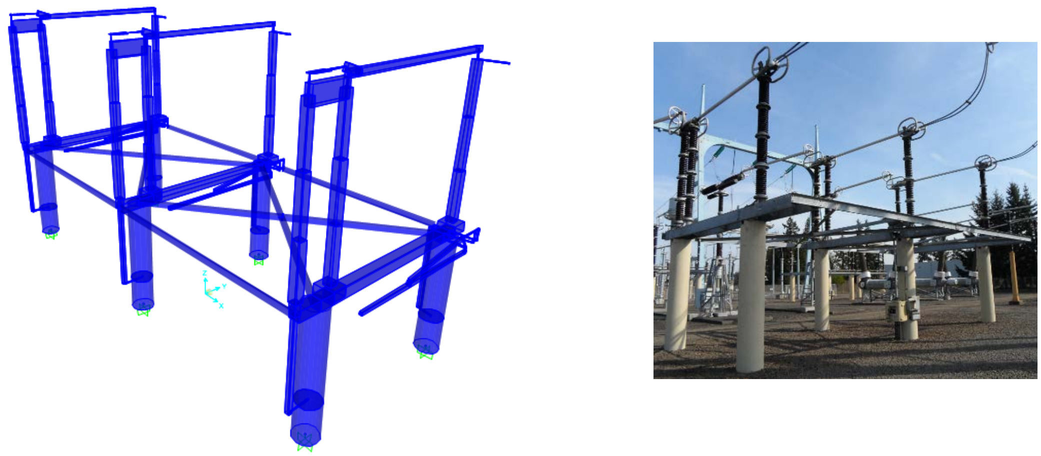

Figure 26: Disconnect Switch on Concrete Supports – 500 kV Bay

5. *Circuit Breaker Subassembly – ELF SP7-2*

A seismic qualification report titled "Dynamic Seismic Analysis of 550 kV ELF SP7-2 Circuit Breaker and Support System," prepared for BPA on September 2, 1992 by Engineering Analytical Dynamics [10], discussed the methodology behind creating a model using the Westinghouse Electric Computer ANalysis (WECAN) computer code. A finite element model of the breaker and support frame was developed to adequately define its mass and stiffness characteristics. However, there was insufficient data provided in the report to accurately recreate the model using SAP2000. Because of this, several assumptions had to be made in order to complete a working model.

The seismic qualification report provided some of the information necessary to duplicate the dimensions, sections properties, and material properties of the WECAN model. The frequencies were provided, which allowed for verification of the new model. The following assumptions were discussed with BPA representatives and used to complete a new model:

- The 1400 pound operating mechanism was cantilevered 24" below the top of the support structure by an element having properties defined in the "Dynamic Seismic Analysis of 550 kV ELF SP7-2 Circuit Breaker and Support System" report prepared for BPA on September 2, 1992 by Engineering Analytical Dynamics [10]
- The aluminum T-shaped casting weighs approximately 50 pounds

- A lumped mass was used to replace the 24”x24”x1.75” steel plate on top of the support structure
- Rigid links were used to connect the insulator column to the support structure.
- Resistor switches dimensions were approximated from BPA Outline ELF SP7-2 drawing

The model was deemed representative once frequencies were within 10% of those discussed in the seismic qualification report. Table 7 compares the natural frequencies of the ELF from the seismic qualification report, to the SAP2000 replica model, which can be seen in Figure 27.

Table 7: Comparison of Qualification Report ELF SP7-2 to Replica Model

TABLE: ELF SP7-2 Circuit Breaker Model Comparison			
Breaker	Source	Frequency X (Hz)	Frequency Y (Hz)
550 kV	SQR Model	1.33	1.21
500 kV	PSU Model	1.21	1.09

Figure 27: ELF SP7-2 Circuit Breaker – 500 kV Bay

6. *Current Transformer (CT)*

A seismic qualification report prepared by Trench Germany GMBH in May of 2009 [11] discussed the methodology used to create a model using the finite element software ANSYS 11.0. The report produced the natural frequencies and mode shapes of the CT, but did not provide sufficient information about material or section properties. Because of this, the mass and natural frequency was used to recreate the model in SAP2000.

The model would be represented as a lumped mass at the end of a cantilevered element with a height obtained from Trench Electric drawing 61-1018. Because the CT was made primarily of porcelain, the same material properties previously mentioned in this report would be used for the replica CT model. Natural frequencies were converted to angular frequencies through Equation 4, and since the mass of each material was listed in the seismic qualification report, the stiffness could be determined through Equation 5. Once the stiffness of the cantilevered element was known, Equation 2 was used to determine the element's section properties.

In the Pearl Substation, the CT under consideration is supported by a steel pedestal as shown on Trench Electric drawing 61-1017. The pedestal was assumed to be rigid in the area of the steel stiffener plates. Once the CT model was verified by comparing the frequencies obtained through a modal analysis to those listed in the seismic qualification report (Table 8), the CT model was placed on top of the support as shown on Trench Electric drawing 61-1017.

The SAP2000 replica model of the CT can be seen in Figure 28. Note the models graphical representation does not look like the field installed equipment.

$$\omega = 2\pi f \tag{4}$$

$$\omega = \sqrt{\frac{kg}{W}} \tag{5}$$

$$f = natural\ frequency, Hz$$

$$\omega = angular\ frequency, rad/sec$$

$$k = stiffness, lb/in$$

$$g = gravitational\ constant = 32.2\ \frac{ft}{sec^2}$$

$$W = weight, lbs$$

Table 8: Comparison of Qualification Report CT-2 to Replica Model

TABLE: Current Transformer Model Comparison			
Transformer	Source	Frequency X (Hz)	Frequency Y (Hz)
550 kV	SQR Model	3.74	3.76
500 kV	PSU Model	3.75	3.75

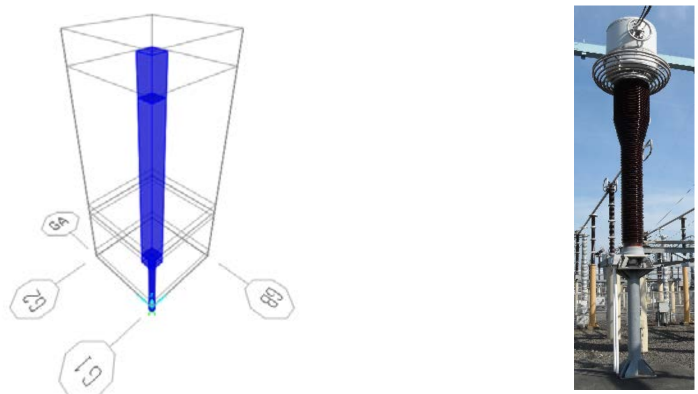

Figure 28: CT – 500 kV Bay

Dynamic Analysis of Equipment

The following sections describe the methodology used to analyze the computer model for each piece of equipment using SAP2000.

1. *Modal Analysis*

   SAP2000 has the ability to calculate the fundamental frequencies of a structure using either Eigen vectors or Ritz vectors for a user-specified number of modes. For the purpose of this evaluation, Eigen vectors were used with a varying number of modes (number of modes varied in order to capture the governing modal participation mass ratio for each piece of equipment). The fundamental periods of the equipment subassemblies in each bay can be seen in Tables 9, 10, and 11. The associated mode shapes can be seen in Appendices A, B, and C for 230 kV, 115 kV, and 500 kV bays respectively.

Table 9: Fundamental Periods of Support Structures and Subassemblies – 230 kV Bay

TABLE: Fundamental Frequencies for Equipment - 230 kV Bay				
Equipment Type	Model Revision	Frequency X	Frequency Y	Frequency Z
Text	Text	Hz	Hz	Hz
(5) TR 140 Insulators	Cap-and-Pin	7.9	7.9	714.3
(2) TR 308 Insulators	Station Post	14.2	14.2	200.6
9' - 1 3/4" Insulator Pedestal	Cap-and-Pin	4.7	4.7	145.0
21' - 1 3/4" Insulator Pedestal	Cap-and-Pin	2.4	2.4	104.3
2000 Amp Disconnect Switch	Cap-and-Pin	3.8	5.3	31.8
	Station Post	4.6	6.8	29.8
ABB O-2947 Circuit Breaker	Porcelain Bushings	3.0	20.3	77.7
	Composite Bushings	3.2	20.9	82.1
Insulator Lattice Support	Cap-and-Pin	14.1	3.6	40.5

Table 10: Fundamental Periods of Support Structures and Subassemblies – 115 kV Bay

TABLE: Fundamental Frequencies for Equipment - 115 kV Bay				
Equipment Type	Model Revision	Frequency X	Frequency Y	Frequency Z
Text	Text	Hz	Hz	Hz
9' - 7" Insulator Pedestal	Cap-and-Pin	5.2	5.2	179.9
17' - 7" Insulator Pedestal	Cap-and-Pin	2.2	2.2	127.0
2000 Amp Disconnect Switch	Cap-and-Pin	6.6	7.1	44.7
	Station Post	8.1	7.8	47.2
Dead Tank Circuit Breaker	Oil	5.7	17.9	62.7
	SF6 (Gas)	14.6	12.4	102.3

Table 11: Fundamental Periods of Support Structures and Subassemblies – 500 kV Bay

TABLE: Fundamental Frequencies for Equipment - 500 kV Bay				
Equipment Type	**Model Revision**	**Frequency X**	**Frequency Y**	**Frequency Z**
Text	Text	Hz	Hz	Hz
12' Insulator Pedestal	Station Post	4.3	4.3	131.4
Surge Arrester	-	6.3	6.3	141.2
CCVT	-	2.5	2.5	29.3
3000 Amp Disconnect Switch	Steel Supports	3.5	5.5	121.6
	Concrete Supports	3.9	5.6	>150
ELF SP7-2 Live Tank Circuit Breaker	SF6 (Gas)	1.2	1.1	59.9
CT	-	1.0	1.0	67.4

2. *Time - History Analysis*

The next objective was to subject each individual subassembly to IEEE 693 compliant time-history ground motion and record the deflections at the terminal pads on the equipment. The event was contained in a .DAT file and uploaded into SAP2000 with time-steps at 0.005 sec. The time-history orthogonal motions in the X and Y directions were scaled to 0.5g, the Z direction was scaled to 0.4g, and all equipment was assumed to have 2% damping. Figure 29 shows the comparison between the IEEE standard and the scaled ground motions used for this project. Ground motions for the X, Y, and Z components were uploaded independently, allowing ground motions in each direction to be analyzed separately.

An analysis was performed for X component motions, Y component motions, as well as for X, Y, and Z components simultaneously. Displacements at the electrical equipment terminal pads for each load case were collected and tabulated in Table A-1 in Appendix A (230 kV bay), Table B-1 in Appendix B (115 kV bay), and Table C-1 in Appendix C (500 kV bay).

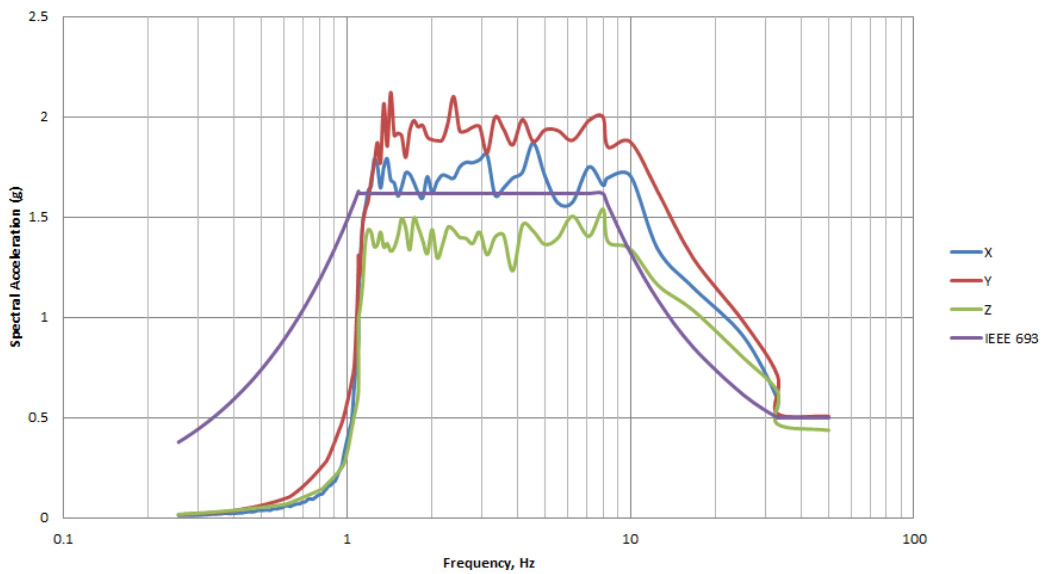

Figure 29: Ground Motion Comparison to IEEE Standard

Bay System Models

After all individual models had been analyzed and their results validated by means of either comparison to seismic qualification reports or experimental testing, they each were imported into bay models based on their location relative to one another.

Without connecting each subassembly together, time history analyses were performed similarly to the individual models. Displacements at the electrical equipment terminal pads were again collected and compared to the individual model results to verify no unexpected changes occurred during the importing process (Table A-2, Table B-2, and Table C-2). After observing identical displacements to the individual models, additional data was collected including member forces at the base of each installation, forces at electrical equipment terminal pads, and forces at the base of insulators and bushings. These results can be seen in Tables A-3 through A-5, B-3 through B-5, and C-3 through C-5.

Bay System Models with Rigid Bus

After comparing the electrical equipment terminal pad displacements from the individual component models to those collected from the system model without bus, components were connected to one another using Sch. 40 aluminum bus. The diameter of the bus varied according to which bay was being considered. Three inch bus was used in the 115 kV bay, four inch bus was used in the 230 kV bay, and five inch bus was used in the 500 kV bay. SAP representations of the system models with rigid bus can be seen in Figures 30, 31, and 32.

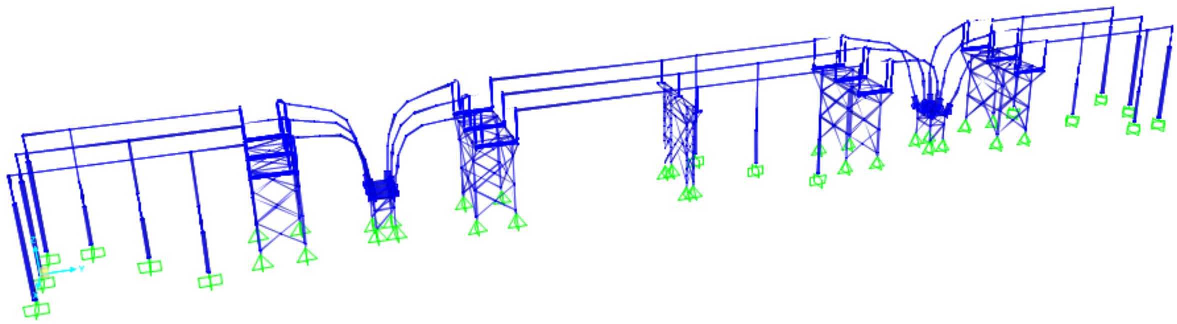

Figure 30: 230 kV Bay System Model with 4” Sch. 40 Aluminum Bus

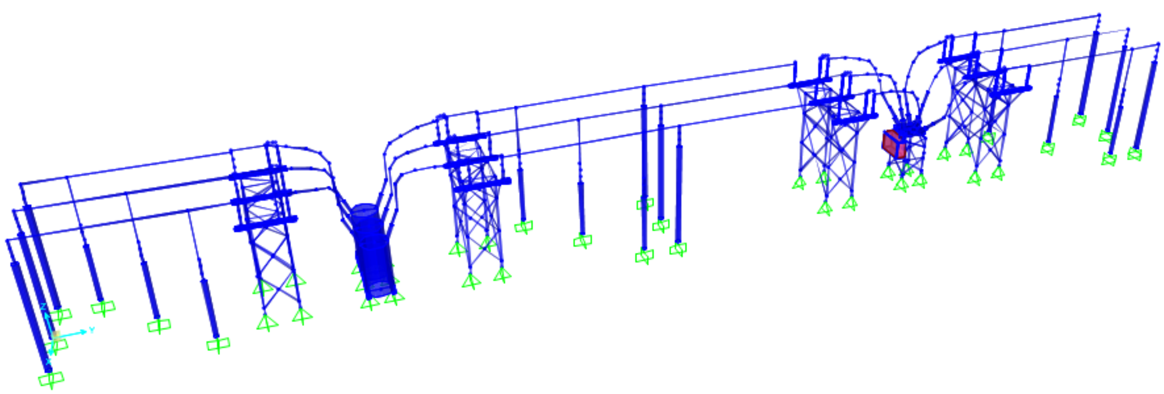

Figure 31: 115 kV Bay System Model with 3” Sch. 40 Aluminum Bus

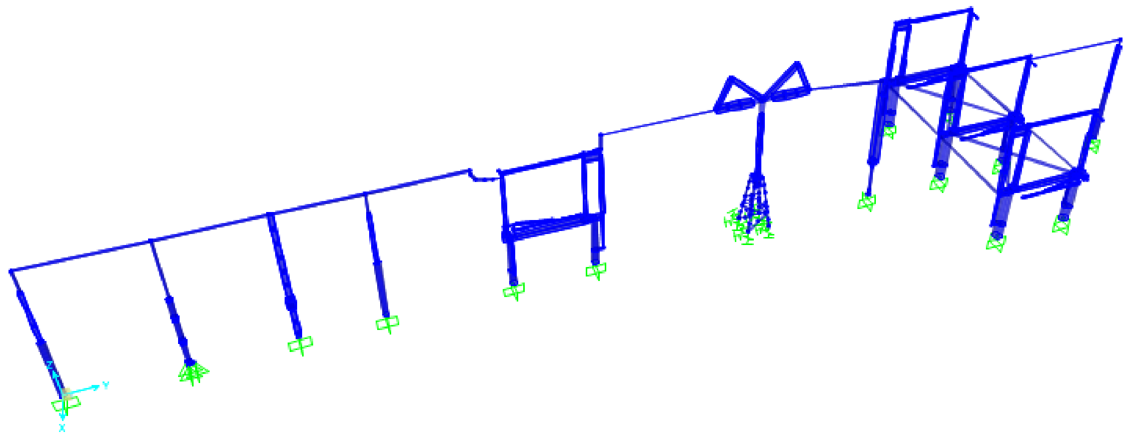

Figure 32: 500 kV Bay System Model with 5” Sch. 40 Aluminum Bus

A linear time history analysis was performed using the same ground motions and load cases used to analyze the individual models. Electrical equipment terminal pad displacements, member forces at the base of each installation, forces at electrical equipment terminal pads, as well as the forces at the base of insulators and bushings were all collected and tabulated. These results can be seen in Tables A-6 through A-9, Tables B-6 through B-9, and Tables C-6 through C-9.

To simplify the computer model, only a single phase was considered for the 500 kV bay system models. Because the equipment properties and spacing in each phase is consistent, this was deemed acceptable by BPA representatives. However, further investigation should be considered to investigate the interaction effects on the disconnect switch with concrete supports since this supported all three phases.

Conclusions

Upon review of the electrical equipment terminal pad displacements collected during time-history analyses, it can be stated that generally, the use of rigid bus to connect each subassembly to one another stiffens the system in the longitudinal direction. However, on occasion, the added weight of the rigid bus increases loads and displacements in the transverse direction. This observation was expected and could be tied to the additional mass of the rigid bus being resisted by each piece of equipment. The addition of rigid bus stiffened the system as a whole in the longitudinal direction, but because there were no connections made in the transverse direction, each piece of equipment was required to resist a greater mass without providing any additional stiffness in the transverse direction.

After comparing the electrical equipment terminal pad loads to the allowable loads provided by IEEE/ANSI standards, a particular area of concern was the connections between the disconnect switches and circuit breakers. In each bay system, this was an area that experienced terminal pad loads much greater than the allowable loads provided. The installation of flexible bus in such locations should be investigated to determine if an increase in forces and displacements can be avoided.

Various electrical equipment in the 230 kV and 500 kV bay systems, with and without, rigid bus experienced forces at the base of insulators and bushings that were much greater than the allowable forces and moments provided. However, it should be noted that no electrical equipment in the 115 kV bay system, with or without rigid bus, experienced forces at the base of insulators and bushings that were greater than the allowable forces and moments provided. This observation was consistent with previous tests and analyses performed by BPA, which provided further evidence as to the accuracy of this research. Insulators and bushings in the 115 kV bay were much shorter than those used in the 230 kV or 500 kV bays, so the allowable loads were much higher comparatively. This resulted in demand/allowable ratios less than 1.0 for all pieces of electrical equipment in both 115 kV bay systems.

The following demand/allowable ratios have been provided for the electrical equipment experiencing high load demands at the base of insulators and bushings in 230 kV and 500 kV bay systems. The forces at the base of insulators and bushings of electrical equipment not listed below were less than the allowable loads provided and as a result, performed adequately during the various time-history ground motions.

1. *230 kV Bay without Rigid Bus*
    - Disconnect Switch with Cap-and-Pin Insulators
        - Demand/Allowable (longitudinal) = 1.05
        - Demand/Allowable (transverse) = 0.95
2. *230 kV Bay with Rigid Bus*
    - Disconnect Switch with Cap-and-Pin Insulators
        - Demand/Allowable (longitudinal) = 1.10
        - Demand/Allowable (transverse) = 0.70
    - Disconnect Switch with Station Post Insulators
        - Demand/Allowable (longitudinal) = 1.00
    - 21’ 1 ¾” Cap-and-Pin Insulator Pedestals
        - Demand/Allowable (transverse) = 1.00

3. *500 kV Bay without Rigid Bus*

- Surge Arrester
  - Demand/Allowable (longitudinal) = 3.18
  - Demand/Allowable (transverse) = 2.66
- CCVT
  - Demand/Allowable (longitudinal) = 1.28
  - Demand/Allowable (transverse) = 1.16
- ELF SP7-2 Circuit Breaker
  - Demand/Allowable (longitudinal) = 3.47
  - Demand/Allowable (transverse) = 4.68

4. *500 kV Bay with Rigid Bus*

- Surge Arrester
  - Demand/Allowable (longitudinal) = 2.95
  - Demand/Allowable (transverse) = 2.01
- CCVT
  - Demand/Allowable (longitudinal) = 0.60
  - Demand/Allowable (transverse) = 1.22
- Disconnect Switch on Concrete Supports
  - Demand/Allowable (longitudinal) = 1.17
- ELF SP7-2 Circuit Breaker
  - Demand/Allowable (longitudinal) = 1.52
  - Demand/Allowable (transverse) = 2.51

This information reflected how the addition of rigid bus generally stiffened the system in the longitudinal direction resulting in reduced forces and moments at the base of insulators and bushings. The data also suggested that the rigid bus allowed stiffer subassemblies to resist loads from nearby electrical equipment resulting in an increase in forces and moments in the longitudinal direction. For example, the 500 kV disconnect switch on concrete supports appeared to resist the large deformations from both the ELF circuit breaker and CT, decreasing deflections and forces at the base of insulators for each.

While the member forces at the base of each installation were collected, the information was not compared to any existing failure criteria and was therefore not used to determine performance of the electrical equipment. This information was provided for BPA records and should be investigated further. It should be noted that all results are based off electrical equipment with pinned or fixed supports and rigid bus connections. In cases where flexible bus or dampers are installed, further analysis should be performed to determine the adequacy of corresponding electrical equipment.

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Appendix A (230 kV Bay)

Mode Shapes

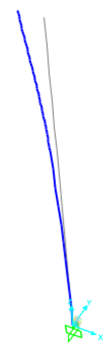

Figure A1: 9’ – 1 ¾” Insulator Pedestals (f_x = 4.7 Hz)

Figure A2: 9’ – 1 ¾” Insulator Pedestals (f_y = 4.7 Hz)

Figure A3: 9’ – 1 ¾” Insulator Pedestals (f_z = 145.0 Hz)

Figure A4: 21’ – 1 ¾” Insulator Pedestals (f_x = 2.4 Hz)

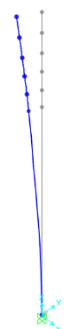

Figure A5: 21’ – 1 ¾” Insulator Pedestals (f_y = 2.4 Hz)

Figure A6: 21’ – 1 ¾” Insulator Pedestals (f_z = 104.3 Hz)

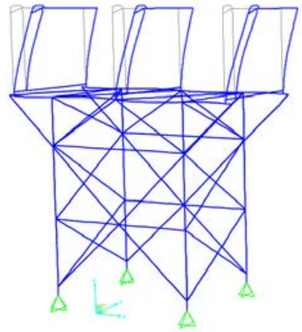

Figure A7: 2000 Amp Disconnect Switch with Cap-and-Pin Insulators (f_x = 3.8 Hz)

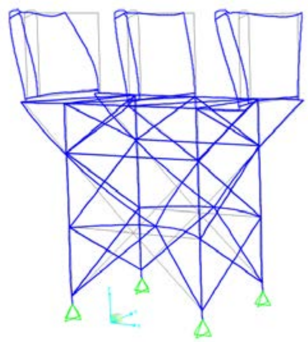

Figure A8: 2000 Amp Disconnect Switch with Cap-and-Pin Insulators (f_y = 5.3 Hz)

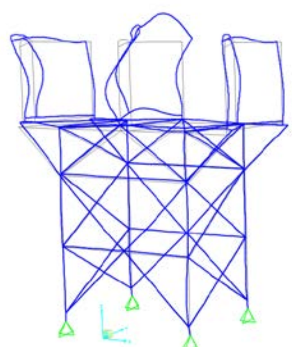

Figure A9: 2000 Amp Disconnect Switch with Cap-and-Pin Insulators (f_z = 31.8 Hz)

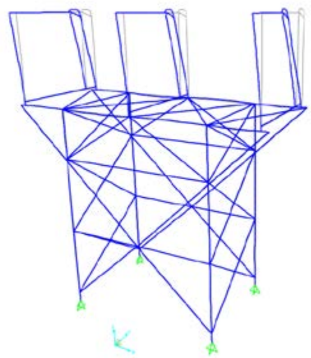

Figure A10: 2000 Amp Disconnect Switch with Station Post Insulators (f_x = 4.6 Hz)

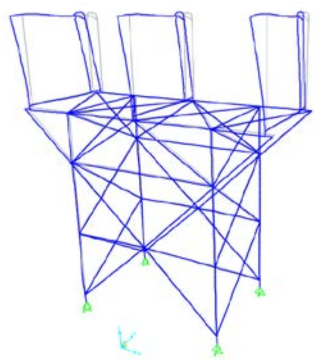

Figure A11: 2000 Amp Disconnect Switch with Station Post Insulators (f_y = 6.8 Hz)

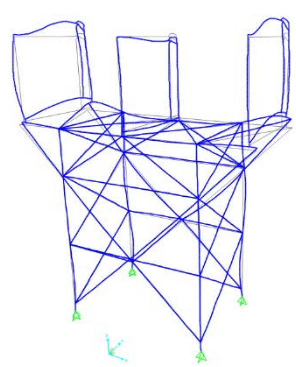

Figure A12: 2000 Amp Disconnect Switch with Station Post Insulators (f_z = 29.8 Hz)

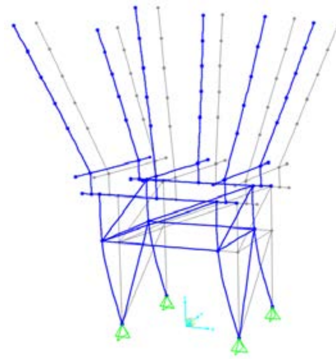

Figure A13: ABB O-2947 Circuit Breaker with Porcelain Bushings (f_x = 3.0 Hz)

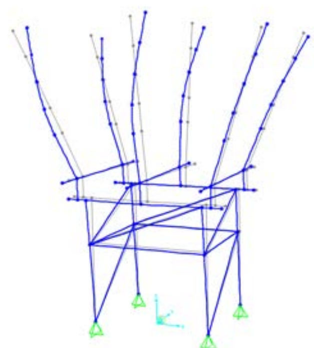

Figure A14: ABB O-2947 Circuit Breaker with Porcelain Bushings (f_y = 20.3 Hz)

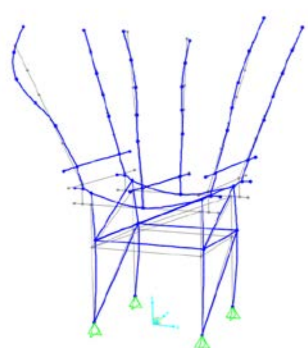

Figure A15: ABB O-2947 Circuit Breaker with Porcelain Bushings (f_z = 77.7 Hz)

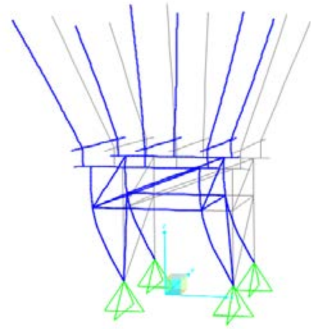

Figure A16: ABB O-2947 Circuit Breaker with Composite Bushings (f_x = 3.2 Hz)

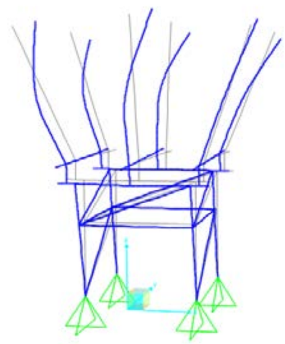

Figure A17: ABB O-2947 Circuit Breaker with Composite Bushings (f_y = 20.9 Hz)

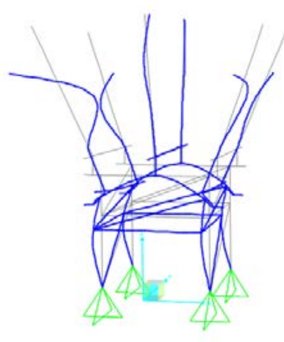

Figure A18: ABB O-2947 Circuit Breaker with Composite Bushings (f_z = 82.1 Hz)

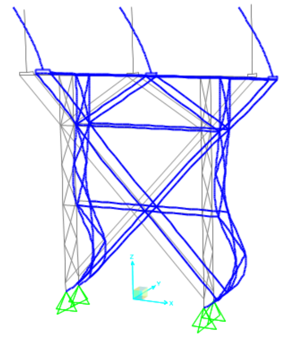

Figure A19: Insulator Lattice Support (f_x = 14.1 Hz)

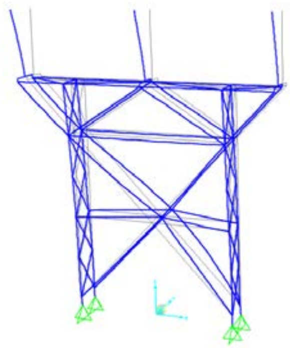

Figure A20: Insulator Lattice Support (f_y = 3.6 Hz)

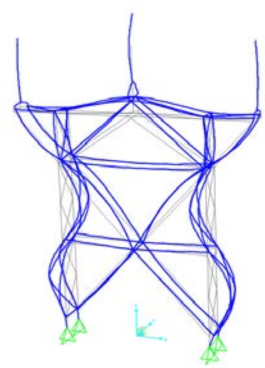

Figure A21: Insulator Lattice Support (f_z = 40.5 Hz)

Time-History Data

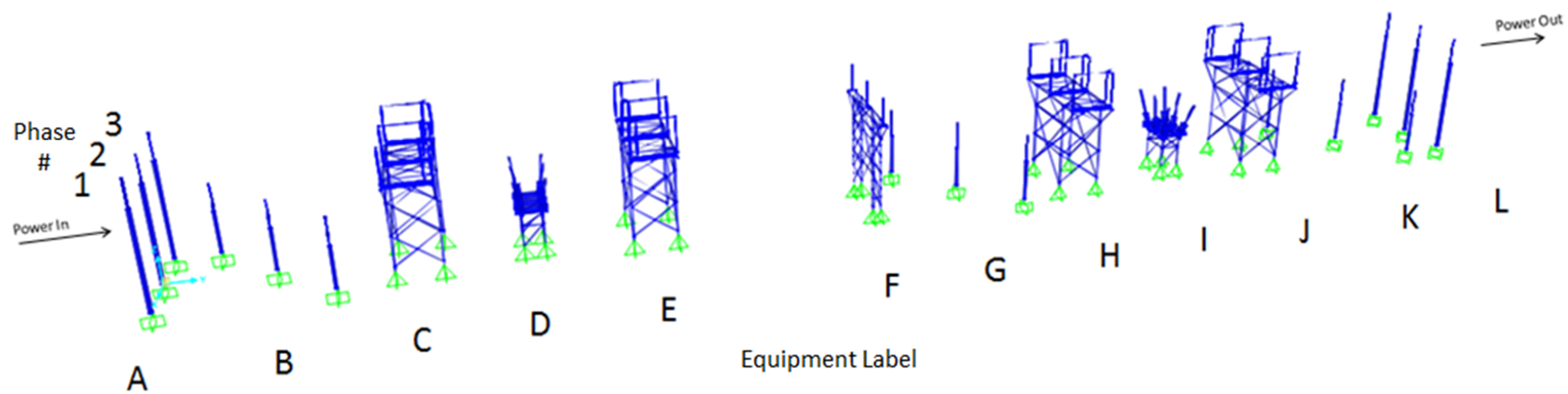

Figure A22: 230 kV Bay Equipment Label Key

230 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Displacements - INDIVIDUAL MODELS

Equipment Label	Phase #	Node #	X-Dir. Only X (in)	Y-Dir. Only Y (in)	XYZ-Dir. Combined X (in)	Y (in)	Z (in)
A	1	1007	4.10	4.55	4.10	4.55	0.00
	2	2007	4.10	4.55	4.10	4.55	0.00
	3	3007	4.10	4.55	4.10	4.55	0.00
B	3	4007	1.19	1.40	1.19	1.40	0.00
	2	5007	1.19	1.40	1.19	1.40	0.00
	1	6007	1.19	1.40	1.19	1.40	0.00
C	1a	7057	0.67	0.58	0.73	0.58	0.03
	2a	7077	0.65	0.50	0.65	0.50	0.02
	3a	7097	0.67	0.58	0.77	0.59	0.03
	1b	7050	1.22	0.63	1.22	0.62	0.03
	2b	7070	1.19	0.53	1.19	0.53	0.02
	3b	7090	1.22	0.63	1.22	0.63	0.03
D	1a	8057	2.27	0.22	2.32	0.22	0.22
	2a	8061	1.97	0.50	1.97	0.50	0.11
	3a	8062	2.27	0.22	2.22	0.22	0.21
	1b	8055	2.25	0.23	2.30	0.22	0.23
	2b	8060	1.96	0.50	1.96	0.51	0.10
	3b	8053	2.26	0.22	2.21	0.22	0.21
E	1a	9070	1.22	0.65	1.24	0.70	0.04
	2a	9050	1.19	0.54	1.19	0.54	0.02
	3a	9090	1.22	0.65	1.21	0.64	0.04
	1b	9077	0.64	0.60	0.79	0.66	0.03
	2b	9057	0.62	0.50	0.62	0.50	0.02
	3b	9097	0.64	0.60	0.70	0.60	0.03
F	1	10015	8.26	2.40	8.25	2.40	0.02
	2	10010	8.18	2.49	8.18	2.49	0.00
	3	10006	8.26	2.40	8.26	2.40	0.02
G	3	11007	1.19	1.40	1.19	1.40	0.00
	2	12007	1.19	1.40	1.19	1.40	0.00
	1	13007	1.19	1.40	1.19	1.40	0.00
H	1a	14138	1.40	1.03	1.61	1.02	0.03
	2a	14139	1.38	0.94	1.38	0.94	0.02
	3a	14140	1.40	1.03	1.65	1.07	0.03
	1b	14054	2.21	1.10	2.27	1.08	0.03
	2b	14085	2.15	1.00	2.15	1.00	0.02
	3b	14116	2.21	1.10	2.15	1.14	0.03
I	1a	15060	1.96	0.17	1.97	0.18	0.17
	2a	15005	1.74	0.38	1.74	0.38	0.07
	3a	15063	1.96	0.17	1.97	0.18	0.16
	1b	15058	1.94	0.18	1.96	0.17	0.17
	2b	15000	1.73	0.38	1.73	0.37	0.08
	3b	15056	1.95	0.18	1.95	0.17	0.17
J	1a	16085	2.22	1.10	2.19	1.13	0.03
	2a	16053	2.16	1.00	2.16	0.99	0.02
	3a	16110	2.22	1.10	2.25	1.07	0.03
	1b	16140	1.40	1.03	1.67	1.06	0.03
	2b	16139	1.38	0.94	1.38	0.93	0.02
	3b	16138	1.40	1.03	1.59	1.01	0.03
K	3	17007	1.19	1.40	1.19	1.40	0.00
	2	18007	1.19	1.40	1.19	1.40	0.00
	1	19007	1.19	1.40	1.19	1.40	0.00
L	1	20007	4.10	4.55	4.10	4.55	0.00
	2	21007	4.10	4.55	4.10	4.55	0.00
	3	22007	4.10	4.55	4.10	4.55	0.00

Note: Red text indicates displacements greater than 6"

230 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Displacements - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Node #	X-Dir. Only	Y-Dir. Only	XYZ-Dir. Combined		
			X (in)	Y (in)	X (in)	Y (in)	Z (in)
A	1	1007	4.10	4.55	4.10	4.55	0.00
	2	2007	4.10	4.55	4.10	4.55	0.00
	3	3007	4.10	4.55	4.10	4.55	0.00
B	3	4007	1.19	1.40	1.19	1.40	0.00
	2	5007	1.19	1.40	1.19	1.40	0.00
	1	6007	1.19	1.40	1.19	1.40	0.00
C	1a	7057	0.67	0.59	0.73	0.59	0.03
	2a	7077	0.65	0.50	0.65	0.50	0.02
	3a	7097	0.67	0.59	0.78	0.60	0.03
	1b	7050	1.22	0.63	1.22	0.63	0.03
	2b	7070	1.19	0.54	1.19	0.54	0.02
	3b	7090	1.22	0.63	1.23	0.64	0.03
D	1a	8087	2.27	0.22	2.32	0.22	0.22
	2a	8091	1.97	0.50	1.97	0.50	0.11
	3a	8092	2.27	0.22	2.22	0.22	0.21
	1b	8085	2.25	0.23	2.30	0.22	0.23
	2b	8090	1.96	0.50	1.96	0.51	0.10
	3b	8083	2.26	0.22	2.21	0.22	0.21
E	1a	9070	1.22	0.63	1.23	0.64	0.04
	2a	9050	1.19	0.54	1.19	0.54	0.02
	3a	9090	1.22	0.63	1.22	0.63	0.04
	1b	9077	0.67	0.59	0.79	0.60	0.03
	2b	9057	0.65	0.50	0.65	0.50	0.02
	3b	9097	0.67	0.59	0.72	0.59	0.03
F	1	10015	8.26	2.40	8.25	2.40	0.02
	2	10010	8.18	2.49	8.18	2.49	0.00
	3	10006	8.26	2.40	8.26	2.40	0.02
G	3	11007	1.19	1.40	1.19	1.40	0.00
	2	12007	1.19	1.40	1.19	1.40	0.00
	1	13007	1.19	1.40	1.19	1.40	0.00
H	1a	14138	1.39	1.03	1.59	1.02	0.03
	2a	14139	1.36	0.93	1.36	0.94	0.02
	3a	14140	1.39	1.03	1.61	1.06	0.03
	1b	14054	2.20	1.10	2.25	1.08	0.03
	2b	14085	2.14	0.99	2.14	1.00	0.02
	3b	14116	2.20	1.10	2.15	1.13	0.03
I	1a	15060	1.96	0.17	1.97	0.18	0.17
	2a	15005	1.74	0.38	1.74	0.38	0.07
	3a	15063	1.96	0.17	1.97	0.18	0.16
	1b	15058	1.94	0.18	1.96	0.17	0.17
	2b	15000	1.73	0.38	1.73	0.37	0.08
	3b	15056	1.95	0.18	1.95	0.17	0.17
J	1a	16085	2.21	1.10	2.19	1.12	0.03
	2a	16053	2.15	0.99	2.15	0.99	0.03
	3a	16110	2.21	1.10	2.23	1.07	0.03
	1b	16140	1.39	1.03	1.62	1.05	0.03
	2b	16138	1.37	0.93	1.37	0.93	0.02
	3b	16139	1.39	1.03	1.57	1.01	0.03
K	3	17007	1.19	1.40	1.19	1.40	0.00
	2	18007	1.19	1.40	1.19	1.40	0.00
	1	19007	1.19	1.40	1.19	1.40	0.00
L	1	20007	4.10	4.55	4.10	4.55	0.00
	2	21007	4.10	4.55	4.10	4.55	0.00
	3	22007	4.10	4.55	4.10	4.55	0.00

Note: Red text indicates displacements greater than 6"

Table A-3

230 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Member Forces at Base - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	1	1001	1001	0	0.00	1.20	0.00	0.00	336.67	0.00	0.00	1.36	378.33	0.00	0.00	1.20	1.36	378.33	336.67
	2	2001	2001	0	0.00	1.20	0.00	0.00	336.67	0.00	0.00	1.36	378.33	0.00	0.00	1.20	1.36	378.33	336.67
	3	3001	3001	0	0.00	1.20	0.00	0.00	336.67	0.00	0.00	1.36	378.33	0.00	0.00	1.20	1.36	378.33	336.67
B	3	4001	4001	0	0.00	0.76	0.00	0.01	112.31	0.00	0.00	0.86	130.19	0.00	0.00	0.76	0.86	130.19	112.31
	2	5001	5001	0	0.00	0.76	0.00	0.01	112.31	0.00	0.00	0.86	130.19	0.00	0.00	0.76	0.86	130.19	112.31
	1	6001	6001	0	0.00	0.76	0.00	0.00	112.31	0.00	0.00	0.86	130.19	0.00	0.00	0.76	0.86	130.19	112.31
C	1a	7047	7015	0	6.16	1.88	0.45	0.00	0.00	11.04	0.49	2.25	0.00	0.00	15.63	2.08	2.44	0.00	0.00
	3a	7052	7017	0	6.16	1.88	0.45	0.00	0.00	11.04	0.49	2.25	0.00	0.00	14.64	1.73	2.41	0.00	0.00
	1b	7031	7001	0	5.86	2.08	0.47	0.00	0.00	11.00	0.49	2.30	0.00	0.00	13.18	2.10	2.51	0.00	0.00
	3b	7036	7003	0	5.86	2.08	0.47	0.00	0.00	11.00	0.49	2.30	0.00	0.00	14.71	2.28	2.48	0.00	0.00
D	1a	8030	8028	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3a	8028	8025	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1b	8039	8037	0	0.26	0.72	0.29	11.91	29.81	0.04	0.22	0.60	29.50	10.94	0.32	0.83	0.73	33.03	35.38
	3b	8038	8035	0	0.00	0.00	0.12	2.08	0.00	0.02	0.24	0.00	0.01	4.31	0.03	0.24	0.12	2.09	4.28
E	1a	9047	9003	0	4.06	0.04	0.02	1.43	4.94	5.30	0.01	0.10	6.52	1.37	8.17	0.04	0.11	7.04	5.47
	3a	9040	9001	0	5.86	0.47	2.13	0.00	0.00	11.00	2.30	0.49	0.00	0.00	12.87	2.54	2.09	0.00	0.00
	1b	9063	9027	0	6.24	0.45	1.89	0.00	0.00	11.04	2.25	0.49	0.00	0.00	14.18	2.37	1.82	0.00	0.00
	3b	9058	9025	0	6.24	1.89	0.45	0.00	0.00	11.04	0.49	2.25	0.00	0.00	14.92	2.05	2.47	0.00	0.00
F	1a	10027	10028	0	2.07	0.74	0.01	0.00	0.00	26.84	0.84	1.14	0.00	0.00	27.12	1.07	1.14	0.00	0.00
	3a	10016	10016	0	2.07	0.01	0.74	0.00	0.00	26.84	1.14	0.84	0.00	0.00	26.82	1.15	1.19	0.00	0.00
	1b	10049	10052	0	2.12	0.01	0.75	0.00	0.00	26.84	1.14	0.84	0.00	0.00	26.64	1.15	1.19	0.00	0.00
	3b	10038	10040	0	2.12	0.75	0.01	0.00	0.00	26.83	0.84	1.14	0.00	0.00	27.02	1.09	1.14	0.00	0.00
G	3	11001	11001	0	0.00	0.76	0.00	0.00	112.31	0.00	0.00	0.86	130.19	0.00	0.00	0.76	0.86	130.19	112.31
	2	12001	12001	0	0.00	0.76	0.00	0.00	112.31	0.00	0.00	0.86	130.19	0.00	0.00	0.76	0.86	130.19	112.31
	1	13001	13001	0	0.00	0.76	0.00	0.00	112.31	0.00	0.00	0.86	130.19	0.00	0.00	0.76	0.86	130.19	112.31
H	1a	14047	14015	0	6.81	1.68	0.38	0.00	0.00	12.18	0.52	2.60	0.00	0.00	15.54	1.99	2.64	0.00	0.00
	3a	14052	14017	0	6.81	1.68	0.38	0.00	0.00	12.18	0.52	2.60	0.00	0.00	12.44	1.93	2.57	0.00	0.00
	1b	14031	14001	0	5.79	2.26	0.42	0.00	0.00	12.17	0.52	2.63	0.00	0.00	11.75	2.53	2.68	0.00	0.00
	3b	14036	14003	0	5.79	2.26	0.42	0.00	0.00	12.17	0.52	2.63	0.00	0.00	14.72	2.46	2.60	0.00	0.00
I	1a	15031	15031	0	9.46	3.32	0.00	0.00	0.06	4.57	0.00	0.01	0.00	0.00	13.13	3.32	0.01	0.00	0.06
	3a	15029	15028	0	9.45	0.01	3.35	0.06	0.00	4.56	0.01	0.00	0.00	0.00	12.49	0.01	3.35	0.06	0.00
	1b	15040	15040	0	9.53	0.00	3.30	0.00	0.00	7.89	0.00	0.00	0.00	0.00	15.55	0.01	3.31	0.00	0.00
	3b	15039	15038	0	9.52	3.33	0.01	0.00	0.00	7.89	0.00	0.00	0.00	0.00	15.43	3.33	0.01	0.00	0.00
J	1a	16065	16003	0	5.45	2.13	0.40	0.00	0.00	12.17	0.52	2.63	0.00	0.00	15.22	2.55	2.59	0.00	0.00
	3a	16051	16001	0	5.45	0.40	2.13	0.00	0.00	12.17	2.63	0.52	0.00	0.00	11.44	2.66	2.28	0.00	0.00
	1b	16081	16027	0	6.29	0.37	1.66	0.00	0.00	12.18	2.60	0.52	0.00	0.00	12.26	2.56	1.76	0.00	0.00
	3b	16076	16025	0	6.29	1.66	0.37	0.00	0.00	12.18	0.52	2.60	0.00	0.00	16.05	2.07	2.62	0.00	0.00
K	3	17001	17001	0	0.00	0.76	0.00	0.01	112.31	0.00	0.00	0.86	130.19	0.00	0.00	0.76	0.86	130.19	112.31
	2	18001	18001	0	0.00	0.76	0.00	0.00	112.31	0.00	0.00	0.86	130.19	0.00	0.00	0.76	0.86	130.19	112.31
	1	19001	19001	0	0.00	0.76	0.00	0.00	112.31	0.00	0.00	0.86	130.19	0.00	0.00	0.76	0.86	130.19	112.31
L	1	20001	20001	0	0.00	1.20	0.00	0.00	336.67	0.00	0.00	1.36	378.33	0.00	0.00	1.20	1.36	378.33	336.67
	2	21001	21001	0	0.00	1.20	0.00	0.00	336.67	0.00	0.00	1.36	378.33	0.00	0.00	1.20	1.36	378.33	336.67
	3	22001	22001	0	0.00	1.20	0.00	0.00	336.67	0.00	0.00	1.36	378.33	0.00	0.00	1.20	1.36	378.33	336.67

230 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Forces - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	1	1006	1007	1	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.11	0.11	0.00	0.00
	2	2006	2007	1	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.11	0.11	0.00	0.00
	3	3006	3007	1	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.11	0.11	0.00	0.00
B	3	4006	4007	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.12	0.14	0.00	0.00
	2	5006	5007	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.12	0.14	0.00	0.00
	1	6006	6007	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.12	0.14	0.00	0.00
C	1a	7102	7057	1	0.02	0.33	0.11	0.16	1.74	0.08	0.14	0.60	0.88	0.28	0.09	0.42	0.59	0.87	1.96
	2a	7124	7077	1	0.00	0.33	0.00	0.00	1.68	0.06	0.00	0.47	0.97	0.00	0.08	0.33	0.47	0.99	1.68
	3a	7146	7097	1	0.02	0.33	0.11	0.16	1.74	0.08	0.14	0.60	0.88	0.28	0.10	0.41	0.61	0.90	1.80
	1b	7098	7050	1	0.15	0.12	0.01	1.78	2.44	0.85	0.01	0.06	10.36	0.56	0.82	0.12	0.06	10.09	2.42
	2b	7120	7070	1	0.00	0.11	0.00	0.00	2.39	0.81	0.00	0.06	9.55	0.00	0.80	0.11	0.06	9.51	2.38
	3b	7142	7090	1	0.15	0.12	0.01	1.78	2.44	0.85	0.01	0.06	10.36	0.56	0.88	0.12	0.06	10.63	2.85
D	1a	8047	8087	0	0.04	0.11	0.05	0.00	0.00	0.01	0.06	0.15	0.00	0.00	0.04	0.15	0.15	0.00	0.00
	2a	8038	8091	1	0.00	0.00	0.12	0.00	0.00	0.02	0.24	0.00	0.00	0.00	0.03	0.24	0.12	0.00	0.00
	3a	8051	8092	0	0.04	0.11	0.05	0.00	0.00	0.01	0.06	0.15	0.00	0.00	0.04	0.15	0.15	0.00	0.00
	1b	8043	8085	0	0.04	0.11	0.04	0.00	0.00	0.01	0.06	0.16	0.00	0.00	0.04	0.15	0.17	0.00	0.00
	2b	8034	8090	1	0.00	0.00	0.12	0.00	0.00	0.02	0.24	0.00	0.00	0.00	0.04	0.25	0.12	0.00	0.00
	3b	8042	8083	1	0.04	0.11	0.05	0.00	0.00	0.01	0.06	0.16	0.00	0.00	0.05	0.15	0.16	0.00	0.00
E	1a	9130	9070	1	0.15	0.12	0.01	1.75	2.46	0.85	0.01	0.06	10.36	0.56	0.90	0.12	0.06	10.74	2.87
	2a	9108	9050	1	0.00	0.12	0.00	0.00	2.40	0.81	0.00	0.06	9.55	0.00	0.82	0.12	0.06	9.59	2.40
	3a	9155	9090	1	0.15	0.12	0.01	1.75	2.46	0.85	0.01	0.06	10.36	0.56	0.84	0.12	0.06	10.12	2.40
	1b	9134	9077	1	0.02	0.33	0.10	0.16	1.73	0.08	0.14	0.60	0.88	0.28	0.10	0.41	0.61	0.91	1.78
	2b	9112	9057	1	0.00	0.33	0.00	0.00	1.67	0.06	0.00	0.47	0.97	0.00	0.08	0.33	0.47	0.97	1.67
	3b	9014	9097	1	0.02	0.33	0.10	0.16	1.73	0.08	0.14	0.60	0.88	0.28	0.08	0.40	0.58	0.90	1.85
F	1	10015	10015	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.02	0.12	0.13	0.00	0.00
	2	10010	10010	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.02	0.12	0.13	0.00	0.00
	3	10005	10006	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.02	0.12	0.13	0.00	0.00
G	3	11006	11007	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.12	0.14	0.00	0.00
	2	12006	12007	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.12	0.14	0.00	0.00
	1	13006	13007	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.12	0.14	0.00	0.00
H	1a	14196	14138	1	0.01	0.22	0.03	0.56	1.77	0.13	0.05	0.30	5.48	0.16	0.12	0.25	0.28	5.38	1.84
	2a	14198	14139	1	0.00	0.21	0.00	0.00	1.73	0.11	0.00	0.23	4.92	0.00	0.11	0.21	0.24	4.94	1.73
	3a	14200	14140	1	0.01	0.22	0.03	0.56	1.77	0.13	0.05	0.30	5.48	0.16	0.13	0.25	0.31	5.72	1.70
	1b	14112	14054	1	0.16	0.02	0.01	1.64	1.60	1.54	0.01	0.04	16.50	0.87	1.50	0.03	0.04	16.10	2.08
	2b	14145	14085	1	0.00	0.02	0.00	0.00	1.56	1.55	0.00	0.02	16.24	0.00	1.55	0.02	0.02	16.35	1.56
	3b	14178	14116	1	0.16	0.02	0.01	1.64	1.60	1.54	0.01	0.04	16.50	0.87	1.59	0.03	0.04	17.06	1.87
I	1a	15018	15060	0	0.03	0.08	0.03	0.00	0.00	0.00	0.04	0.11	0.00	0.00	0.03	0.10	0.11	0.00	0.00
	2a	15000	15005	1	0.00	0.00	0.07	0.00	0.00	0.01	0.14	0.00	0.00	0.00	0.02	0.14	0.07	0.00	0.00
	3a	15022	15063	0	0.03	0.08	0.03	0.00	0.00	0.00	0.04	0.11	0.00	0.00	0.03	0.09	0.13	0.00	0.00
	1b	15014	15058	0	0.03	0.08	0.03	0.00	0.00	0.00	0.04	0.11	0.00	0.00	0.03	0.09	0.12	0.00	0.00
	2b	15005	15000	1	0.00	0.00	0.07	0.00	0.00	0.01	0.14	0.00	0.00	0.00	0.02	0.15	0.07	0.00	0.00
	3b	15013	15056	1	0.03	0.08	0.03	0.00	0.00	0.00	0.04	0.11	0.00	0.00	0.03	0.10	0.11	0.00	0.00
J	1a	16160	16085	1	0.16	0.02	0.01	1.71	1.62	1.54	0.01	0.04	16.50	0.87	1.57	0.03	0.04	16.80	1.86
	2a	16052	16053	1	0.00	0.02	0.00	0.00	1.57	1.55	0.00	0.02	16.24	0.00	1.54	0.02	0.02	16.14	1.57
	3a	16122	16110	1	0.16	0.02	0.01	1.71	1.62	1.54	0.01	0.04	16.50	0.87	1.51	0.03	0.04	16.17	2.06
	1b	16200	16140	1	0.01	0.22	0.03	0.56	1.82	0.13	0.05	0.30	5.48	0.16	0.13	0.25	0.30	5.59	1.79
	2b	16196	16138	1	0.00	0.22	0.00	0.00	1.77	0.11	0.00	0.23	4.92	0.00	0.11	0.22	0.23	4.92	1.77
	3b	16198	16139	1	0.01	0.22	0.03	0.56	1.82	0.13	0.05	0.30	5.48	0.16	0.12	0.23	0.29	5.31	1.86
K	3	17006	17007	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.12	0.14	0.00	0.00
	2	18006	18007	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.12	0.14	0.00	0.00
	1	19006	19007	1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.12	0.14	0.00	0.00
L	1	20006	20007	1	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.11	0.11	0.00	0.00
	2	21006	21007	1	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.11	0.11	0.00	0.00
	3	22006	22007	1	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.11	0.11	0.00	0.00

230 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Insulator Forces at the Base - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	1	1002	1002	0	0.00	0.76	0.00	0.00	33.44	0.00	0.00	0.82	34.91	0.00	0.00	0.76	0.82	34.91	33.44
	2	2002	2002	0	0.00	0.76	0.00	0.00	33.44	0.00	0.00	0.82	34.91	0.00	0.00	0.76	0.82	34.91	33.44
	3	3002	3002	0	0.00	0.76	0.00	0.00	33.44	0.00	0.00	0.82	34.91	0.00	0.00	0.76	0.82	34.91	33.44
B	3	4002	4002	0	0.00	0.65	0.00	0.00	30.31	0.00	0.00	0.76	35.87	0.00	0.00	0.65	0.76	35.87	30.31
	2	5002	5002	0	0.00	0.65	0.00	0.00	30.31	0.00	0.00	0.76	35.87	0.00	0.00	0.65	0.76	35.87	30.31
	1	6002	6002	0	0.00	0.65	0.00	0.00	30.31	0.00	0.00	0.76	35.87	0.00	0.00	0.65	0.76	35.87	30.31
C	1a	7101	7055	0	0.05	0.49	0.14	9.51	33.99	0.10	0.22	0.86	57.17	14.67	0.16	0.59	0.84	56.25	42.16
	2a	7123	7075	0	0.00	0.48	0.00	0.00	33.41	0.08	0.00	0.70	45.59	0.00	0.14	0.48	0.69	45.53	33.42
	3a	7145	7095	0	0.05	0.49	0.14	9.51	33.99	0.10	0.22	0.86	57.17	14.67	0.18	0.62	0.87	58.10	43.15
	1b	7099	7051	0	0.16	0.83	0.16	9.30	57.44	0.81	0.05	0.94	55.52	3.82	0.84	0.82	0.92	54.20	56.98
	2b	7121	7071	0	0.00	0.80	0.00	0.00	55.90	0.77	0.00	0.83	49.29	0.00	0.79	0.80	0.83	49.10	55.90
	3b	7143	7091	0	0.16	0.83	0.16	9.30	57.44	0.81	0.05	0.94	55.52	3.82	0.82	0.83	0.96	56.43	57.99
	1c	7097	7048	0	0.17	0.38	0.07	1.23	17.56	0.88	0.03	0.39	6.96	1.24	0.83	0.38	0.38	6.80	17.54
	2c	7119	7068	0	0.00	0.38	0.00	0.00	16.94	0.83	0.00	0.35	6.63	0.00	0.82	0.38	0.35	6.60	16.94
	3c	7141	7088	0	0.17	0.38	0.07	1.23	17.56	0.88	0.03	0.39	6.96	1.24	0.91	0.39	0.40	7.30	17.58
D	1a	8050	8063	1	0.26	0.72	0.30	12.28	29.77	0.04	0.22	0.59	28.57	10.95	0.31	0.85	0.70	31.44	36.47
	2a	8035	8059	0	0.00	0.00	0.76	31.35	0.02	0.13	1.09	0.00	0.08	50.04	0.22	1.08	0.76	31.36	49.58
	3a	8054	8064	1	0.26	0.72	0.30	12.30	29.83	0.04	0.22	0.58	28.48	10.94	0.30	0.81	0.65	30.75	34.99
	1b	8046	8056	1	0.26	0.72	0.29	11.87	29.76	0.04	0.22	0.61	29.60	10.94	0.28	0.84	0.66	31.98	35.28
	2b	8031	8058	0	0.00	0.00	0.76	31.25	0.03	0.11	1.09	0.00	0.07	49.98	0.26	1.10	0.76	31.24	50.88
	3b	8039	8054	0	0.26	0.72	0.29	11.91	29.81	0.04	0.22	0.60	29.50	10.94	0.32	0.83	0.73	33.03	35.38
E	1a	9129	9068	0	0.17	0.39	0.07	1.19	17.56	0.88	0.03	0.39	6.96	1.24	0.96	0.39	0.40	7.22	17.64
	2a	9107	9048	0	0.00	0.38	0.00	0.00	17.11	0.83	0.00	0.35	6.63	0.00	0.86	0.38	0.36	6.66	17.11
	3a	9154	9088	0	0.17	0.39	0.07	1.19	17.56	0.88	0.03	0.39	6.96	1.24	0.88	0.38	0.38	6.79	17.49
	1b	9131	9071	0	0.15	0.83	0.16	9.19	57.71	0.81	0.05	0.94	55.52	3.82	0.85	0.84	0.97	57.21	58.81
	2b	9109	9051	0	0.00	0.81	0.00	0.00	56.19	0.77	0.00	0.83	49.29	0.01	0.78	0.81	0.84	49.48	56.18
	3b	9156	9091	0	0.15	0.83	0.16	9.19	57.71	0.81	0.05	0.94	55.52	3.82	0.79	0.82	0.92	54.25	56.61
	1c	9133	9075	0	0.05	0.50	0.14	9.54	34.64	0.10	0.22	0.86	57.17	14.67	0.19	0.63	0.88	58.41	43.59
	2c	9111	9055	0	0.00	0.48	0.00	0.00	33.72	0.08	0.00	0.70	45.59	0.00	0.14	0.48	0.70	45.64	33.72
	3c	9157	9095	0	0.05	0.50	0.14	9.54	34.63	0.10	0.22	0.86	57.17	14.67	0.13	0.58	0.84	55.91	40.87
F	1	10011	10107	0	0.04	0.59	0.00	0.02	26.76	0.01	0.00	0.87	37.90	0.07	0.18	0.59	0.87	37.90	26.73
	2	10006	10108	0	0.00	0.58	0.00	0.00	26.76	0.00	0.00	0.90	39.18	0.00	0.18	0.58	0.90	39.18	26.76
	3	10001	10106	0	0.04	0.59	0.00	0.02	26.76	0.01	0.00	0.87	37.89	0.07	0.15	0.59	0.87	37.90	26.78
G	3	11002	11002	0	0.00	0.65	0.00	0.00	30.31	0.00	0.00	0.76	35.87	0.00	0.00	0.65	0.76	35.87	30.31
	2	12002	12002	0	0.00	0.65	0.00	0.00	30.31	0.00	0.00	0.76	35.87	0.00	0.00	0.65	0.76	35.87	30.31
	1	13002	13002	0	0.00	0.65	0.00	0.00	30.31	0.00	0.00	0.76	35.87	0.00	0.00	0.65	0.76	35.87	30.31
H	1a	14101	14073	0	0.05	0.61	0.09	4.24	37.06	0.14	0.21	0.82	40.86	12.26	0.19	0.72	0.81	40.05	44.27
	2a	14134	14104	0	0.00	0.59	0.00	0.00	36.46	0.13	0.00	0.75	35.83	0.00	0.19	0.59	0.77	35.89	36.46
	3a	14167	14135	0	0.05	0.61	0.09	4.24	37.07	0.14	0.21	0.82	40.87	12.26	0.21	0.72	0.85	42.53	45.00
	1b	14096	14051	0	0.15	0.89	0.10	4.25	53.09	1.49	0.06	0.96	40.70	3.27	1.46	0.90	0.94	39.76	54.11
	2b	14129	14082	0	0.00	0.86	0.00	0.00	51.81	1.50	0.00	0.93	38.94	0.00	1.51	0.86	0.93	39.09	51.81
	3b	14162	14113	0	0.15	0.89	0.10	4.25	53.09	1.49	0.06	0.96	40.70	3.27	1.58	0.88	0.99	42.18	52.08
	1c	14091	14045	0	0.20	0.69	0.08	1.73	30.64	1.54	0.08	0.75	17.00	2.64	1.50	0.70	0.73	16.63	31.46
	2c	14124	14076	0	0.00	0.67	0.00	0.00	29.95	1.55	0.00	0.73	16.77	0.00	1.55	0.67	0.74	16.87	29.95
	3c	14157	14107	0	0.20	0.69	0.08	1.73	30.64	1.54	0.08	0.75	17.00	2.64	1.56	0.67	0.77	17.60	29.85
I	1a	15021	15064	1	0.18	0.51	0.21	8.52	21.00	0.03	0.15	0.39	18.76	7.42	0.18	0.57	0.47	22.37	24.08
	2a	15006	15062	0	0.00	0.00	0.55	22.16	0.02	0.08	0.71	0.00	0.06	32.71	0.15	0.71	0.55	22.19	32.50
	3a	15025	15065	1	0.18	0.51	0.21	8.55	21.08	0.03	0.14	0.38	18.77	7.40	0.23	0.54	0.48	23.05	22.67
	1b	15017	15059	1	0.18	0.51	0.20	8.30	20.99	0.02	0.15	0.39	19.41	7.47	0.19	0.59	0.47	22.82	24.15
	2b	15001	15061	0	0.00	0.00	0.55	22.07	0.02	0.09	0.70	0.00	0.06	32.89	0.14	0.71	0.55	22.11	33.62
	3b	15010	15057	0	0.00	0.00	0.55	22.07	0.02	0.09	0.70	0.00	0.06	32.89	0.14	0.71	0.55	22.11	33.62
J	1a	16139	16076	0	0.19	0.67	0.08	1.79	31.00	1.54	0.08	0.75	17.00	2.64	1.59	0.66	0.77	17.38	30.69
	2a	16002	16044	0	0.00	0.65	0.00	0.00	30.21	1.55	0.00	0.73	16.77	0.00	1.56	0.65	0.73	16.67	30.21
	3a	16178	16101	0	0.19	0.67	0.08	1.79	31.00	1.54	0.08	0.75	17.00	2.64	1.57	0.68	0.73	16.62	31.32
	1b	16144	16082	0	0.16	0.86	0.10	4.31	53.37	1.49	0.06	0.96	40.70	3.27	1.51	0.87	0.99	41.82	53.04
	2b	16017	16050	0	0.00	0.84	0.00	0.00	52.06	1.50	0.00	0.93	38.94	0.00	1.49	0.84	0.93	38.79	52.06
	3b	16183	16107	0	0.16	0.86	0.10	4.31	53.37	1.49	0.06	0.96	40.70	3.27	1.43	0.86	0.93	39.51	53.70
	1c	16149	16135	0	0.05	0.59	0.09	4.22	37.03	0.14	0.21	0.82	40.87	12.26	0.26	0.72	0.83	41.68	45.42
	2c	16025	16073	0	0.00	0.57	0.00	0.00	36.41	0.13	0.00	0.75	35.83	0.00	0.21	0.57	0.74	35.77	36.41
	3c	16188	16129	0	0.05	0.59	0.09	4.22	37.03	0.14	0.21	0.82	40.86	12.26	0.22	0.73	0.80	39.44	43.89
K	3	17002	17002	0	0.00	0.65	0.00	0.00	30.31	0.00	0.00	0.76	35.87	0.00	0.00	0.65	0.76	35.87	30.31
	2	18002	18002	0	0.00	0.65	0.00	0.00	30.31	0.00	0.00	0.76	35.87	0.00	0.00	0.65	0.76	35.87	30.31
	1	19002	19002	0	0.00	0.65	0.00	0.00	30.31	0.00	0.00	0.76	35.87	0.00	0.00	0.65	0.76	35.87	30.31
L	1	20002	20002	0	0.00	0.76	0.00	0.00	33.44	0.00	0.00	0.82	34.91	0.00	0.00	0.76	0.82	34.91	33.44
	2	21002	21002	0	0.00	0.76	0.00	0.00	33.44	0.00	0.00	0.82	34.91	0.00	0.00	0.76	0.82	34.91	33.44
	3	22002	22002	0	0.00	0.76	0.00	0.00	33.44	0.00	0.00	0.82	34.91	0.00	0.00	0.76	0.82	34.91	33.44

230 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Displacements - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Node #	X-Dir. Only X (in)	Y-Dir. Only Y (in)	XYZ-Dir. Combined X (in)	XYZ-Dir. Combined Y (in)	XYZ-Dir. Combined Z (in)
A	1	1007	4.74	0.72	4.74	0.69	0.00
	2	2007	4.91	0.65	4.91	0.66	0.00
	3	3007	4.71	0.71	4.71	0.80	0.00
B	3	4007	1.20	0.69	1.21	0.71	0.00
	2	5007	1.14	0.71	1.14	0.70	0.00
	1	6007	1.00	0.74	1.13	0.73	0.00
C	1a	7057	0.73	0.70	0.84	0.67	0.03
	2a	7077	0.72	0.63	0.74	0.64	0.03
	3a	7097	0.78	0.69	0.88	0.78	0.04
	1b	7050	1.00	0.74	1.37	0.71	0.03
	2b	7070	1.15	0.67	1.15	0.68	0.03
	3b	7090	1.10	0.73	1.34	0.83	0.04
D	1a	8087	2.24	0.24	2.44	0.30	0.28
	2a	8091	1.94	0.38	1.95	0.39	0.10
	3a	8092	2.31	0.27	2.37	0.32	0.29
	1b	8085	2.35	0.27	2.52	0.34	0.28
	2b	8090	2.04	0.40	2.06	0.40	0.09
	3b	8083	2.42	0.30	2.42	0.36	0.29
E	1a	9070	1.10	0.90	1.51	0.93	0.04
	2a	9050	1.12	0.85	1.10	0.85	0.03
	3a	9090	1.04	0.99	1.46	0.97	0.04
	1b	9077	0.71	0.85	0.84	0.87	0.04
	2b	9057	0.65	0.80	0.66	0.80	0.03
	3b	9097	0.73	0.93	0.88	0.91	0.04
F	1	10015	7.96	0.87	7.97	0.89	0.02
	2	10010	7.86	0.82	7.86	0.82	0.00
	3	10006	7.11	0.95	7.12	0.94	0.02
G	3	11007	1.43	0.81	1.44	0.81	0.00
	2	12007	1.48	0.89	1.48	0.89	0.00
	1	13007	0.95	0.91	0.89	0.91	0.00
H	1a	14138	1.48	0.87	1.55	0.89	0.03
	2a	14139	1.05	0.82	1.04	0.82	0.02
	3a	14140	1.27	0.95	1.54	0.94	0.03
	1b	14054	1.51	0.91	1.97	0.93	0.03
	2b	14085	1.58	0.86	1.61	0.86	0.02
	3b	14116	1.63	1.01	1.89	1.00	0.03
I	1a	15060	2.32	0.34	2.46	0.40	0.30
	2a	15005	2.09	0.41	2.06	0.41	0.07
	3a	15063	2.30	0.37	2.36	0.31	0.30
	1b	15058	2.24	0.35	2.32	0.37	0.25
	2b	15000	2.02	0.41	1.99	0.42	0.08
	3b	15056	2.26	0.28	2.22	0.33	0.29
J	1a	16085	1.53	1.12	2.57	1.40	0.03
	2a	16053	1.54	1.09	1.58	1.07	0.02
	3a	16110	1.52	0.95	2.49	0.95	0.03
	1b	16140	1.45	1.06	2.08	1.32	0.04
	2b	16138	1.21	1.04	1.23	1.02	0.02
	3b	16139	1.44	0.91	1.63	0.91	0.03
K	3	17007	0.86	0.64	1.00	0.67	0.00
	2	18007	1.48	0.71	1.48	0.70	0.00
	1	19007	1.34	0.68	1.44	0.72	0.00
L	1	20007	4.82	1.08	4.86	1.34	0.00
	2	21007	4.73	1.06	4.73	1.04	0.00
	3	22007	4.92	0.93	4.93	0.93	0.00

Note: Red text indicates displacements greater than 6"

230 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Member Forces at Base - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	1	1001	1001	0	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
	2	2001	2001	0	0.00	1.30	0.07	14.98	368.88	0.06	0.01	0.79	163.98	2.30	0.06	1.31	0.80	166.06	369.17
	3	3001	3001	0	0.02	1.39	0.07	15.09	390.40	0.16	0.01	0.74	155.45	2.27	0.16	1.39	0.74	155.16	390.79
B	3	4001	4001	0	0.02	0.76	0.04	6.01	110.07	0.17	0.07	0.75	97.59	9.19	0.18	0.76	0.74	96.95	110.61
	2	5001	5001	0	0.00	0.64	0.01	0.75	98.90	0.09	0.01	0.76	100.66	1.75	0.09	0.65	0.76	100.68	99.39
	1	6001	6001	0	0.03	0.67	0.04	5.47	98.16	0.20	0.18	0.81	105.71	25.82	0.20	0.77	0.80	105.08	113.26
C	1a	7047	7015	0	5.88	1.83	0.35	0.00	0.00	12.73	0.66	2.76	0.00	0.00	15.23	2.31	2.72	0.00	0.00
	3a	7052	7017	0	5.51	1.83	0.31	0.00	0.00	13.12	0.72	2.65	0.00	0.00	13.75	1.76	2.70	0.00	0.00
	1b	7031	7001	0	5.46	1.89	0.37	0.00	0.00	12.86	0.69	2.82	0.00	0.00	12.88	1.84	2.79	0.00	0.00
	3b	7036	7003	0	5.82	1.92	0.33	0.00	0.00	12.45	0.64	2.71	0.00	0.00	16.44	1.89	2.74	0.00	0.00
D	1a	8030	8028	0	0.19	0.09	0.13	4.20	2.45	0.17	0.20	0.06	1.79	2.91	0.30	0.25	0.14	4.30	4.44
	3a	8028	8025	0	0.21	0.07	0.10	3.41	5.94	0.21	0.17	0.04	2.25	7.62	0.33	0.21	0.12	5.13	10.14
	1b	8039	8037	0	0.23	0.83	0.49	26.87	31.77	0.25	0.48	0.55	33.69	28.12	0.40	0.96	0.84	45.59	48.47
	3b	8038	8035	0	0.00	0.01	0.15	9.99	0.20	0.25	0.30	0.04	2.43	13.02	0.25	0.30	0.15	10.70	13.25
E	1a	9047	9003	0	3.71	0.03	0.02	1.00	4.06	7.49	0.03	0.15	9.70	2.20	8.74	0.05	0.14	9.42	5.03
	3a	9040	9001	0	4.93	0.32	1.77	0.00	0.00	16.01	3.52	0.66	0.00	0.00	15.72	3.60	1.97	0.00	0.00
	1b	9063	9027	0	5.20	0.31	1.48	0.00	0.00	16.05	3.36	0.82	0.00	0.00	15.55	3.27	1.77	0.00	0.00
	3b	9058	9025	0	5.04	1.47	0.31	0.00	0.00	16.35	0.68	3.44	0.00	0.00	17.91	1.73	3.52	0.00	0.00
F	1a	10027	10028	0	2.94	0.92	0.06	0.00	0.00	22.01	0.61	1.13	0.00	0.00	22.54	1.00	1.14	0.00	0.00
	3a	10016	10016	0	2.86	0.05	0.92	0.00	0.00	21.89	1.12	0.60	0.00	0.00	21.23	1.11	1.07	0.00	0.00
	1b	10049	10052	0	2.62	0.06	0.95	0.00	0.00	22.03	1.14	0.62	0.00	0.00	21.56	1.14	1.18	0.00	0.00
	3b	10038	10040	0	2.58	0.95	0.05	0.00	0.00	22.02	0.60	1.12	0.00	0.00	22.25	0.99	1.11	0.00	0.00
G	3	11001	11001	0	0.01	0.69	0.04	4.80	108.56	0.11	0.07	0.77	104.01	9.88	0.11	0.73	0.77	104.39	114.97
	2	12001	12001	0	0.00	0.71	0.02	1.87	101.98	0.07	0.02	0.90	119.57	2.11	0.07	0.71	0.89	119.20	102.37
	1	13001	13001	0	0.01	0.70	0.04	5.14	91.08	0.15	0.11	0.87	117.97	15.51	0.16	0.80	0.88	117.51	104.88
H	1a	14047	14015	0	4.89	1.39	0.26	0.00	0.00	11.75	0.51	2.57	0.00	0.00	11.85	1.53	2.55	0.00	0.00
	3a	14052	14017	0	4.79	1.40	0.24	0.00	0.00	12.19	0.54	2.56	0.00	0.00	12.63	1.60	2.57	0.00	0.00
	1b	14031	14001	0	4.55	1.56	0.28	0.00	0.00	11.96	0.60	2.61	0.00	0.00	12.23	1.77	2.58	0.00	0.00
	3b	14036	14003	0	4.67	1.61	0.26	0.00	0.00	11.67	0.49	2.60	0.00	0.00	11.50	1.60	2.61	0.00	0.00
I	1a	15031	15031	0	11.22	3.80	0.01	0.00	0.07	5.31	0.09	0.01	0.00	0.00	11.74	3.76	0.01	0.00	0.07
	3a	15029	15028	0	11.00	0.01	3.83	0.07	0.00	5.34	0.01	0.09	0.00	0.00	12.54	0.02	3.79	0.07	0.00
	1b	15040	15040	0	10.94	0.01	3.78	0.00	0.00	8.26	0.00	0.09	0.00	0.00	15.24	0.01	3.74	0.00	0.00
	3b	15039	15038	0	11.07	3.81	0.01	0.00	0.00	8.64	0.09	0.00	0.00	0.00	12.69	3.77	0.01	0.00	0.00
J	1a	16065	16003	0	5.26	1.55	0.38	0.00	0.00	11.59	0.64	2.52	0.00	0.00	14.46	1.92	2.74	0.00	0.00
	3a	16051	16001	0	4.39	0.34	1.49	0.00	0.00	12.17	2.56	0.90	0.00	0.00	14.09	2.46	1.94	0.00	0.00
	1b	16081	16027	0	4.57	0.36	1.58	0.00	0.00	12.33	2.48	0.74	0.00	0.00	14.22	2.68	1.64	0.00	0.00
	3b	16076	16025	0	5.03	1.61	0.31	0.00	0.00	11.41	0.94	2.52	0.00	0.00	14.27	2.01	2.42	0.00	0.00
K	3	17001	17001	0	0.04	0.71	0.06	8.32	94.47	0.23	0.24	0.67	86.63	34.54	0.24	0.83	0.66	86.94	111.41
	2	18001	18001	0	0.00	0.73	0.02	2.15	110.66	0.11	0.04	0.70	92.80	6.18	0.11	0.73	0.69	91.44	111.20
	1	19001	19001	0	0.02	0.72	0.07	10.58	103.51	0.11	0.32	0.72	94.73	48.85	0.12	0.86	0.73	97.02	120.54
L	1	20001	20001	0	0.02	1.43	0.17	39.33	400.24	0.09	0.24	0.73	167.30	52.98	0.10	1.46	0.89	203.64	406.44
	2	21001	21001	0	0.00	1.34	0.04	7.60	379.03	0.05	0.01	0.86	191.63	1.44	0.05	1.34	0.84	187.56	378.77
	3	22001	22001	0	0.00	1.43	0.12	26.21	402.57	0.02	0.02	0.74	165.34	4.97	0.02	1.43	0.75	166.07	402.97

Table A-8

230 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Forces - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial	Shear 2	Shear 3	Moment 2	Moment 3	Axial	Shear 2	Shear 3	Moment 2	Moment 3	Axial	Shear 2	Shear 3	Moment 2	Moment 3
					kips	kips	kips	kip-in	kip-in	kips	kips	kips	kip-in	kip-in	kips	kips	kips	kip-in	kip-in
A	1	1006	1007	1	0.00	0.26	0.08	0.74	3.81	0.04	0.01	1.01	8.50	0.22	0.04	0.26	1.03	8.30	3.85
	2	2006	2007	1	0.00	0.24	0.02	0.23	2.28	0.06	0.00	0.96	9.91	0.03	0.06	0.24	0.95	9.79	2.27
	3	3006	3007	1	0.02	0.24	0.08	0.68	3.05	0.16	0.01	1.01	9.91	0.22	0.16	0.24	1.03	9.79	3.05
B	3	4006	4007	1	0.02	0.15	0.01	0.33	17.22	0.17	0.01	0.06	9.24	0.60	0.18	0.15	0.06	9.13	17.11
	2	5006	5007	1	0.00	0.15	0.00	0.08	15.27	0.09	0.00	0.07	9.42	0.16	0.09	0.15	0.07	9.44	15.28
	1	6006	6007	1	0.03	0.13	0.01	0.35	9.61	0.20	0.03	0.08	9.94	1.89	0.20	0.15	0.07	9.82	10.09
C	1a	7102	7057	1	0.02	0.50	0.16	2.60	3.46	0.10	0.16	1.10	22.33	0.70	0.12	0.54	1.03	21.23	3.46
	2a	7124	7077	1	0.00	0.46	0.01	0.21	4.30	0.05	0.06	0.90	15.63	0.15	0.07	0.49	0.91	15.81	4.34
	3a	7146	7097	1	0.03	0.48	0.20	1.83	3.50	0.07	0.25	0.94	13.43	0.51	0.11	0.60	1.09	15.07	3.68
	1b	7098	7050	1	0.34	0.16	0.04	3.17	5.32	1.04	0.10	0.26	23.17	5.57	0.93	0.20	0.28	23.31	8.18
	2b	7120	7070	1	0.02	0.16	0.00	0.41	4.76	0.97	0.03	0.31	24.65	0.63	0.98	0.15	0.32	24.79	4.55
	3b	7142	7090	1	0.45	0.17	0.04	3.60	5.21	0.94	0.10	0.30	24.58	5.98	1.19	0.22	0.30	24.55	8.13
D	1a	8047	8087	0	0.12	0.12	0.18	2.25	11.82	0.23	0.15	0.25	7.45	7.49	0.32	0.21	0.32	6.88	15.49
	2a	8038	8091	1	0.00	0.01	0.15	10.35	0.11	0.25	0.30	0.04	1.79	9.57	0.25	0.30	0.15	9.82	9.77
	3a	8051	8092	0	0.14	0.14	0.19	3.29	13.57	0.25	0.16	0.28	6.63	7.15	0.29	0.24	0.38	7.97	15.07
	1b	8043	8085	0	0.13	0.17	0.20	3.89	12.52	0.22	0.16	0.27	7.20	7.76	0.29	0.22	0.40	10.21	14.60
	2b	8034	8090	1	0.00	0.00	0.19	9.48	0.10	0.24	0.30	0.03	0.79	10.14	0.25	0.30	0.19	9.34	10.06
	3b	8042	8083	1	0.13	0.16	0.19	3.78	12.78	0.24	0.19	0.28	8.29	8.03	0.32	0.28	0.39	8.51	14.02
E	1a	9130	9070	1	0.28	0.16	0.04	3.82	4.54	1.16	0.09	0.35	28.67	5.53	1.29	0.22	0.34	27.31	9.64
	2a	9108	9050	1	0.01	0.15	0.00	0.31	3.70	1.20	0.01	0.37	29.64	0.22	1.20	0.15	0.38	29.63	3.73
	3a	9155	9090	1	0.29	0.17	0.05	3.89	4.50	1.28	0.09	0.39	32.09	5.36	1.18	0.21	0.42	34.35	8.44
	1b	9134	9077	1	0.03	0.44	0.09	0.93	9.70	0.10	0.25	1.12	13.44	0.61	0.13	0.53	1.14	13.21	9.43
	2b	9112	9057	1	0.00	0.39	0.01	0.13	9.59	0.09	0.03	1.03	13.35	0.07	0.12	0.39	1.03	13.28	9.55
	3b	9014	9097	1	0.03	0.46	0.11	1.43	8.75	0.10	0.27	1.26	15.44	0.56	0.14	0.55	1.25	16.04	8.92
F	1	10015	10015	1	0.02	0.42	0.06	0.97	21.60	0.02	0.00	0.59	3.94	0.53	0.10	0.42	0.59	3.81	21.83
	2	10010	10010	1	0.00	0.42	0.02	0.30	21.15	0.04	0.00	0.67	5.56	0.06	0.08	0.42	0.67	5.33	21.15
	3	10005	10006	1	0.02	0.43	0.05	1.37	24.89	0.09	0.01	0.58	4.62	1.09	0.10	0.43	0.57	4.70	24.91
G	3	11006	11007	1	0.01	0.12	0.01	0.51	26.72	0.11	0.01	0.09	7.89	0.58	0.10	0.12	0.09	7.99	26.62
	2	12006	12007	1	0.00	0.16	0.00	0.22	25.59	0.07	0.00	0.09	10.15	0.16	0.07	0.16	0.09	10.10	25.50
	1	13006	13007	1	0.01	0.11	0.01	0.52	13.64	0.15	0.02	0.10	9.66	1.00	0.16	0.12	0.10	9.66	13.85
H	1a	14196	14138	1	0.01	0.38	0.06	1.87	5.08	0.06	0.04	0.41	18.40	0.46	0.06	0.39	0.42	19.31	5.01
	2a	14198	14139	1	0.00	0.21	0.01	0.15	6.91	0.05	0.02	0.31	11.90	0.15	0.05	0.21	0.31	11.96	6.97
	3a	14200	14140	1	0.01	0.27	0.05	1.21	5.79	0.08	0.09	0.35	11.57	0.58	0.08	0.32	0.33	10.88	5.80
	1b	14112	14054	1	0.23	0.11	0.04	2.99	4.55	0.87	0.03	0.12	19.55	4.56	0.93	0.14	0.13	20.82	8.09
	2b	14145	14085	1	0.01	0.09	0.00	0.23	3.69	0.95	0.01	0.16	20.55	0.28	0.94	0.08	0.16	20.52	3.82
	3b	14178	14116	1	0.31	0.12	0.05	3.83	5.14	0.92	0.03	0.13	21.95	3.86	0.93	0.12	0.13	21.58	7.82
I	1a	15018	15060	0	0.10	0.22	0.16	5.81	8.34	0.18	0.13	0.29	7.71	6.23	0.24	0.26	0.37	9.29	12.62
	2a	15000	15005	1	0.00	0.00	0.19	9.18	0.10	0.16	0.27	0.02	1.06	8.60	0.16	0.27	0.20	9.57	8.56
	3a	15022	15063	0	0.13	0.20	0.21	4.83	8.78	0.19	0.12	0.32	7.15	5.35	0.25	0.28	0.32	10.39	11.74
	1b	15014	15058	0	0.14	0.11	0.15	3.38	9.55	0.36	0.15	0.32	9.50	9.36	0.40	0.21	0.38	11.62	14.78
	2b	15005	15000	1	0.02	0.02	0.12	9.55	0.41	0.39	0.37	0.04	3.32	11.20	0.37	0.36	0.13	8.93	11.02
	3b	15013	15056	1	0.11	0.14	0.13	3.46	8.28	0.41	0.20	0.26	8.57	12.42	0.44	0.27	0.32	10.30	15.28
J	1a	16160	16085	1	0.68	0.13	0.07	5.46	5.68	1.35	0.07	0.33	31.25	7.00	1.98	0.15	0.37	35.13	11.43
	2a	16052	16053	1	0.04	0.11	0.01	1.19	4.66	1.38	0.02	0.37	33.20	1.25	1.34	0.11	0.36	32.57	4.60
	3a	16122	16110	1	0.39	0.14	0.07	4.66	6.96	1.28	0.06	0.25	26.04	9.51	1.47	0.15	0.24	24.39	11.79
	1b	16200	16140	1	0.03	0.30	0.18	4.87	3.25	0.09	0.24	0.62	19.25	1.56	0.13	0.46	0.77	23.43	3.63
	2b	16196	16138	1	0.00	0.25	0.02	0.82	4.37	0.05	0.08	0.63	22.44	0.41	0.06	0.24	0.62	22.09	4.38
	3b	16198	16139	1	0.02	0.39	0.12	4.18	3.32	0.13	0.07	0.66	25.65	0.90	0.13	0.40	0.67	26.00	3.61
K	3	17006	17007	1	0.04	0.12	0.01	0.38	11.51	0.23	0.05	0.10	8.47	1.55	0.24	0.13	0.10	8.70	12.57
	2	18006	18007	1	0.00	0.20	0.00	0.09	20.90	0.11	0.01	0.09	8.35	0.23	0.11	0.20	0.09	8.40	20.97
	1	19006	19007	1	0.00	0.20	0.00	0.09	20.90	0.11	0.01	0.09	8.35	0.23	0.11	0.20	0.09	8.40	20.97
L	1	20006	20007	1	0.02	0.27	0.13	1.40	2.59	0.09	0.20	0.75	7.89	1.34	0.10	0.32	0.85	8.08	3.34
	2	21006	21007	1	0.00	0.26	0.04	0.34	1.65	0.05	0.01	0.91	7.37	0.08	0.05	0.26	0.89	7.11	1.69
	3	22006	22007	1	0.00	0.26	0.12	0.87	3.55	0.02	0.01	0.74	4.51	0.24	0.02	0.26	0.74	4.51	3.55

230 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Insulator Forces at the Base - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial	Shear 2	Shear 3	Moment 2	Moment 3	Axial	Shear 2	Shear 3	Moment 2	Moment 3	Axial	Shear 2	Shear 3	Moment 2	Moment 3
					kips	kips	kips	kip-in	kip-in	kips	kips	kips	kip-in	kip-in	kips	kips	kips	kip-in	kip-in
A	1	1002	1002	0	0.00	0.91	0.02	3.22	39.58	0.04	0.00	0.20	37.29	0.50	0.04	0.91	0.20	36.87	39.72
	2	2002	2002	0	0.00	0.91	0.01	0.74	41.29	0.06	0.00	0.21	33.67	0.03	0.06	0.91	0.21	33.19	41.27
	3	3002	3002	0	0.02	0.91	0.02	3.22	41.29	0.16	0.00	0.21	36.43	0.48	0.16	0.91	0.21	36.87	41.27
B	3	4002	4002	0	0.02	0.64	0.04	1.56	30.62	0.17	0.06	0.60	17.12	2.02	0.18	0.64	0.60	17.32	30.79
	2	5002	5002	0	0.00	0.54	0.00	0.14	28.52	0.09	0.01	0.63	17.35	0.36	0.09	0.54	0.63	17.38	28.61
	1	6002	6002	0	0.03	0.56	0.03	1.34	25.16	0.20	0.16	0.65	18.31	5.75	0.20	0.65	0.65	18.03	28.43
C	1a	7101	7055	0	0.05	0.63	0.17	10.72	47.25	0.10	0.25	1.29	72.88	16.07	0.15	0.72	1.22	68.50	51.57
	2a	7123	7075	0	0.00	0.64	0.02	0.99	45.91	0.06	0.08	1.06	63.70	5.55	0.13	0.67	1.07	63.94	48.07
	3a	7145	7095	0	0.05	0.69	0.22	15.06	47.72	0.08	0.33	1.11	69.16	23.31	0.18	0.84	1.28	79.90	58.68
	1b	7099	7051	0	0.23	0.61	0.15	10.26	43.13	1.12	0.58	1.06	66.51	40.68	1.01	0.94	1.00	62.71	64.09
	2b	7121	7071	0	0.02	0.73	0.02	0.93	51.02	1.12	0.16	1.02	64.97	11.25	1.14	0.84	1.02	64.89	59.44
	3b	7143	7091	0	0.32	0.66	0.22	14.67	46.62	1.06	0.51	1.02	64.43	35.77	1.28	0.91	1.16	74.16	64.16
	1c	7097	7048	0	0.36	0.35	0.04	1.50	14.50	1.04	0.29	0.52	9.04	11.80	0.93	0.50	0.52	8.52	20.71
	2c	7119	7068	0	0.02	0.38	0.01	0.13	16.89	0.98	0.08	0.55	9.60	3.46	0.98	0.40	0.55	9.54	17.91
	3c	7141	7088	0	0.45	0.36	0.04	2.07	15.86	0.95	0.25	0.54	8.79	11.02	1.19	0.48	0.55	10.21	20.69
D	1a	8050	8063	1	0.21	0.73	0.48	24.24	24.70	0.24	0.39	0.49	28.16	22.74	0.36	1.03	0.81	40.87	37.64
	2a	8035	8059	0	0.01	0.01	0.80	32.14	0.62	0.33	0.77	0.07	5.64	38.22	0.38	0.79	0.80	31.53	38.97
	3a	8054	8064	1	0.21	0.72	0.50	25.04	24.91	0.26	0.42	0.51	32.50	24.16	0.39	0.98	0.84	47.11	44.28
	1b	8046	8056	1	0.23	0.79	0.48	26.49	33.08	0.24	0.43	0.53	30.97	24.01	0.38	1.00	0.95	52.87	40.21
	2b	8031	8058	0	0.01	0.01	0.81	36.80	0.54	0.29	0.84	0.05	3.70	39.86	0.35	0.85	0.83	36.55	40.11
	3b	8039	8054	0	0.23	0.83	0.49	26.87	31.77	0.25	0.48	0.55	33.69	28.12	0.40	0.96	0.84	45.59	48.47
E	1a	9129	9068	0	0.29	0.38	0.05	1.00	15.85	1.17	0.24	0.64	10.88	8.14	1.32	0.57	0.63	11.23	22.18
	2a	9107	9048	0	0.01	0.36	0.01	0.11	16.46	1.20	0.02	0.66	11.40	0.68	1.21	0.35	0.66	11.39	16.12
	3a	9154	9088	0	0.29	0.35	0.05	1.15	15.79	1.29	0.23	0.72	12.11	8.47	1.21	0.52	0.74	11.93	22.00
	1b	9131	9071	0	0.18	0.74	0.11	7.24	51.42	1.30	0.42	1.26	79.22	28.16	1.32	1.02	1.30	81.95	71.00
	2b	9109	9051	0	0.01	0.77	0.01	0.74	53.29	1.38	0.04	1.24	78.57	2.47	1.37	0.76	1.25	78.58	52.29
	3b	9156	9091	0	0.21	0.66	0.12	7.79	45.90	1.45	0.43	1.38	87.73	28.75	1.39	0.99	1.36	86.12	70.17
	1c	9133	9075	0	0.06	0.61	0.09	7.09	42.37	0.11	0.33	1.34	84.83	23.70	0.22	0.71	1.37	87.13	52.45
	2c	9111	9055	0	0.00	0.53	0.01	0.75	37.20	0.11	0.04	1.22	76.43	2.55	0.19	0.53	1.22	76.27	37.43
	3c	9157	9095	0	0.06	0.62	0.12	8.01	44.91	0.12	0.35	1.48	94.05	25.00	0.22	0.71	1.47	92.48	53.12
F	1	10011	10107	0	0.06	0.90	0.04	2.04	26.40	0.02	0.01	0.38	7.96	0.12	0.26	0.90	0.39	7.73	26.46
	2	10006	10108	0	0.00	0.83	0.01	0.62	26.35	0.04	0.00	0.27	10.77	0.03	0.22	0.83	0.27	10.28	26.34
	3	10001	10106	0	0.05	0.90	0.04	1.63	23.74	0.09	0.04	0.42	5.20	0.42	0.22	0.90	0.41	5.74	23.77
G	3	11002	11002	0	0.01	0.55	0.03	0.98	36.20	0.11	0.06	0.63	19.83	2.43	0.11	0.60	0.63	19.84	36.39
	2	12002	12002	0	0.00	0.57	0.01	0.25	37.73	0.07	0.01	0.73	21.65	0.47	0.07	0.58	0.73	21.61	37.69
	1	13002	13002	0	0.01	0.56	0.03	0.93	24.38	0.15	0.09	0.72	22.26	3.54	0.16	0.65	0.72	22.30	22.88
H	1a	14101	14073	0	0.05	0.68	0.07	2.99	43.48	0.05	0.13	0.99	40.36	6.85	0.18	0.70	1.01	41.65	45.25
	2a	14134	14104	0	0.00	0.45	0.01	0.38	28.59	0.06	0.04	0.82	34.69	2.34	0.19	0.48	0.82	34.80	28.38
	3a	14167	14135	0	0.05	0.58	0.07	3.23	35.56	0.11	0.21	0.91	41.02	12.63	0.21	0.74	0.89	40.42	44.18
	1b	14096	14051	0	0.22	0.52	0.06	2.32	33.84	0.91	0.24	0.83	33.34	12.40	1.01	0.70	0.84	34.04	44.77
	2b	14129	14082	0	0.01	0.61	0.01	0.33	37.32	1.01	0.05	0.80	32.95	3.16	1.04	0.62	0.80	32.73	38.03
	3b	14162	14113	0	0.27	0.68	0.07	2.90	39.00	0.99	0.14	0.89	36.84	6.96	0.98	0.78	0.88	36.19	45.68
	1c	14091	14045	0	0.26	0.47	0.07	1.03	22.09	0.90	0.25	0.74	14.98	7.46	0.94	0.67	0.73	15.06	29.42
	2c	14124	14076	0	0.01	0.52	0.01	0.17	22.64	0.97	0.04	0.73	15.50	1.92	0.93	0.53	0.73	15.39	23.10
	3c	14157	14107	0	0.32	0.58	0.07	1.09	23.24	0.95	0.16	0.84	17.00	4.73	0.96	0.70	0.82	16.60	27.24
I	1a	15021	15064	1	0.25	0.67	0.40	24.85	36.95	0.20	0.23	0.54	35.36	18.32	0.38	0.81	0.74	47.44	45.76
	2a	15006	15062	0	0.01	0.01	0.73	37.29	0.36	0.20	0.62	0.06	3.84	36.00	0.24	0.62	0.72	38.03	35.79
	3a	15025	15065	1	0.24	0.67	0.39	24.73	35.82	0.21	0.25	0.58	38.74	17.11	0.33	0.78	0.60	39.88	45.65
	1b	15017	15059	1	0.22	0.60	0.33	17.97	23.07	0.36	0.30	0.48	33.83	22.51	0.50	0.78	0.60	41.27	36.31
	2b	15001	15061	0	0.02	0.02	0.68	29.39	1.63	0.42	0.58	0.07	6.70	39.92	0.39	0.58	0.67	28.64	39.32
	3b	15010	15057	0	0.02	0.02	0.68	29.39	1.63	0.42	0.58	0.07	6.70	39.92	0.39	0.58	0.67	28.64	39.32
J	1a	16139	16076	0	0.69	0.53	0.18	4.73	22.09	1.35	0.48	0.83	19.58	17.51	1.98	0.98	0.98	24.09	38.59
	2a	16002	16044	0	0.04	0.51	0.04	0.77	22.21	1.39	0.19	0.89	20.98	8.60	1.32	0.52	0.87	20.56	23.25
	3a	16178	16101	0	0.39	0.49	0.13	2.59	22.72	1.28	0.62	0.71	15.75	22.89	1.46	0.90	0.68	15.28	37.73
	1b	16144	16082	0	0.62	0.61	0.24	11.29	35.93	1.58	0.48	0.87	40.07	28.52	2.14	1.08	1.11	50.22	63.20
	2b	16017	16050	0	0.05	0.64	0.04	1.57	37.58	1.67	0.24	0.93	42.06	14.72	1.71	0.62	0.91	41.23	38.72
	3b	16183	16107	0	0.37	0.53	0.14	5.95	33.84	1.40	0.64	0.80	34.35	36.86	1.58	0.96	0.81	34.53	59.46
	1c	16149	16135	0	0.07	0.64	0.25	12.80	40.71	0.12	0.58	0.97	46.40	35.52	0.23	1.01	1.23	58.40	63.39
	2c	16025	16073	0	0.00	0.53	0.04	1.71	33.22	0.07	0.17	1.03	45.92	10.51	0.19	0.53	1.02	45.33	34.21
	3c	16188	16129	0	0.04	0.68	0.18	7.42	42.64	0.13	0.24	1.04	43.43	12.53	0.19	0.77	1.03	43.58	48.14
K	3	17002	17002	0	0.04	0.57	0.05	2.04	22.18	0.23	0.20	0.52	16.26	8.75	0.24	0.67	0.54	16.62	25.03
	2	18002	18002	0	0.00	0.61	0.01	0.53	37.76	0.11	0.04	0.56	17.97	1.67	0.11	0.61	0.56	17.76	37.82
	1	19002	19002	0	0.02	0.60	0.06	3.23	34.40	0.11	0.28	0.57	15.97	13.74	0.12	0.71	0.58	17.34	36.45
L	1	20002	20002	0	0.02	0.88	0.05	3.60	41.82	0.09	0.03	0.13	21.28	7.38	0.10	0.89	0.14	22.54	41.40
	2	21002	21002	0	0.00	0.88	0.01	1.21	42.04	0.05	0.00	0.12	28.00	0.11	0.05	0.88	0.12	27.04	42.01
	3	22002	22002	0	0.00	0.94	0.03	4.04	41.18	0.02	0.01	0.11	23.05	0.59	0.02	0.94	0.12	22.87	41.21

Appendix B (115 kV Bay)

Mode Shapes

Figure B1: 9’ – 7” Insulator Pedestals (f_x = 7.2 Hz)

Figure B2: 9’ – 7” Insulator Pedestals (f_y = 7.2 Hz)

Figure B3: 9’ – 7” Insulator Pedestals (f_z = 189.5 Hz)

Figure B4: 17’ – 7” Insulator Pedestals (f_x = 4.1 Hz)

Figure B5: 17’ – 7” Insulator Pedestals (f_y = 4.1 Hz)

Figure B6: 17’ – 7” Insulator Pedestals (f_z = 141.5 Hz)

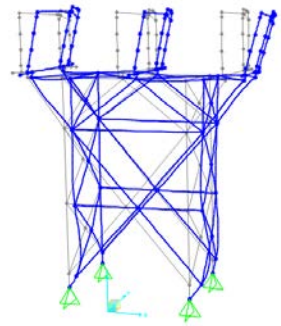

Figure B7: 2000 Amp Disconnect Switch with Cap-and-Pin Insulators (f_x = 6.6 Hz)

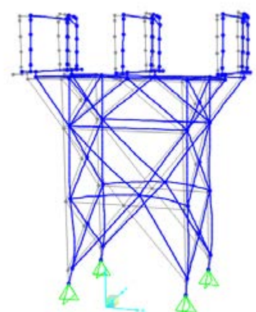

Figure B8: 2000 Amp Disconnect Switch with Cap-and-Pin Insulators (f_y = 7.1 Hz)

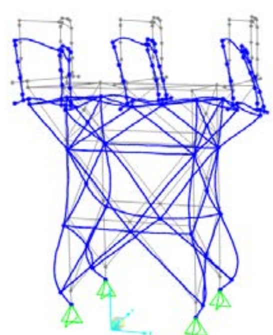

Figure B9: 2000 Amp Disconnect Switch with Cap-and-Pin Insulators (f_z = 44.7 Hz)

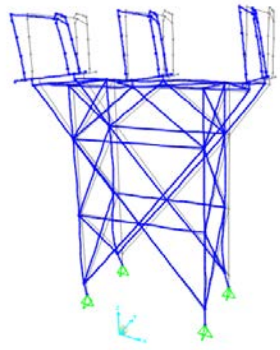

Figure B10: 2000 Amp Disconnect Switch with Station Post Insulators (f_x = 8.1 Hz)

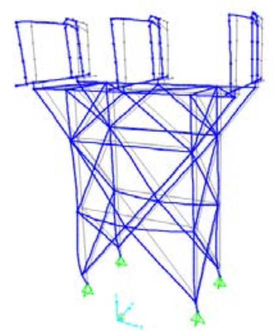

Figure B11: 2000 Amp Disconnect Switch with Station Post Insulators (f_y = 7.8 Hz)

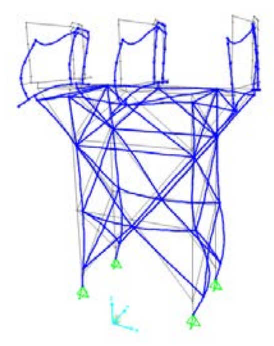

Figure B12: 2000 Amp Disconnect Switch with Station Post Insulators (f_z = 47.2 Hz)

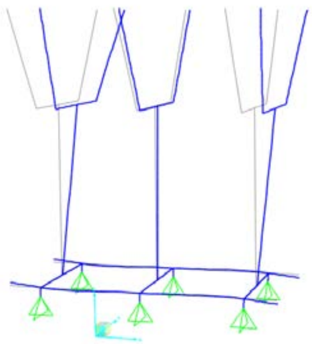

Figure B13: Dead Tank Oil Circuit Breaker (f_x = 5.7 Hz)

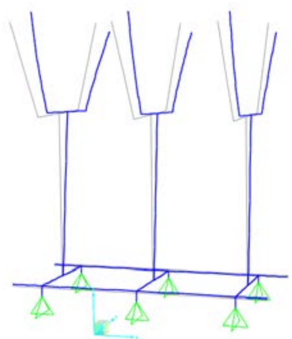

Figure B14: Dead Tank Oil Circuit Breaker (f_y = 17.9 Hz)

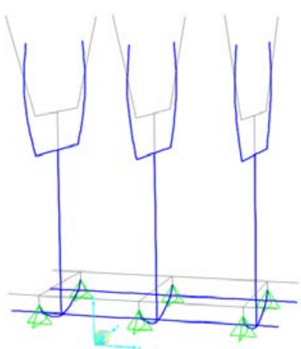

Figure B15: Dead Tank Oil Circuit Breaker (f_z = 62.7 Hz)

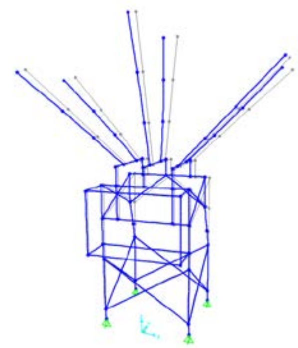

Figure B16: Dead Tank SF6 Circuit Breaker (f_x = 14.6 Hz)

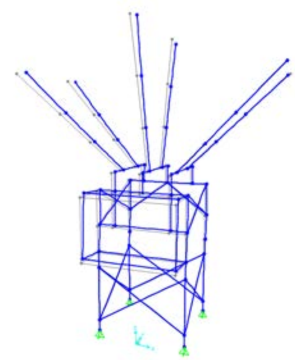

Figure B17: Dead Tank SF6 Circuit Breaker (f_y = 12.4 Hz)

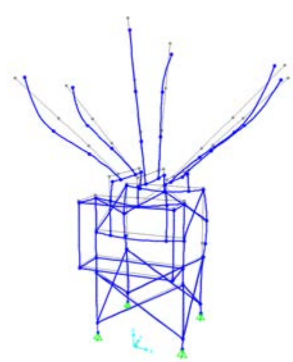

Figure B18: Dead Tank SF6 Circuit Breaker (f_z = 102.3 Hz)

Time-History Data

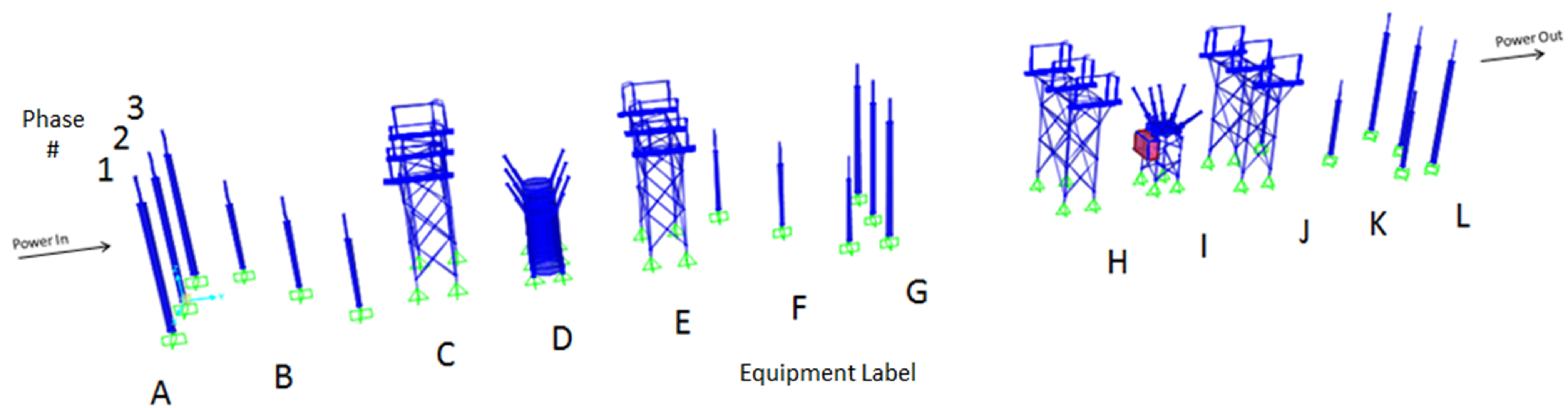

Figure B19: 115 kV Bay Equipment Label Key

115 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Displacements - INDIVIDUAL MODELS

Equipment Label	Phase #	Node #	X-Dir. Only X (in)	Y-Dir. Only Y (in)	XYZ-Dir. Combined X (in)	Y (in)	Z (in)
A	1	1005	4.16	5.19	4.16	5.19	0.00
	2	2005	4.16	5.19	4.16	5.19	0.00
	3	3005	4.16	5.19	4.16	5.19	0.00
B	3	4005	0.85	0.96	0.85	0.96	0.00
	2	5005	0.85	0.96	0.85	0.96	0.00
	1	6005	0.85	0.96	0.85	0.96	0.00
C	1a	7044	0.42	0.43	0.42	0.47	0.05
	2a	7067	0.35	0.43	0.35	0.43	0.04
	3a	7092	0.42	0.43	0.43	0.49	0.05
	1b	7040	0.49	0.43	0.48	0.48	0.05
	2b	7068	0.41	0.43	0.41	0.44	0.04
	3b	7093	0.49	0.43	0.49	0.49	0.07
D	1a	8040	0.98	0.06	0.98	0.06	0.02
	2a	8036	0.44	0.06	0.44	0.06	0.02
	3a	8032	0.98	0.06	0.98	0.06	0.02
	1b	8039	0.98	0.06	0.98	0.06	0.02
	2b	8035	0.44	0.06	0.44	0.06	0.02
	3b	8031	0.98	0.06	0.98	0.06	0.02
E	1a	9093	0.49	0.43	0.49	0.49	0.06
	2a	9068	0.41	0.43	0.41	0.43	0.04
	3a	9040	0.49	0.43	0.48	0.47	0.05
	1b	9092	0.42	0.43	0.43	0.49	0.05
	2b	9067	0.35	0.43	0.35	0.43	0.04
	3b	9044	0.42	0.43	0.42	0.47	0.05
F	3	10005	0.85	0.96	0.85	0.96	0.00
	2	11005	0.85	0.96	0.85	0.96	0.00
	1	12005	0.85	0.96	0.85	0.96	0.00
G	1	13005	4.16	5.19	4.16	5.19	0.00
	2	14005	4.16	5.19	4.16	5.19	0.00
	3	15005	4.16	5.19	4.16	5.19	0.00
H	1a	16044	0.34	0.36	0.34	0.54	0.05
	2a	16067	0.30	0.37	0.30	0.37	0.04
	3a	16092	0.34	0.36	0.34	0.38	0.03
	1b	16040	0.37	0.37	0.37	0.54	0.05
	2b	16068	0.32	0.37	0.32	0.37	0.04
	3b	16093	0.37	0.37	0.36	0.39	0.04
I	1a	17064	0.04	0.12	0.04	0.13	0.03
	2a	17065	0.06	0.14	0.06	0.14	0.02
	3a	17061	0.04	0.12	0.04	0.14	0.04
	1b	17063	0.06	0.12	0.07	0.13	0.03
	2b	17066	0.10	0.14	0.10	0.14	0.03
	3b	17062	0.06	0.12	0.07	0.15	0.03
J	1a	18059	0.37	0.37	0.36	0.39	0.04
	2a	18034	0.32	0.37	0.32	0.37	0.04
	3a	18006	0.37	0.37	0.37	0.54	0.05
	1b	18058	0.34	0.36	0.34	0.38	0.03
	2b	18033	0.30	0.37	0.30	0.37	0.04
	3b	18010	0.34	0.36	0.34	0.53	0.05
K	3	19005	0.85	0.96	0.85	0.96	0.00
	2	20005	0.85	0.96	0.85	0.96	0.00
	1	21005	0.85	0.96	0.85	0.96	0.00
L	1	22005	4.16	5.19	4.16	5.19	0.00
	2	23005	4.16	5.19	4.16	5.19	0.00
	3	24005	4.16	5.19	4.16	5.19	0.00

115 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Displacements - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Node #	X-Dir. Only	Y-Dir. Only	XYZ-Dir. Combined		
			X (in)	Y (in)	X (in)	Y (in)	Z (in)
A	1	1005	4.16	5.19	4.16	5.19	0.00
	2	2005	4.16	5.19	4.16	5.19	0.00
	3	3005	4.16	5.19	4.16	5.19	0.00
B	3	4005	0.85	0.96	0.85	0.96	0.00
	2	5005	0.85	0.96	0.85	0.96	0.00
	1	6005	0.85	0.96	0.85	0.96	0.00
C	1a	7044	0.42	0.43	0.42	0.47	0.05
	2a	7067	0.35	0.43	0.35	0.43	0.04
	3a	7092	0.42	0.43	0.43	0.49	0.05
	1b	7040	0.49	0.43	0.48	0.48	0.05
	2b	7068	0.41	0.43	0.41	0.44	0.04
	3b	7093	0.49	0.43	0.49	0.50	0.06
D	1a	8040	0.98	0.07	0.98	0.07	0.02
	2a	8036	0.44	0.07	0.44	0.07	0.02
	3a	8032	0.98	0.07	0.98	0.07	0.02
	1b	8039	0.98	0.07	0.98	0.07	0.02
	2b	8035	0.44	0.07	0.44	0.07	0.02
	3b	8031	0.98	0.07	0.98	0.07	0.02
E	1a	9093	0.49	0.43	0.49	0.49	0.06
	2a	9068	0.41	0.43	0.41	0.43	0.04
	3a	9040	0.49	0.43	0.48	0.47	0.05
	1b	9092	0.42	0.43	0.43	0.49	0.05
	2b	9067	0.35	0.43	0.35	0.43	0.04
	3b	9044	0.42	0.43	0.42	0.47	0.05
F	3	10005	0.85	0.96	0.85	0.96	0.00
	2	11005	0.85	0.96	0.85	0.96	0.00
	1	12005	0.85	0.96	0.85	0.96	0.00
G	1	13005	4.16	5.19	4.16	5.19	0.00
	2	14005	4.16	5.19	4.16	5.19	0.00
	3	15005	4.16	5.19	4.16	5.19	0.00
H	1a	16044	0.34	0.37	0.34	0.53	0.05
	2a	16067	0.30	0.37	0.30	0.37	0.04
	3a	16092	0.34	0.37	0.34	0.38	0.04
	1b	16040	0.36	0.37	0.36	0.53	0.05
	2b	16068	0.32	0.37	0.32	0.37	0.04
	3b	16093	0.36	0.37	0.36	0.39	0.04
I	1a	17064	0.04	0.13	0.04	0.14	0.03
	2a	17065	0.07	0.14	0.07	0.14	0.02
	3a	17061	0.04	0.13	0.05	0.15	0.04
	1b	17063	0.06	0.13	0.07	0.14	0.03
	2b	17066	0.11	0.14	0.11	0.14	0.03
	3b	17062	0.06	0.13	0.08	0.15	0.03
J	1a	18093	0.36	0.37	0.36	0.39	0.04
	2a	18068	0.32	0.37	0.32	0.37	0.04
	3a	18040	0.36	0.37	0.36	0.53	0.05
	1b	18092	0.34	0.37	0.34	0.38	0.04
	2b	18067	0.30	0.37	0.30	0.37	0.04
	3b	18044	0.34	0.37	0.34	0.53	0.05
K	3	19005	0.85	0.96	0.85	0.96	0.00
	2	20005	0.85	0.96	0.85	0.96	0.00
	1	21005	0.85	0.96	0.85	0.96	0.00
L	1	22005	4.16	5.19	4.16	5.19	0.00
	2	23005	4.16	5.19	4.16	5.19	0.00
	3	24005	4.16	5.19	4.16	5.19	0.00

Table B-3

115 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Member Forces at Base - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	1	1001	1001	0	0.00	0.69	0.00	0.00	155.46	0.00	0.00	0.86	193.96	0.00	0.00	0.69	0.86	193.96	155.46
	2	2001	2001	0	0.00	0.69	0.00	0.00	155.46	0.00	0.00	0.86	193.96	0.00	0.00	0.69	0.86	193.96	155.46
	3	3001	3001	0	0.00	0.69	0.00	0.00	155.46	0.00	0.00	0.86	193.96	0.00	0.00	0.69	0.86	193.96	155.46
B	3	4001	4001	0	0.00	0.59	0.00	0.00	78.94	0.00	0.00	0.67	89.61	0.00	0.00	0.59	0.67	89.61	78.94
	2	5001	5001	0	0.00	0.59	0.00	0.00	78.94	0.00	0.00	0.67	89.61	0.00	0.00	0.59	0.67	89.61	78.94
	1	6001	6001	0	0.00	0.59	0.00	0.00	78.94	0.00	0.00	0.67	89.61	0.00	0.00	0.59	0.67	89.61	78.94
C	1a	7030	7003	0	6.51	1.32	0.81	0.00	0.00	12.31	0.29	1.78	0.00	0.00	14.60	1.54	1.92	0.00	0.00
	3a	7026	7001	0	6.51	1.32	0.81	0.00	0.00	12.31	0.29	1.78	0.00	0.00	14.38	1.19	1.94	0.00	0.00
	1b	7040	7017	0	5.12	1.66	0.80	0.00	0.00	12.37	0.29	1.74	0.00	0.00	13.48	1.70	1.88	0.00	0.00
	3b	7036	7015	0	5.12	1.66	0.80	0.00	0.00	12.37	0.29	1.74	0.00	0.00	14.57	1.73	1.90	0.00	0.00
D	1a	8022	8018	1	33.60	96.04	0.09	0.00	0.00	41.21	0.00	9.55	0.00	0.00	64.43	96.04	9.57	0.00	0.00
	2a	8021	8017	1	0.00	217.30	0.00	0.00	0.00	41.22	0.00	9.55	0.00	0.00	41.22	217.30	9.55	0.00	0.00
	3a	8020	8016	1	33.60	96.04	0.09	0.00	0.00	41.21	0.00	9.55	0.00	0.00	57.62	96.03	9.52	0.00	0.00
	1b	8019	8015	1	33.60	96.04	0.09	0.00	0.00	41.21	0.00	9.55	0.00	0.00	57.62	96.04	9.52	0.00	0.00
	2b	8018	8014	1	0.00	217.30	0.00	0.00	0.00	41.22	0.00	9.55	0.00	0.00	41.22	217.30	9.55	0.00	0.00
	3b	8017	8013	1	33.60	96.04	0.09	0.00	0.00	41.21	0.00	9.55	0.00	0.00	64.42	96.03	9.57	0.00	0.00
E	1a	9036	9015	0	5.12	1.66	0.80	0.00	0.00	12.37	0.29	1.74	0.00	0.00	14.52	1.73	1.89	0.00	0.00
	3a	9040	9017	0	5.12	1.66	0.80	0.00	0.00	12.37	0.29	1.74	0.00	0.00	13.39	1.70	1.86	0.00	0.00
	1b	9026	9001	0	6.51	1.32	0.81	0.00	0.00	12.31	0.29	1.78	0.00	0.00	14.29	1.19	1.93	0.00	0.00
	3b	9030	9003	0	6.51	1.32	0.81	0.00	0.00	12.31	0.29	1.78	0.00	0.00	14.45	1.54	1.90	0.00	0.00
F	3	10001	10001	0	0.00	0.59	0.00	0.00	78.94	0.00	0.00	0.67	89.61	0.00	0.00	0.59	0.67	89.61	78.94
	2	11001	11001	0	0.00	0.59	0.00	0.00	78.94	0.00	0.00	0.67	89.61	0.00	0.00	0.59	0.67	89.61	78.94
	1	12001	12001	0	0.00	0.59	0.00	0.00	78.94	0.00	0.00	0.67	89.61	0.00	0.00	0.59	0.67	89.61	78.94
G	1	13001	13001	0	0.00	0.69	0.00	0.00	155.46	0.00	0.00	0.86	193.96	0.00	0.00	0.69	0.86	193.96	155.46
	2	14001	14001	0	0.00	0.69	0.00	0.00	155.46	0.00	0.00	0.86	193.96	0.00	0.00	0.69	0.86	193.96	155.46
	3	15001	15001	0	0.00	0.69	0.00	0.00	155.46	0.00	0.00	0.86	193.96	0.00	0.00	0.69	0.86	193.96	155.46
H	1a	16030	16003	0	4.61	1.36	0.67	0.00	0.00	11.59	0.27	1.72	0.00	0.00	15.50	1.34	2.28	0.00	0.00
	3a	16026	16001	0	4.61	1.36	0.67	0.00	0.00	11.59	0.27	1.72	0.00	0.00	10.04	1.42	1.56	0.00	0.00
	1b	16040	16017	0	5.02	1.26	0.65	0.00	0.00	11.64	0.27	1.69	0.00	0.00	13.09	1.12	2.24	0.00	0.00
	3b	16036	16015	0	5.02	1.26	0.65	0.00	0.00	11.64	0.27	1.69	0.00	0.00	11.37	1.44	1.52	0.00	0.00
I	1a	17003	17002	0	5.64	1.14	0.28	0.00	0.00	7.38	0.14	1.52	0.00	0.00	9.15	1.09	1.52	0.00	0.00
	3a	17001	17001	0	5.64	0.28	1.14	0.00	0.00	7.38	1.52	0.14	0.00	0.00	10.07	1.61	1.19	0.00	0.00
	1b	17005	17003	0	2.13	0.79	0.68	0.00	0.00	7.37	1.72	0.10	0.00	0.00	8.39	1.87	0.66	0.00	0.00
	3b	17007	17004	0	2.13	0.68	0.79	0.00	0.00	7.37	0.10	1.72	0.00	0.00	7.22	0.71	2.09	0.00	0.00
J	1a	18036	18015	0	5.02	1.26	0.65	0.00	0.00	11.64	0.27	1.69	0.00	0.00	11.30	1.44	1.52	0.00	0.00
	3a	18040	18017	0	5.02	1.26	0.65	0.00	0.00	11.64	0.27	1.69	0.00	0.00	13.05	1.12	2.23	0.00	0.00
	1b	18026	18001	0	4.61	1.36	0.67	0.00	0.00	11.59	0.27	1.72	0.00	0.00	10.04	1.42	1.56	0.00	0.00
	3b	18030	18003	0	4.61	1.36	0.67	0.00	0.00	11.59	0.27	1.72	0.00	0.00	15.44	1.34	2.27	0.00	0.00
K	3	19001	19001	0	0.00	0.59	0.00	0.00	78.94	0.00	0.00	0.67	89.61	0.00	0.00	0.59	0.67	89.61	78.94
	2	20001	20001	0	0.00	0.59	0.00	0.00	78.94	0.00	0.00	0.67	89.61	0.00	0.00	0.59	0.67	89.61	78.94
	1	21001	21001	0	0.00	0.59	0.00	0.00	78.94	0.00	0.00	0.67	89.61	0.00	0.00	0.59	0.67	89.61	78.94
L	1	22001	22001	0	0.00	0.69	0.00	0.00	155.46	0.00	0.00	0.86	193.96	0.00	0.00	0.69	0.86	193.96	155.46
	2	23001	23001	0	0.00	0.69	0.00	0.00	155.46	0.00	0.00	0.86	193.96	0.00	0.00	0.69	0.86	193.96	155.46
	3	24001	24001	0	0.00	0.69	0.00	0.00	155.46	0.00	0.00	0.86	193.96	0.00	0.00	0.69	0.86	193.96	155.46

115 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Forces - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	1	1004	1005	1	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.09	0.11	0.00	0.00
	2	2004	2005	1	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.09	0.11	0.00	0.00
	3	3004	3005	1	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.09	0.11	0.00	0.00
B	3	4004	4005	1	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.10	0.11	0.00	0.00
	2	5004	5005	1	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.10	0.11	0.00	0.00
	1	6004	6005	1	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.10	0.11	0.00	0.00
C	1a	7097	7044	1	0.04	0.13	0.08	1.15	0.47	0.07	0.01	0.14	1.90	0.03	0.07	0.13	0.15	2.11	0.47
	2a	7124	7067	1	0.00	0.11	0.00	0.00	0.43	0.07	0.00	0.14	1.90	0.00	0.07	0.11	0.14	1.91	0.43
	3a	7151	7092	1	0.04	0.13	0.08	1.15	0.47	0.07	0.01	0.14	1.90	0.03	0.08	0.14	0.16	2.24	0.46
	1b	7100	7040	1	0.23	0.09	0.05	2.49	0.47	0.37	0.00	0.08	4.06	0.03	0.41	0.09	0.09	4.51	0.48
	2b	7127	7068	1	0.00	0.08	0.00	0.00	0.44	0.37	0.00	0.09	4.10	0.00	0.38	0.08	0.09	4.12	0.44
	3b	7154	7093	1	0.23	0.09	0.05	2.49	0.47	0.37	0.00	0.08	4.06	0.03	0.44	0.09	0.10	4.78	0.46
D	1a	8012	8040	1	0.00	0.00	0.17	0.00	0.00	0.01	0.12	0.00	0.00	0.00	0.01	0.12	0.17	0.00	0.00
	2a	8008	8036	1	0.00	0.00	0.12	0.00	0.00	0.01	0.12	0.00	0.00	0.00	0.01	0.12	0.12	0.00	0.00
	3a	8004	8032	1	0.00	0.00	0.17	0.00	0.00	0.01	0.12	0.00	0.00	0.00	0.01	0.12	0.17	0.00	0.00
	1b	8010	8039	1	0.00	0.00	0.17	0.00	0.00	0.01	0.12	0.00	0.00	0.00	0.01	0.12	0.17	0.00	0.00
	2b	8006	8035	1	0.00	0.00	0.12	0.00	0.00	0.01	0.12	0.00	0.00	0.00	0.01	0.12	0.12	0.00	0.00
	3b	8002	8031	1	0.00	0.00	0.17	0.00	0.00	0.01	0.12	0.00	0.00	0.00	0.01	0.12	0.17	0.00	0.00
E	1a	9154	9093	1	0.23	0.09	0.05	2.49	0.47	0.37	0.00	0.08	4.06	0.03	0.43	0.09	0.10	4.75	0.47
	2a	9127	9068	1	0.00	0.08	0.00	0.00	0.44	0.37	0.00	0.09	4.10	0.00	0.37	0.08	0.09	4.08	0.44
	3a	9100	9040	1	0.23	0.09	0.05	2.49	0.47	0.37	0.00	0.08	4.06	0.03	0.41	0.09	0.09	4.47	0.47
	1b	9151	9092	1	0.04	0.13	0.08	1.15	0.47	0.07	0.01	0.14	1.90	0.03	0.08	0.14	0.16	2.22	0.46
	2b	9124	9067	1	0.00	0.11	0.00	0.00	0.43	0.07	0.00	0.14	1.90	0.00	0.07	0.11	0.13	1.89	0.43
	3b	9097	9044	1	0.04	0.13	0.08	1.15	0.47	0.07	0.01	0.14	1.90	0.03	0.07	0.13	0.15	2.09	0.47
F	3	10004	10005	1	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.10	0.11	0.00	0.00
	2	11004	11005	1	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.10	0.11	0.00	0.00
	1	12004	12005	1	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.10	0.11	0.00	0.00
G	1	13004	13005	1	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.09	0.11	0.00	0.00
	2	14004	14005	1	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.09	0.11	0.00	0.00
	3	15004	15005	1	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.09	0.11	0.00	0.00
H	1a	16097	16044	1	0.02	0.11	0.07	0.40	0.30	0.04	0.00	0.13	0.74	0.02	0.05	0.11	0.18	1.07	0.31
	2a	16124	16067	1	0.00	0.11	0.00	0.00	0.26	0.04	0.00	0.13	0.75	0.00	0.04	0.11	0.13	0.75	0.26
	3a	16151	16092	1	0.02	0.11	0.07	0.40	0.30	0.04	0.00	0.13	0.74	0.02	0.04	0.11	0.14	0.78	0.29
	1b	16100	16040	1	0.09	0.02	0.01	1.08	0.53	0.15	0.00	0.02	1.99	0.03	0.22	0.03	0.02	2.88	0.54
	2b	16127	16068	1	0.00	0.02	0.00	0.00	0.45	0.16	0.00	0.02	2.05	0.00	0.16	0.02	0.02	2.05	0.45
	3b	16154	16093	1	0.09	0.02	0.01	1.08	0.53	0.15	0.00	0.02	1.99	0.03	0.16	0.02	0.02	2.11	0.52
I	1a	17087	17064	1	0.02	0.08	0.07	0.00	0.00	0.01	0.04	0.11	0.00	0.00	0.02	0.08	0.14	0.00	0.00
	2a	17088	17065	1	0.00	0.00	0.10	0.00	0.00	0.02	0.12	0.00	0.00	0.00	0.02	0.12	0.10	0.00	0.00
	3a	17084	17061	1	0.02	0.08	0.07	0.00	0.00	0.01	0.04	0.11	0.00	0.00	0.03	0.11	0.15	0.00	0.00
	1b	17086	17063	1	0.03	0.08	0.09	0.00	0.00	0.01	0.02	0.12	0.00	0.00	0.03	0.09	0.15	0.00	0.00
	2b	17089	17066	1	0.00	0.00	0.13	0.00	0.00	0.01	0.12	0.00	0.00	0.00	0.01	0.12	0.13	0.00	0.00
	3b	17085	17062	1	0.00	0.00	0.13	0.00	0.00	0.01	0.12	0.00	0.00	0.00	0.01	0.12	0.13	0.00	0.00
J	1a	18154	18093	1	0.09	0.02	0.01	1.08	0.53	0.15	0.00	0.02	1.99	0.03	0.16	0.02	0.02	2.11	0.53
	2a	18127	18068	1	0.00	0.02	0.00	0.00	0.45	0.16	0.00	0.02	2.05	0.00	0.16	0.02	0.02	2.04	0.45
	3a	18100	18040	1	0.09	0.02	0.01	1.08	0.53	0.15	0.00	0.02	1.99	0.03	0.22	0.02	0.02	2.87	0.53
	1b	18151	18092	1	0.02	0.11	0.07	0.40	0.30	0.04	0.00	0.13	0.74	0.02	0.04	0.11	0.14	0.78	0.30
	2b	18124	18067	1	0.00	0.11	0.00	0.00	0.26	0.04	0.00	0.13	0.75	0.00	0.04	0.11	0.13	0.74	0.26
	3b	18097	18044	1	0.02	0.11	0.07	0.40	0.30	0.04	0.00	0.13	0.74	0.02	0.05	0.11	0.18	1.06	0.30
K	3	19004	19005	1	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.10	0.11	0.00	0.00
	2	20004	20005	1	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.10	0.11	0.00	0.00
	1	21004	21005	1	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.10	0.11	0.00	0.00
L	1	22004	22005	1	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.09	0.11	0.00	0.00
	2	23004	23005	1	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.09	0.11	0.00	0.00
	3	24004	24005	1	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.09	0.11	0.00	0.00

115 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Insulator Forces at the Base - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	1	1002	1002	0	0.00	0.39	0.00	0.00	10.37	0.00	0.00	0.48	12.93	0.00	0.00	0.39	0.48	12.93	10.37
	2	2002	2002	0	0.00	0.39	0.00	0.00	10.37	0.00	0.00	0.48	12.93	0.00	0.00	0.39	0.48	12.93	10.37
	3	3002	3002	0	0.00	0.39	0.00	0.00	10.37	0.00	0.00	0.48	12.93	0.00	0.00	0.39	0.48	12.93	10.37
B	3	4002	4002	0	0.00	0.41	0.00	0.00	11.39	0.00	0.00	0.47	12.93	0.00	0.00	0.41	0.47	12.93	11.39
	2	5002	5002	0	0.00	0.41	0.00	0.00	11.39	0.00	0.00	0.47	12.93	0.00	0.00	0.41	0.47	12.93	11.39
	1	6002	6002	0	0.00	0.41	0.00	0.00	11.39	0.00	0.00	0.47	12.93	0.00	0.00	0.41	0.47	12.93	11.39
C	1a	7095	7043	0	0.06	0.40	0.27	6.66	12.15	0.10	0.01	0.45	10.95	0.40	0.12	0.40	0.50	12.17	11.90
	2a	7122	7066	0	0.00	0.32	0.00	0.00	9.81	0.10	0.00	0.45	10.91	0.00	0.10	0.32	0.45	10.97	9.81
	3a	7149	7091	0	0.06	0.40	0.27	6.66	12.15	0.10	0.01	0.45	10.95	0.40	0.12	0.41	0.53	12.89	12.41
	1b	7101	7041	0	0.18	0.45	0.32	7.92	14.89	0.27	0.02	0.53	12.97	0.51	0.31	0.44	0.59	14.42	14.54
	2b	7128	7065	0	0.00	0.39	0.00	0.00	12.65	0.28	0.00	0.53	13.04	0.00	0.28	0.39	0.53	13.11	12.65
	3b	7155	7090	0	0.18	0.45	0.32	7.92	14.89	0.27	0.02	0.53	12.97	0.51	0.32	0.46	0.62	15.25	15.26
	1c	7098	7039	0	0.25	0.35	0.25	4.10	9.41	0.41	0.01	0.40	6.68	0.34	0.45	0.35	0.45	7.43	9.17
	2c	7125	7064	0	0.00	0.29	0.00	0.00	7.90	0.41	0.00	0.41	6.75	0.00	0.41	0.29	0.41	6.78	7.90
	3c	7152	7089	0	0.25	0.35	0.25	4.10	9.41	0.41	0.01	0.40	6.68	0.34	0.48	0.35	0.48	7.86	9.66
D	1a	8011	8038	0	0.00	0.00	0.44	18.36	0.03	0.04	0.27	0.00	0.00	11.80	0.04	0.27	0.44	18.36	11.81
	2a	8007	8034	0	0.00	0.00	0.31	13.19	0.00	0.04	0.27	0.00	0.00	11.81	0.04	0.27	0.31	13.19	11.80
	3a	8003	8030	0	0.00	0.00	0.44	18.36	0.03	0.04	0.27	0.00	0.00	11.80	0.04	0.27	0.44	18.36	11.80
	1b	8009	8037	0	0.00	0.00	0.44	18.36	0.03	0.04	0.27	0.00	0.00	11.80	0.04	0.27	0.44	18.36	11.80
	2b	8005	8033	0	0.00	0.00	0.31	13.19	0.00	0.04	0.27	0.00	0.00	11.81	0.04	0.27	0.31	13.19	11.80
	3b	8001	8029	0	0.00	0.00	0.44	18.36	0.03	0.04	0.27	0.00	0.00	11.80	0.04	0.27	0.44	18.36	11.81
E	1a	9152	9089	0	0.25	0.35	0.25	4.10	9.41	0.41	0.01	0.40	6.68	0.34	0.48	0.35	0.47	7.81	9.58
	2a	9125	9064	0	0.00	0.29	0.00	0.00	7.90	0.41	0.00	0.41	6.75	0.00	0.41	0.29	0.41	6.72	7.90
	3a	9098	9039	0	0.25	0.35	0.25	4.10	9.41	0.41	0.01	0.40	6.68	0.34	0.45	0.35	0.45	7.35	9.25
	1b	9155	9090	0	0.18	0.45	0.32	7.92	14.89	0.27	0.02	0.53	12.97	0.51	0.32	0.46	0.61	15.13	15.13
	2b	9128	9065	0	0.00	0.39	0.00	0.00	12.65	0.28	0.00	0.53	13.04	0.00	0.28	0.39	0.53	12.98	12.65
	3b	9101	9041	0	0.18	0.45	0.32	7.92	14.89	0.27	0.02	0.53	12.97	0.51	0.31	0.44	0.58	14.27	14.71
	1c	9149	9091	0	0.06	0.40	0.27	6.66	12.15	0.10	0.01	0.45	10.95	0.40	0.11	0.41	0.52	12.79	12.37
	2c	9122	9066	0	0.00	0.32	0.00	0.00	9.81	0.10	0.00	0.45	10.91	0.00	0.10	0.32	0.45	10.86	9.81
	3c	9095	9043	0	0.06	0.40	0.27	6.66	12.16	0.10	0.01	0.45	10.95	0.40	0.11	0.40	0.49	12.04	11.94
F	3	10002	10002	0	0.00	0.41	0.00	0.00	11.39	0.00	0.00	0.47	12.93	0.00	0.00	0.41	0.47	12.93	11.39
	2	11002	11002	0	0.00	0.41	0.00	0.00	11.39	0.00	0.00	0.47	12.93	0.00	0.00	0.41	0.47	12.93	11.39
	1	12002	12002	0	0.00	0.41	0.00	0.00	11.39	0.00	0.00	0.47	12.93	0.00	0.00	0.41	0.47	12.93	11.39
G	1	13002	13002	0	0.00	0.39	0.00	0.00	10.37	0.00	0.00	0.48	12.93	0.00	0.00	0.39	0.48	12.93	10.37
	2	14002	14002	0	0.00	0.39	0.00	0.00	10.37	0.00	0.00	0.48	12.93	0.00	0.00	0.39	0.48	12.93	10.37
	3	15002	15002	0	0.00	0.39	0.00	0.00	10.37	0.00	0.00	0.48	12.93	0.00	0.00	0.39	0.48	12.93	10.37
H	1a	16095	16043	0	0.03	0.33	0.21	5.81	9.87	0.07	0.01	0.40	10.74	0.27	0.10	0.33	0.57	15.40	9.88
	2a	16122	16066	0	0.00	0.32	0.00	0.00	9.50	0.07	0.00	0.39	10.60	0.00	0.07	0.32	0.39	10.63	9.50
	3a	16149	16091	0	0.03	0.33	0.21	5.81	9.87	0.07	0.01	0.40	10.74	0.27	0.06	0.33	0.42	11.33	9.85
	1b	16101	16041	0	0.06	0.44	0.29	9.02	15.29	0.09	0.01	0.54	16.72	0.34	0.15	0.44	0.78	24.07	15.54
	2b	16128	16065	0	0.00	0.40	0.00	0.00	13.88	0.10	0.00	0.55	16.90	0.00	0.10	0.40	0.55	16.94	13.88
	3b	16155	16090	0	0.06	0.44	0.29	9.02	15.29	0.09	0.01	0.54	16.72	0.34	0.10	0.43	0.57	17.63	15.13
	1c	16098	16039	0	0.11	0.23	0.14	1.73	5.23	0.19	0.01	0.25	3.16	0.12	0.26	0.24	0.36	4.58	5.31
	2c	16125	16064	0	0.00	0.21	0.00	0.00	4.75	0.19	0.00	0.26	3.26	0.00	0.19	0.21	0.26	3.27	4.75
	3c	16152	16089	0	0.11	0.23	0.14	1.73	5.23	0.19	0.01	0.25	3.16	0.12	0.20	0.23	0.27	3.36	5.17
I	1a	17082	17053	0	0.06	0.16	0.13	5.64	6.56	0.04	0.08	0.26	10.23	3.49	0.06	0.16	0.31	12.74	6.85
	2a	17080	17051	0	0.00	0.00	0.22	9.35	0.00	0.05	0.29	0.00	0.00	12.02	0.05	0.29	0.22	9.35	12.02
	3a	17078	17049	0	0.06	0.16	0.13	5.64	6.56	0.04	0.08	0.26	10.23	3.49	0.07	0.21	0.31	12.99	8.93
	1b	17083	17054	0	0.07	0.16	0.17	7.43	6.83	0.02	0.04	0.27	10.72	1.72	0.08	0.18	0.33	13.60	7.62
	2b	17081	17052	0	0.00	0.00	0.29	12.41	0.00	0.03	0.29	0.00	0.00	12.27	0.03	0.30	0.29	12.41	12.28
	3b	17079	17050	0	0.00	0.00	0.29	12.41	0.00	0.03	0.29	0.00	0.00	12.27	0.03	0.30	0.29	12.41	12.28
J	1a	18152	18089	0	0.11	0.23	0.14	1.73	5.23	0.19	0.01	0.25	3.16	0.12	0.20	0.23	0.27	3.35	5.22
	2a	18125	18064	0	0.00	0.21	0.00	0.00	4.76	0.19	0.00	0.26	3.26	0.00	0.19	0.21	0.26	3.25	4.76
	3a	18098	18039	0	0.11	0.23	0.14	1.73	5.23	0.19	0.01	0.25	3.16	0.12	0.26	0.23	0.36	4.57	5.25
	1b	18155	18090	0	0.06	0.44	0.29	9.01	15.29	0.09	0.01	0.54	16.72	0.34	0.10	0.44	0.57	17.61	15.27
	2b	18128	18065	0	0.00	0.40	0.00	0.00	13.90	0.10	0.00	0.55	16.90	0.00	0.10	0.40	0.55	16.85	13.90
	3b	18101	18041	0	0.06	0.44	0.29	9.01	15.29	0.09	0.01	0.54	16.72	0.34	0.15	0.44	0.78	23.99	15.36
	1c	18149	18091	0	0.03	0.33	0.21	5.81	9.88	0.07	0.01	0.40	10.74	0.27	0.06	0.32	0.42	11.32	9.84
	2c	18122	18066	0	0.00	0.31	0.00	0.00	9.41	0.07	0.00	0.39	10.60	0.00	0.07	0.31	0.39	10.58	9.41
	3c	18095	18043	0	0.03	0.33	0.21	5.81	9.88	0.07	0.01	0.40	10.74	0.27	0.10	0.33	0.57	15.35	9.92
K	3	19002	19002	0	0.00	0.41	0.00	0.00	11.39	0.00	0.00	0.47	12.93	0.00	0.00	0.41	0.47	12.93	11.39
	2	20002	20002	0	0.00	0.41	0.00	0.00	11.39	0.00	0.00	0.47	12.93	0.00	0.00	0.41	0.47	12.93	11.39
	1	21002	21002	0	0.00	0.41	0.00	0.00	11.39	0.00	0.00	0.47	12.93	0.00	0.00	0.41	0.47	12.93	11.39
L	1	22002	22002	0	0.00	0.39	0.00	0.00	10.37	0.00	0.00	0.48	12.93	0.00	0.00	0.39	0.48	12.93	10.37
	2	23002	23002	0	0.00	0.39	0.00	0.00	10.37	0.00	0.00	0.48	12.93	0.00	0.00	0.39	0.48	12.93	10.37
	3	24002	24002	0	0.00	0.39	0.00	0.00	10.37	0.00	0.00	0.48	12.93	0.00	0.00	0.39	0.48	12.93	10.37

115 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Displacements - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Node #	X-Dir. Only	Y-Dir. Only	XYZ-Dir. Combined		
			X (in)	Y (in)	X (in)	Y (in)	Z (in)
A	1	1005	4.85	0.63	4.85	0.59	0.00
	2	2005	4.97	0.59	4.97	0.62	0.00
	3	3005	4.60	0.62	4.61	0.93	0.00
B	3	4005	1.22	0.63	1.27	0.88	0.00
	2	5005	0.96	0.65	0.94	0.66	0.00
	1	6005	0.99	0.73	0.97	0.73	0.00
C	1a	7044	0.53	0.63	0.47	0.59	0.06
	2a	7067	0.40	0.58	0.39	0.61	0.06
	3a	7092	0.50	0.61	0.54	0.92	0.08
	1b	7040	0.61	0.63	0.57	0.59	0.06
	2b	7068	0.51	0.58	0.47	0.61	0.06
	3b	7093	0.62	0.61	0.64	0.92	0.08
D	1a	8040	0.96	0.09	0.97	0.08	0.03
	2a	8036	0.43	0.09	0.42	0.10	0.04
	3a	8032	0.96	0.09	0.95	0.11	0.05
	1b	8039	0.98	0.07	0.98	0.07	0.03
	2b	8035	0.44	0.07	0.44	0.07	0.03
	3b	8031	0.97	0.07	0.98	0.08	0.03
E	1a	9093	0.62	0.50	0.66	0.58	0.07
	2a	9068	0.49	0.48	0.49	0.48	0.05
	3a	9040	0.57	0.49	0.54	0.50	0.05
	1b	9092	0.49	0.50	0.49	0.57	0.05
	2b	9067	0.37	0.48	0.36	0.48	0.04
	3b	9044	0.54	0.48	0.50	0.50	0.05
F	3	10005	1.01	0.93	1.03	0.95	0.00
	2	11005	0.87	0.89	0.86	0.89	0.00
	1	12005	1.31	0.88	1.32	0.88	0.00
G	1	13005	4.83	0.50	4.83	0.58	0.00
	2	14005	4.93	0.48	4.93	0.48	0.00
	3	15005	5.43	0.49	5.43	0.50	0.00
H	1a	16044	0.48	0.50	0.48	0.57	0.06
	2a	16067	0.39	0.48	0.40	0.48	0.05
	3a	16092	0.46	0.48	0.47	0.50	0.06
	1b	16040	0.51	0.50	0.52	0.57	0.06
	2b	16068	0.41	0.48	0.41	0.47	0.05
	3b	16093	0.51	0.48	0.51	0.50	0.07
I	1a	17064	0.05	0.20	0.06	0.22	0.06
	2a	17065	0.09	0.25	0.09	0.25	0.05
	3a	17061	0.05	0.19	0.06	0.18	0.05
	1b	17063	0.06	0.21	0.09	0.19	0.04
	2b	17066	0.10	0.27	0.10	0.27	0.07
	3b	17062	0.06	0.20	0.08	0.22	0.05
J	1a	18093	0.35	0.49	0.36	0.45	0.06
	2a	18068	0.28	0.46	0.29	0.46	0.04
	3a	18040	0.31	0.47	0.30	0.53	0.06
	1b	18092	0.30	0.49	0.31	0.46	0.05
	2b	18067	0.25	0.46	0.25	0.46	0.05
	3b	18044	0.40	0.47	0.39	0.53	0.06
K	3	19005	0.82	0.83	0.82	0.87	0.00
	2	20005	0.91	0.79	0.91	0.78	0.00
	1	21005	1.08	0.81	1.08	0.79	0.00
L	1	22005	4.52	0.49	4.52	0.46	0.00
	2	23005	4.81	0.46	4.81	0.47	0.00
	3	24005	4.80	0.48	4.80	0.53	0.00

115 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Member Forces at Base - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	1	1001	1001	0	0.00	0.81	0.13	19.75	182.70	0.01	0.01	0.25	38.43	1.04	0.01	0.82	0.27	39.29	182.86
	2	2001	2001	0	0.00	0.83	0.03	4.39	187.23	0.02	0.00	0.24	36.28	0.54	0.02	0.83	0.24	37.36	187.28
	3	3001	3001	0	0.04	0.83	0.13	19.19	187.23	0.07	0.01	0.25	37.29	1.04	0.10	0.83	0.27	39.29	187.28
B	3	4001	4001	0	0.05	0.62	0.30	36.96	94.87	0.09	0.19	0.57	69.13	22.06	0.12	0.65	0.78	95.21	99.57
	2	5001	5001	0	0.01	0.55	0.06	7.43	76.22	0.04	0.06	0.60	71.72	6.65	0.05	0.54	0.61	73.01	75.68
	1	6001	6001	0	0.08	0.85	0.30	35.35	101.58	0.11	0.30	0.69	81.87	36.22	0.12	0.76	0.71	83.77	97.04
C	1a	7030	7003	0	6.85	0.35	0.94	0.00	0.00	17.13	0.14	2.47	0.00	0.00	16.91	0.39	2.31	0.00	0.00
	3a	7026	7001	0	7.60	1.82	1.12	0.00	0.00	17.18	0.76	2.38	0.00	0.00	22.69	1.99	3.30	0.00	0.00
	1b	7040	7017	0	5.60	1.92	0.92	0.00	0.00	16.49	0.43	2.42	0.00	0.00	15.61	1.86	2.26	0.00	0.00
	3b	7036	7015	0	6.54	1.91	1.11	0.00	0.00	16.98	0.73	2.33	0.00	0.00	20.56	1.97	3.23	0.00	0.00
D	1a	8022	8018	1	0.27	31.67	0.34	12.72	45.00	0.31	1.43	0.85	32.48	7.56	0.47	31.72	1.03	40.88	42.47
	2a	8021	8017	1	33.34	92.41	0.16	0.00	0.00	2.35	4.01	0.40	0.00	0.00	33.88	92.77	0.41	0.00	0.00
	3a	8020	8016	1	0.45	209.75	0.03	0.00	0.00	3.61	4.10	0.42	0.00	0.00	3.82	209.90	0.43	0.00	0.00
	1b	8019	8015	1	33.38	91.83	0.22	0.00	0.00	2.65	3.82	0.43	0.00	0.00	33.54	91.66	0.57	0.00	0.00
	2b	8018	8014	1	32.66	92.40	0.15	0.00	0.00	3.29	3.89	0.41	0.00	0.00	32.23	92.80	0.45	0.00	0.00
	3b	8017	8013	1	0.29	209.60	0.04	0.00	0.00	3.13	4.10	0.43	0.00	0.00	3.20	209.73	0.44	0.00	0.00
E	1a	9036	9015	0	2.37	0.33	0.09	4.73	17.74	10.86	0.09	0.50	26.56	4.39	12.15	0.36	0.55	29.28	19.08
	3a	9040	9017	0	2.38	0.33	0.10	5.39	17.63	10.65	0.09	0.49	26.25	4.57	9.85	0.31	0.53	27.97	16.62
	1b	9026	9001	0	3.51	0.25	0.09	4.62	13.06	11.00	0.08	0.52	27.19	4.19	12.10	0.23	0.57	29.95	12.07
	3b	9030	9003	0	3.61	0.25	0.10	5.27	13.02	10.84	0.10	0.51	26.86	5.03	12.61	0.30	0.54	28.43	15.50
F	3	10001	10001	0	0.04	0.56	0.13	1.39	12.57	0.08	0.07	0.63	2.74	1.33	0.09	0.58	0.64	3.12	13.27
	2	11001	11001	0	0.00	0.31	0.01	0.11	22.21	0.04	0.01	0.60	2.25	0.21	0.04	0.31	0.60	2.21	22.05
	1	12001	12001	0	0.03	0.44	0.11	1.11	33.73	0.17	0.02	0.59	2.49	0.41	0.18	0.44	0.60	2.86	33.74
G	1	13001	13001	0	0.03	0.48	0.07	4.06	14.25	0.18	0.01	0.21	13.13	0.58	0.19	0.48	0.25	15.12	14.26
	2	14001	14001	0	0.00	0.51	0.03	1.33	12.16	0.06	0.00	0.20	13.78	0.10	0.06	0.51	0.20	13.68	12.08
	3	15001	15001	0	0.01	0.57	0.06	4.19	12.42	0.03	0.00	0.20	14.25	0.41	0.03	0.57	0.21	15.49	12.48
H	1a	16030	16003	0	4.28	0.34	0.08	4.30	18.14	11.88	0.09	0.55	29.12	4.60	12.83	0.36	0.61	32.24	18.91
	3a	16026	16001	0	4.33	0.34	0.09	4.72	18.12	11.64	0.10	0.53	28.07	5.25	11.64	0.39	0.54	28.47	20.35
	1b	16040	16017	0	3.64	0.41	0.08	4.32	21.61	11.66	0.09	0.54	28.48	4.38	12.71	0.40	0.59	31.53	21.20
	3b	16036	16015	0	3.60	0.41	0.09	4.74	21.58	11.41	0.10	0.52	27.46	5.16	12.92	0.41	0.52	27.67	21.93
I	1a	17003	17002	0	2.96	0.20	0.05	0.71	4.09	6.27	0.02	0.62	9.15	0.89	7.55	0.20	0.63	9.28	4.46
	3a	17001	17001	0	3.01	0.05	0.20	4.10	0.78	6.42	0.61	0.03	1.13	9.02	6.47	0.62	0.19	3.93	9.16
	1b	17005	17003	0	1.58	0.11	0.23	2.90	2.27	6.19	0.77	0.02	1.53	10.23	6.31	0.79	0.23	3.43	11.21
	3b	17007	17004	0	1.55	0.23	0.12	2.34	2.89	6.12	0.02	0.76	9.90	1.42	6.64	0.22	0.77	10.03	3.10
J	1a	18036	18015	0	2.79	0.23	0.08	4.40	12.37	11.24	0.09	0.52	27.91	4.54	11.45	0.29	0.50	26.47	15.20
	3a	18040	18017	0	2.85	0.23	0.10	5.31	12.35	11.02	0.10	0.52	27.59	4.96	12.22	0.25	0.56	29.81	13.41
	1b	18026	18001	0	2.43	0.25	0.08	4.42	13.34	11.63	0.09	0.54	28.53	4.28	11.17	0.28	0.51	27.01	14.53
	3b	18030	18003	0	2.47	0.25	0.10	5.38	13.28	11.45	0.11	0.53	28.19	5.30	13.04	0.25	0.57	30.28	13.29
K	3	19001	19001	0	0.04	0.51	0.13	1.48	10.81	0.07	0.03	0.55	2.20	0.54	0.10	0.51	0.57	2.86	10.82
	2	20001	20001	0	0.01	0.39	0.01	0.23	20.36	0.04	0.00	0.53	1.67	0.07	0.04	0.39	0.52	1.64	20.33
	1	21001	21001	0	0.04	0.39	0.10	1.01	29.71	0.15	0.01	0.54	2.07	0.22	0.15	0.39	0.53	2.43	29.67
L	1	22001	22001	0	0.04	0.42	0.10	5.01	13.81	0.15	0.00	0.19	12.99	0.29	0.15	0.42	0.22	13.41	13.77
	2	23001	23001	0	0.00	0.46	0.04	2.13	11.41	0.04	0.00	0.19	13.62	0.03	0.04	0.46	0.20	13.55	11.39
	3	24001	24001	0	0.00	0.48	0.11	6.58	12.30	0.01	0.00	0.19	14.46	0.15	0.02	0.48	0.27	18.73	12.34

115 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Forces - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	1	1004	1005	1	0.00	0.16	0.31	0.72	2.80	0.01	0.01	0.59	1.76	0.33	0.01	0.17	0.64	1.82	2.85
	2	2004	2005	1	0.00	0.15	0.08	0.41	2.60	0.02	0.01	0.54	1.92	0.12	0.02	0.15	0.57	2.02	2.56
	3	3004	3005	1	0.04	0.16	0.31	0.72	2.80	0.07	0.01	0.59	1.92	0.31	0.10	0.17	0.56	2.02	2.85
B	3	4004	4005	1	0.04	0.27	0.05	3.55	20.97	0.09	0.02	0.06	6.36	2.34	0.12	0.26	0.09	8.10	20.61
	2	5004	5005	1	0.01	0.20	0.01	0.83	14.81	0.04	0.01	0.06	6.99	0.75	0.04	0.20	0.06	7.06	14.63
	1	6004	6005	1	0.08	0.15	0.04	3.72	10.65	0.11	0.03	0.07	8.46	3.61	0.12	0.14	0.07	9.04	10.05
C	1a	7097	7044	1	0.21	0.49	0.36	0.66	5.41	0.35	0.12	0.79	1.11	4.32	0.37	0.47	0.74	1.25	6.02
	2a	7124	7067	1	0.02	0.39	0.08	0.09	5.37	0.07	0.08	0.78	0.25	1.01	0.07	0.36	0.81	0.27	5.17
	3a	7151	7092	1	0.25	0.53	0.44	0.83	5.84	0.37	0.18	0.75	1.29	4.52	0.48	0.57	1.09	1.63	7.87
	1b	7100	7040	1	0.23	0.39	0.32	3.94	7.36	0.54	0.21	0.74	9.07	5.67	0.54	0.36	0.69	8.79	7.57
	2b	7127	7068	1	0.05	0.41	0.07	0.85	8.20	0.39	0.10	0.62	7.43	1.91	0.40	0.38	0.64	7.62	7.53
	3b	7154	7093	1	0.29	0.44	0.40	5.00	8.21	0.52	0.30	0.71	8.83	7.02	0.74	0.52	1.02	12.81	10.59
D	1a	8012	8040	1	107.25	32.68	0.08	1.06	645.82	4.52	1.18	0.00	0.05	28.47	107.17	32.96	0.08	1.06	646.17
	2a	8008	8036	1	0.06	0.09	0.53	12.84	6.69	0.27	0.23	0.07	2.50	17.18	0.26	0.24	0.52	13.26	18.41
	3a	8004	8032	1	0.01	0.00	0.42	12.60	0.29	0.33	0.24	0.02	1.21	18.21	0.33	0.24	0.42	12.53	18.14
	1b	8010	8039	1	0.18	0.11	0.46	6.80	8.93	0.48	0.28	0.12	5.27	22.48	0.45	0.26	0.51	7.52	20.30
	2b	8006	8035	1	0.06	0.03	0.36	8.45	2.55	0.61	0.29	0.03	2.09	23.84	0.63	0.31	0.36	7.73	24.89
	3b	8002	8031	1	0.26	0.14	0.50	7.68	11.53	0.46	0.28	0.12	5.31	22.04	0.61	0.34	0.44	8.72	27.55
E	1a	9154	9093	1	0.14	0.48	0.13	1.89	9.94	0.34	0.18	0.59	6.72	4.09	0.39	0.53	0.67	7.79	11.12
	2a	9127	9068	1	0.01	0.43	0.01	0.16	8.87	0.24	0.06	0.53	5.64	1.11	0.24	0.43	0.53	5.59	8.80
	3a	9100	9040	1	0.11	0.40	0.12	1.55	8.37	0.31	0.17	0.56	6.14	3.92	0.33	0.41	0.55	5.92	8.64
	1b	9151	9092	1	0.20	0.50	0.11	0.77	7.75	0.29	0.11	0.61	0.63	3.01	0.38	0.53	0.68	1.02	8.72
	2b	9124	9067	1	0.01	0.40	0.01	0.06	6.52	0.13	0.05	0.61	0.15	0.60	0.13	0.39	0.60	0.17	6.53
	3b	9097	9044	1	0.17	0.44	0.12	0.63	7.33	0.26	0.10	0.58	0.57	2.90	0.29	0.42	0.58	0.79	6.77
F	3	10004	10005	1	0.00	0.45	0.01	0.11	22.21	0.04	0.02	0.94	2.25	0.21	0.04	0.45	0.94	2.21	22.05
	2	11004	11005	1	0.03	0.54	0.17	1.11	33.73	0.17	0.04	0.94	2.49	0.41	0.18	0.55	0.97	2.86	33.74
	1	12004	12005	1	0.03	0.81	0.06	4.06	14.25	0.18	0.01	0.21	13.13	0.58	0.19	0.80	0.25	15.12	14.26
G	1	13004	13005	1	0.00	0.82	0.01	1.33	12.16	0.06	0.00	0.22	13.78	0.10	0.06	0.82	0.21	13.68	12.08
	2	14004	14005	1	0.01	0.91	0.06	4.19	12.42	0.03	0.00	0.22	14.25	0.41	0.03	0.91	0.24	15.49	12.48
	3	15004	15005	1	0.07	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00
H	1a	16097	16044	1	0.12	0.31	0.13	1.05	3.22	0.20	0.05	0.53	1.88	1.27	0.24	0.32	0.59	2.18	3.45
	2a	16124	16067	1	0.01	0.24	0.01	0.06	2.24	0.11	0.01	0.54	2.89	0.08	0.10	0.24	0.53	2.91	2.22
	3a	16151	16092	1	0.12	0.32	0.13	0.98	3.21	0.21	0.05	0.51	1.77	1.25	0.25	0.32	0.52	1.92	3.33
	1b	16100	16040	1	0.09	0.57	0.17	3.79	12.33	0.30	0.09	0.77	15.32	2.46	0.34	0.59	0.87	17.38	12.79
	2b	16127	16068	1	0.01	0.47	0.02	0.47	9.93	0.29	0.01	0.66	12.44	0.20	0.29	0.46	0.65	12.27	9.85
	3b	16154	16093	1	0.08	0.58	0.17	3.92	12.56	0.29	0.10	0.76	15.22	2.53	0.31	0.58	0.80	16.14	12.66
I	1a	17087	17064	1	0.01	0.01	0.14	4.41	0.17	0.39	0.45	0.01	0.13	7.74	0.38	0.45	0.14	4.38	7.71
	2a	17088	17065	1	0.01	0.01	0.14	3.09	0.20	0.62	0.54	0.01	0.29	7.26	0.62	0.54	0.14	3.12	7.29
	3a	17084	17061	1	0.14	0.09	0.12	1.30	3.91	0.30	0.12	0.38	4.76	2.84	0.40	0.17	0.43	5.39	5.72
	1b	17086	17063	1	0.13	0.10	0.07	1.86	6.65	0.20	0.06	0.34	5.29	2.08	0.25	0.14	0.39	5.88	7.07
	2b	17089	17066	1	0.23	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
	3b	17085	17062	1	0.23	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
J	1a	18154	18093	1	0.08	0.42	0.16	3.56	9.06	0.34	0.12	0.77	15.55	3.34	0.31	0.46	0.70	13.97	10.39
	2a	18127	18068	1	0.02	0.36	0.03	0.67	7.80	0.31	0.04	0.57	10.25	0.79	0.32	0.36	0.58	10.62	7.80
	3a	18100	18040	1	0.07	0.37	0.16	3.51	7.76	0.32	0.13	0.72	14.27	3.54	0.38	0.35	0.81	16.31	7.98
	1b	18151	18092	1	0.15	0.25	0.12	1.18	2.23	0.14	0.06	0.56	2.18	1.72	0.19	0.26	0.53	2.37	2.85
	2b	18124	18067	1	0.02	0.20	0.02	0.17	1.87	0.12	0.02	0.58	3.84	0.18	0.13	0.20	0.58	3.84	1.83
	3b	18097	18044	1	0.11	0.20	0.13	1.13	1.81	0.14	0.07	0.53	2.19	1.70	0.19	0.19	0.63	2.88	2.83
K	3	19004	19005	1	0.01	0.52	0.02	0.23	20.36	0.04	0.01	0.83	1.67	0.07	0.04	0.52	0.82	1.64	20.33
	2	20004	20005	1	0.04	0.49	0.16	1.01	29.71	0.15	0.02	0.86	2.07	0.22	0.15	0.50	0.85	2.43	29.67
	1	21004	21005	1	0.04	0.76	0.06	5.01	13.81	0.15	0.00	0.21	12.99	0.29	0.15	0.76	0.20	13.41	13.77
L	1	22004	22005	1	0.00	0.81	0.02	2.13	11.41	0.04	0.00	0.21	13.62	0.03	0.04	0.81	0.21	13.55	11.39
	2	23004	23005	1	0.00	0.80	0.08	6.58	12.30	0.01	0.00	0.22	14.46	0.15	0.02	0.80	0.27	18.73	12.34
	3	24004	24005	1	0.00	0.25	0.54	1.17	1.73	0.00	0.25	0.54	1.17	1.73	0.00	0.25	0.54	1.17	1.73

115 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Insulator Forces at the Base - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	1	1002	1002	0	0.00	0.48	0.11	8.49	11.65	0.01	0.00	0.20	15.51	0.51	0.01	0.48	0.22	16.90	11.58
	2	2002	2002	0	0.00	0.48	0.04	2.24	12.12	0.02	0.00	0.19	13.89	0.17	0.02	0.48	0.20	14.59	12.07
	3	3002	3002	0	0.04	0.48	0.11	8.49	12.12	0.07	0.00	0.20	15.51	0.49	0.10	0.48	0.19	14.75	12.04
B	3	4002	4002	0	0.04	0.48	0.20	2.95	30.25	0.09	0.12	0.38	3.52	1.29	0.12	0.50	0.53	5.62	29.13
	2	5002	5002	0	0.01	0.40	0.04	0.49	21.80	0.04	0.04	0.40	3.25	0.52	0.04	0.39	0.41	3.47	21.54
	1	6002	6002	0	0.08	0.56	0.20	2.79	14.28	0.11	0.20	0.45	3.63	2.47	0.12	0.52	0.46	3.62	13.20
C	1a	7095	7043	0	0.04	0.67	0.34	3.09	17.65	0.02	0.18	0.76	7.19	4.43	0.04	0.59	0.74	7.09	15.81
	2a	7122	7066	0	0.01	0.26	0.07	0.68	9.05	0.07	0.07	0.56	5.79	1.44	0.07	0.28	0.58	5.86	8.74
	3a	7149	7091	0	0.06	0.36	0.35	4.14	9.76	0.10	0.18	0.62	7.44	3.97	0.14	0.40	0.89	10.74	10.78
	1b	7101	7041	0	0.23	0.30	0.25	3.94	7.36	0.55	0.20	0.58	9.07	5.67	0.55	0.30	0.55	8.79	7.57
	2b	7128	7065	0	0.05	0.33	0.05	0.85	8.20	0.40	0.08	0.47	7.43	1.91	0.41	0.31	0.49	7.62	7.53
	3b	7155	7090	0	0.29	0.34	0.32	5.00	8.21	0.53	0.26	0.56	8.83	7.02	0.75	0.42	0.81	12.81	10.59
	1c	7098	7039	0	0.21	0.38	0.28	0.66	5.41	0.33	0.10	0.62	1.11	4.32	0.36	0.37	0.60	1.25	6.02
	2c	7125	7064	0	0.02	0.30	0.07	0.09	5.37	0.05	0.06	0.62	0.25	1.01	0.05	0.29	0.65	0.27	5.17
	3c	7152	7089	0	0.24	0.42	0.35	0.83	5.84	0.35	0.13	0.60	1.29	4.52	0.46	0.44	0.87	1.63	7.87
D	1a	8011	8038	0	0.18	0.11	0.23	6.80	8.93	0.48	0.27	0.12	5.27	22.48	0.45	0.25	0.24	7.52	20.30
	2a	8007	8034	0	0.06	0.03	0.20	8.45	2.55	0.61	0.29	0.03	2.09	23.84	0.63	0.30	0.19	7.73	24.89
	3a	8003	8030	0	0.26	0.14	0.24	7.68	11.53	0.46	0.27	0.12	5.31	22.04	0.61	0.33	0.25	8.72	27.55
	1b	8009	8037	0	0.06	0.08	0.30	12.84	6.69	0.27	0.22	0.06	2.50	17.18	0.26	0.23	0.30	13.26	18.41
	2b	8005	8033	0	0.01	0.00	0.25	12.60	0.29	0.33	0.23	0.02	1.21	18.21	0.33	0.23	0.25	12.53	18.14
	3b	8001	8029	0	0.07	0.08	0.27	9.95	6.33	0.26	0.21	0.06	2.89	16.60	0.29	0.25	0.30	10.28	19.74
E	1a	9152	9089	0	0.19	0.39	0.08	0.77	7.75	0.27	0.09	0.46	0.63	3.01	0.35	0.42	0.51	1.02	8.72
	2a	9125	9064	0	0.01	0.30	0.01	0.06	6.52	0.11	0.03	0.46	0.15	0.60	0.11	0.30	0.45	0.17	6.53
	3a	9098	9039	0	0.16	0.35	0.09	0.63	7.33	0.24	0.08	0.43	0.57	2.90	0.27	0.34	0.42	0.79	6.77
	1b	9155	9090	0	0.14	0.39	0.11	1.89	9.94	0.35	0.15	0.45	6.72	4.09	0.40	0.43	0.51	7.79	11.12
	2b	9128	9065	0	0.01	0.35	0.01	0.16	8.87	0.25	0.05	0.38	5.64	1.11	0.25	0.35	0.38	5.59	8.80
	3b	9101	9041	0	0.11	0.32	0.09	1.55	8.37	0.32	0.15	0.41	6.14	3.92	0.34	0.33	0.40	5.92	8.64
	1c	9149	9091	0	0.02	0.37	0.12	1.83	10.55	0.09	0.10	0.45	5.53	2.46	0.10	0.38	0.52	6.37	11.14
	2c	9122	9066	0	0.00	0.29	0.01	0.16	8.18	0.09	0.04	0.39	4.29	0.77	0.09	0.29	0.39	4.23	8.37
	3c	9095	9043	0	0.03	0.63	0.12	1.41	15.89	0.12	0.07	0.48	4.80	2.11	0.12	0.62	0.49	4.72	14.99
F	3	10002	10002	0	0.04	0.36	0.07	2.39	8.29	0.08	0.04	0.34	10.08	2.16	0.09	0.37	0.35	11.03	7.88
	2	11002	11002	0	0.00	0.25	0.00	0.21	19.36	0.04	0.01	0.33	9.67	0.34	0.04	0.25	0.33	9.56	19.07
	1	12002	12002	0	0.03	0.37	0.06	1.82	28.88	0.17	0.01	0.32	9.73	0.68	0.18	0.38	0.32	10.22	28.38
G	1	13002	13002	0	0.03	0.33	0.12	3.07	7.36	0.18	0.01	0.40	10.23	0.51	0.19	0.34	0.46	11.90	7.37
	2	14002	14002	0	0.00	0.36	0.04	0.92	5.13	0.06	0.00	0.38	10.97	0.09	0.06	0.36	0.38	10.87	5.06
	3	15002	15002	0	0.01	0.41	0.11	3.31	4.82	0.03	0.01	0.38	11.35	0.38	0.03	0.41	0.40	12.47	5.09
H	1a	16095	16043	0	0.03	0.44	0.14	2.68	12.38	0.07	0.05	0.56	9.16	1.10	0.09	0.45	0.64	10.50	12.54
	2a	16122	16066	0	0.00	0.39	0.02	0.32	9.89	0.07	0.01	0.48	6.83	0.31	0.07	0.39	0.47	6.71	10.05
	3a	16149	16091	0	0.03	0.42	0.15	2.72	11.71	0.08	0.05	0.55	9.23	1.11	0.08	0.44	0.60	10.03	11.56
	1b	16101	16041	0	0.09	0.46	0.15	3.79	12.33	0.30	0.08	0.65	15.32	2.46	0.34	0.48	0.74	17.38	12.79
	2b	16128	16065	0	0.01	0.38	0.02	0.47	9.93	0.30	0.01	0.54	12.44	0.20	0.30	0.37	0.54	12.27	9.85
	3b	16155	16090	0	0.09	0.47	0.16	3.92	12.56	0.30	0.09	0.65	15.22	2.53	0.32	0.47	0.68	16.14	12.66
	1c	16098	16039	0	0.11	0.21	0.11	1.05	3.22	0.19	0.04	0.41	1.88	1.27	0.23	0.21	0.46	2.18	3.45
	2c	16125	16064	0	0.01	0.15	0.01	0.06	2.24	0.09	0.00	0.42	2.89	0.08	0.09	0.15	0.42	2.91	2.22
	3c	16152	16089	0	0.11	0.21	0.11	0.98	3.21	0.20	0.04	0.40	1.77	1.25	0.23	0.21	0.41	1.92	3.33
I	1a	17082	17053	0	0.15	0.13	0.13	7.46	10.49	0.31	0.14	0.47	29.92	5.35	0.32	0.18	0.44	28.14	9.81
	2a	17080	17051	0	0.01	0.02	0.24	13.74	1.10	0.63	0.63	0.02	1.24	41.88	0.63	0.63	0.23	13.58	41.94
	3a	17078	17049	0	0.15	0.13	0.15	8.45	9.84	0.30	0.14	0.45	28.77	5.96	0.41	0.21	0.50	31.98	12.17
	1b	17083	17054	0	0.14	0.09	0.08	3.55	9.49	0.19	0.07	0.32	15.99	1.41	0.21	0.12	0.32	16.78	9.11
	2b	17081	17052	0	0.14	0.14	0.08	5.23	12.59	0.21	0.07	0.42	26.97	2.86	0.25	0.17	0.48	31.42	14.60
	3b	17079	17050	0	0.14	0.14	0.08	5.23	12.59	0.21	0.07	0.42	26.97	2.86	0.25	0.17	0.48	31.42	14.60
J	1a	18152	18089	0	0.14	0.17	0.10	1.18	2.23	0.13	0.05	0.44	2.18	1.72	0.17	0.18	0.41	2.37	2.85
	2a	18125	18064	0	0.02	0.13	0.01	0.17	1.87	0.13	0.01	0.46	3.84	0.18	0.13	0.13	0.46	3.84	1.83
	3a	18098	18039	0	0.10	0.13	0.10	1.13	1.81	0.12	0.05	0.42	2.19	1.70	0.17	0.13	0.50	2.88	2.83
	1b	18155	18090	0	0.08	0.34	0.14	3.56	9.06	0.34	0.11	0.66	15.55	3.34	0.31	0.39	0.59	13.97	10.39
	2b	18128	18065	0	0.02	0.29	0.03	0.67	7.80	0.31	0.03	0.46	10.25	0.79	0.32	0.29	0.47	10.62	7.80
	3b	18101	18041	0	0.08	0.29	0.14	3.51	7.76	0.33	0.12	0.61	14.27	3.54	0.38	0.29	0.69	16.31	7.98
	1c	18149	18091	0	0.02	0.32	0.13	2.55	8.45	0.07	0.05	0.58	9.30	1.30	0.06	0.34	0.52	8.41	8.83
	2c	18122	18066	0	0.00	0.23	0.03	0.47	8.26	0.06	0.02	0.42	5.07	0.48	0.06	0.24	0.43	5.32	8.42
	3c	18095	18043	0	0.04	0.60	0.14	2.41	17.00	0.08	0.03	0.61	8.02	0.80	0.10	0.60	0.68	9.20	16.98
K	3	19002	19002	0	0.04	0.30	0.07	2.74	9.52	0.07	0.02	0.30	8.29	0.71	0.10	0.30	0.32	8.81	9.86
	2	20002	20002	0	0.01	0.28	0.01	0.41	16.04	0.04	0.00	0.29	7.68	0.11	0.04	0.28	0.29	7.44	16.01
	1	21002	21002	0	0.04	0.31	0.05	2.08	25.55	0.15	0.01	0.30	8.21	0.33	0.15	0.31	0.29	8.45	25.48
L	1	22002	22002	0	0.04	0.28	0.16	3.62	7.76	0.15	0.01	0.37	10.19	0.25	0.15	0.28	0.40	10.20	7.72
	2	23002	23002	0	0.00	0.30	0.06	1.52	5.64	0.04	0.00	0.37	10.86	0.03	0.04	0.30	0.38	10.73	5.63
	3	24002	24002	0	0.00	0.34	0.18	5.05	5.49	0.01	0.00	0.38	11.69	0.13	0.02	0.34	0.50	14.84	5.51

Appendix C (500 kV Bay)

Mode Shapes

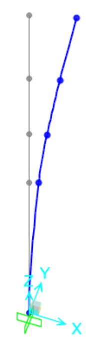

Figure C1: 12' Insulator Pedestals (f_x = 4.3 Hz)

Figure C2: 12' Insulator Pedestals (f_y = 4.3 Hz)

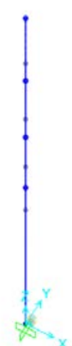

Figure C3: 12' Insulator Pedestals (f_z = 131.4 Hz)

Figure C4: Surge Arrester (f_x = 6.3 Hz)

Figure C5: Surge Arrester (f_y = 6.3 Hz)

Figure C6: Surge Arrester (f_z = 141.2 Hz)

Figure C7: CCVT (f_x = 2.5 Hz)

Figure C8: CCVT (f_y = 2.5 Hz)

Figure C9: CCVT (f_z = 29.3 Hz)

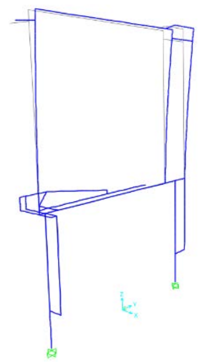

Figure C10: 3000 Amp Disconnect Switch on Steel Supports (f_x = 3.5 Hz)

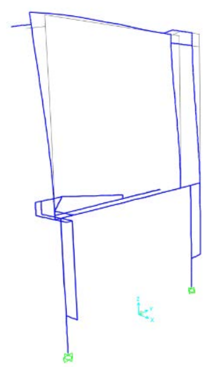

Figure C11: 3000 Amp Disconnect Switch on Steel Supports (f_y = 5.5 Hz)

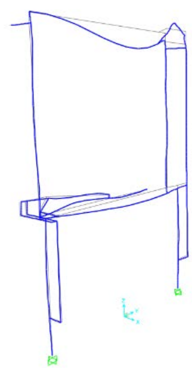

Figure C12: 3000 Amp Disconnect Switch on Steel Supports (f_z = 121.6 Hz)

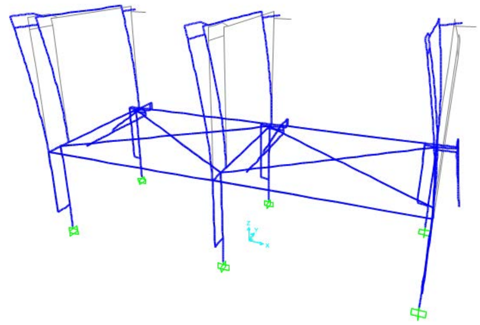

Figure C13: 3000 Amp Disconnect Switch on Concrete Supports (f_x = 3.9 Hz)

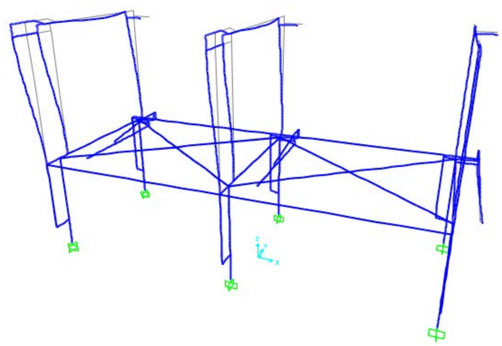

Figure C14: 3000 Amp Disconnect Switch on Concrete Supports (f_y = 5.6 Hz)

Figure C15: ELF SP7-2 Live Tank Circuit Breaker (f_x = 1.2 Hz)

Figure C16: ELF SP7-2 Live Tank Circuit Breaker (f_y = 1.1 Hz)

Figure C17: ELF SP7-2 Live Tank Circuit Breaker (f_z = 59.9Hz)

Figure C18: Current Transformer (f_x = 1.0 Hz)

Figure C19: Current Transformer (f_y = 1.0 Hz)

Figure C20: Current Transformer (f_z = 67.4 Hz)

Time-History Data

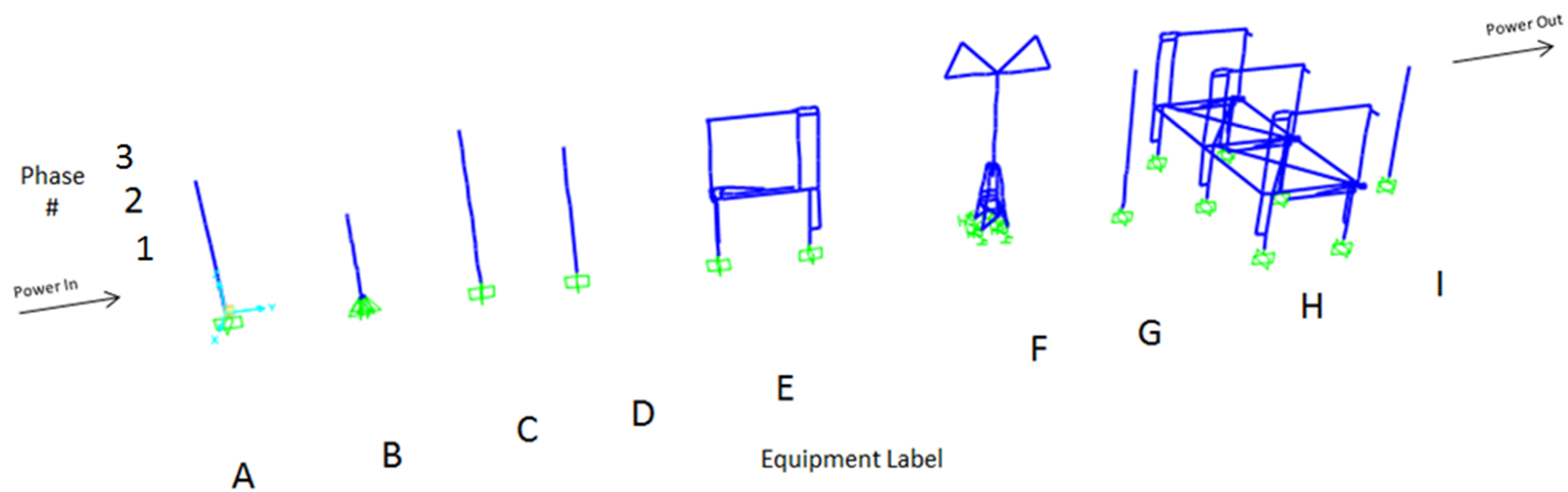

Figure C21: 500 kV Bay Equipment Label Key

500 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Displacements - INDIVIDUAL MODELS

Equipment Label	Phase #	Node #	X-Dir. Only	Y-Dir. Only	XYZ-Dir. Combined		
			X (in)	Y (in)	X (in)	Y (in)	Z (in)
A	2	2005	1.44	1.60	1.43	1.60	0.00
B	2	5013	0.62	0.75	0.62	0.75	0.00
C	2	8012	4.69	5.11	4.69	5.11	0.01
D	2	11005	1.44	1.60	1.43	1.60	0.00
E	2a	14015	0.00	0.01	0.87	1.63	0.00
	2b	14019	0.00	0.00	0.92	2.59	0.01
F	2a	17071	11.66	9.02	11.66	9.01	7.41
	2b	17068	11.66	9.02	11.64	9.01	7.41
G	2	20009	6.79	7.96	6.79	7.96	0.00
H	1a	22058	0.03	0.01	0.92	2.49	0.01
	1b	22054	0.03	0.01	0.86	1.48	0.00
	2a	22014	0.00	0.00	0.93	2.48	0.01
	2b	22010	0.00	0.00	0.88	1.49	0.00
	3a	22102	0.03	0.01	0.94	2.48	0.01
	3b	22098	0.03	0.00	0.89	1.48	0.00
I	2	24005	1.44	1.60	1.43	1.60	0.00

Note: Red text indicates displacements greater than 6"

500 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Displacements - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Node #	X-Dir. Only	Y-Dir. Only	XYZ-Dir. Combined		
			X (in)	Y (in)	X (in)	Y (in)	Z (in)
A	2	2005	1.43	1.59	1.43	1.59	0.00
B	2	5013	0.63	0.75	0.63	0.75	0.00
C	2	8012	4.69	5.11	4.69	5.11	0.00
D	2	11005	1.43	1.59	1.43	1.59	0.00
E	2a	14015	0.00	0.01	0.87	1.63	0.00
	2b	14019	0.00	0.00	0.93	2.59	0.01
F	2a	17071	11.66	9.02	11.66	9.01	7.41
	2b	17068	11.66	9.02	11.64	9.01	7.41
G	2	20009	6.79	7.96	6.79	7.96	0.00
H	1a	22058	0.03	0.01	0.92	2.48	0.01
	1b	22054	0.03	0.01	0.86	1.48	0.00
	2a	22014	0.00	0.00	0.93	2.47	0.01
	2b	22010	0.00	0.00	0.88	1.49	0.00
	3a	22102	0.03	0.00	0.94	2.47	0.01
	3b	22098	0.03	0.00	0.89	1.48	0.00
I	2	24005	1.43	1.59	1.43	1.59	0.00

Note: Red text indicates displacements greater than 6"

500 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Member Forces at Base - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	2	2001	2001	0	0.00	1.46	0.00	0.00	315.96	0.00	0.00	1.63	351.40	0.00	0.00	1.46	1.63	351.40	315.96
B	2a	5010	5002	1	0.85	25.62	0.43	0.00	0.00	0.59	17.66	0.90	0.00	0.00	0.81	24.41	1.23	0.00	0.00
	2b	5011	5003	1	0.85	25.62	0.43	0.00	0.00	0.59	17.66	0.90	0.00	0.00	1.27	38.32	0.68	0.00	0.00
	2c	5012	5004	1	0.00	0.00	0.87	0.00	0.00	1.17	35.32	0.00	0.00	0.00	1.17	35.32	0.87	0.00	0.00
C	2	8001	8001	0	0.00	2.70	0.00	0.00	653.22	0.00	0.00	3.40	746.22	0.00	0.00	2.70	3.40	746.23	653.22
D	2	11001	11001	0	0.00	1.46	0.00	0.00	315.96	0.00	0.00	1.63	351.40	0.00	0.00	1.46	1.63	351.40	315.96
E	2a	14051	14044	0	0.01	2.02	0.01	1.09	454.20	3.84	0.02	3.34	248.64	2.50	3.84	2.01	3.34	248.44	452.83
	2b	14001	14002	0	0.02	0.01	3.72	734.97	0.90	3.85	1.54	0.01	1.10	210.58	3.85	1.54	3.73	735.25	210.28
F	2a	17033	17003	0	35.84	2.08	0.04	0.00	0.00	24.85	0.07	4.63	0.00	0.00	54.39	2.14	4.61	0.00	0.00
	2b	17010	17002	0	35.11	0.09	5.58	0.00	0.00	25.57	1.71	0.05	0.00	0.00	43.53	1.62	5.59	0.00	0.00
	2c	17042	17040	0	35.10	0.09	5.58	0.00	0.00	25.58	1.75	0.05	0.00	0.00	43.81	1.66	5.59	0.00	0.00
	2d	17001	17001	0	35.84	2.08	0.04	0.00	0.00	24.85	0.07	4.59	0.00	0.00	54.27	2.15	4.56	0.00	0.00
G	2	20001	20001	0	0.00	3.70	0.00	0.00	1162.92	0.00	0.00	4.34	1363.88	0.00	0.00	3.70	4.34	1363.88	1162.92
H	1a	22103	22086	0	0.55	3.61	1.09	95.22	716.65	3.40	0.05	1.49	298.82	6.05	3.27	3.63	1.83	304.72	719.01
	1b	22100	22085	0	0.54	4.52	1.09	88.75	706.10	3.39	0.04	3.80	343.70	3.76	3.24	4.53	3.82	340.97	707.64
	2a	22051	22042	0	0.03	3.49	0.02	1.36	700.40	3.41	0.01	1.48	298.18	1.02	3.26	3.49	1.47	297.51	700.67
	2b	22048	22041	0	0.02	4.64	0.02	5.64	719.77	3.39	0.01	3.80	344.34	1.22	3.51	4.64	3.81	347.44	719.47
	3a	22155	22130	0	0.51	3.61	1.07	93.67	716.68	3.40	0.05	1.49	298.64	5.14	3.51	3.59	2.03	345.69	714.81
	3b	22152	22129	0	0.50	4.52	1.11	98.42	706.63	3.38	0.05	3.79	343.57	5.86	3.63	4.51	4.35	393.41	704.52
I	2	24001	24001	0	0.00	1.46	0.00	0.00	315.96	0.00	0.00	1.63	351.40	0.00	0.00	1.46	1.63	351.40	315.96

500 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Forces - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	2	2004	2005	1	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.38	0.42	0.00	0.00
B	2	5009	5013	1	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.16	0.19	0.00	0.00
C	2	8011	8012	1	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.51	0.59	0.00	0.00
D	2	11004	11005	1	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.38	0.42	0.00	0.00
E	2a	14030	14015	1	0.00	0.00	0.67	5.08	0.01	0.15	0.48	0.01	0.03	17.25	0.15	0.48	0.67	5.10	17.25
	2b	14011	14019	1	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.06	0.00	0.01	0.02	0.01	0.06
F	2a	17079	17071	1	0.01	0.01	1.13	3.51	0.06	0.74	1.37	0.00	0.01	5.53	0.74	1.51	1.13	3.50	6.08
	2b	17054	17069	0	0.01	0.01	1.13	3.51	0.06	0.74	1.37	0.00	0.01	5.53	0.74	1.47	1.13	3.50	6.03
G	2	20007	20009	1	0.00	3.66	0.00	0.00	0.00	0.00	0.00	4.29	0.00	0.00	0.00	3.66	4.29	0.00	0.00
H	1a	22059	22058	1	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.06	0.00	0.01	0.02	0.01	0.06
	1b	22078	22054	1	0.00	0.01	0.70	4.00	0.38	0.15	0.49	0.00	0.04	17.59	0.15	0.49	0.69	4.03	17.41
	2a	22007	22014	1	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.06	0.00	0.01	0.02	0.01	0.06
	2b	22026	22010	1	0.00	0.00	0.69	3.98	0.01	0.15	0.49	0.00	0.01	17.64	0.15	0.49	0.69	3.99	17.63
	3a	22111	22102	1	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.06	0.00	0.01	0.02	0.01	0.06
	3c	22130	22098	1	0.00	0.01	0.70	4.00	0.38	0.15	0.49	0.00	0.02	17.58	0.15	0.49	0.70	3.99	17.75
I	2	24004	24005	1	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.38	0.42	0.00	0.00

500 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Insulator Forces at the Base - SYSTEM MODEL without RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	2	2002	2002	0	0.00	1.23	0.00	0.00	105.11	0.00	0.00	1.36	116.90	0.00	0.00	1.23	1.36	116.90	105.11
B	2	5004	5001	0	0.00	2.77	0.00	0.00	365.88	0.00	0.00	3.32	437.22	0.00	0.00	2.77	3.32	437.22	365.88
C	2	8006	8006	0	0.00	2.53	0.00	0.00	377.39	0.00	0.00	2.97	414.64	0.00	0.00	2.53	2.97	414.64	377.39
D	2	11002	11002	0	0.00	1.23	0.00	0.00	105.11	0.00	0.00	1.36	116.90	0.00	0.00	1.23	1.36	116.90	105.11
E	2a	14024	14012	0	0.00	0.00	1.16	143.64	0.14	0.15	1.15	0.01	0.79	111.91	0.15	1.15	1.16	143.51	111.86
	2b	14023	14011	0	0.00	0.00	1.72	177.04	0.13	2.98	1.94	0.00	0.19	162.10	2.98	1.94	1.72	176.97	162.08
	2c	14022	14010	0	0.00	0.00	1.47	133.00	0.10	3.13	1.48	0.00	0.14	102.73	3.13	1.48	1.47	132.92	102.72
F	2	17027	17061	0	0.00	10.71	0.07	6.74	2277.01	0.00	0.02	7.43	1689.64	4.28	2.78	10.70	7.46	1688.56	2274.59
G	2	20008	20006	0	0.00	3.66	0.00	0.00	829.99	0.00	0.00	4.29	973.42	0.00	0.00	3.66	4.29	973.42	829.99
H	1a	22070	22049	0	0.05	0.03	1.35	145.85	1.76	3.31	1.54	0.00	0.40	107.62	3.28	1.53	1.35	145.99	106.89
	1b	22071	22050	0	0.05	0.04	1.69	192.37	3.12	3.15	2.01	0.00	0.50	168.53	3.13	2.00	1.69	192.64	167.16
	1c	22072	22051	0	0.01	0.03	1.24	146.33	2.23	0.15	1.17	0.01	0.98	114.11	0.15	1.16	1.24	146.37	113.52
	2a	22018	22005	0	0.00	0.00	1.34	145.79	0.06	3.32	1.54	0.00	0.11	107.94	3.31	1.54	1.34	145.84	107.86
	2b	22019	22006	0	0.00	0.00	1.68	192.24	0.11	3.16	2.02	0.00	0.15	169.02	3.15	2.02	1.68	192.30	168.90
	2c	22020	22007	0	0.00	0.00	1.25	146.94	0.09	0.15	1.17	0.00	0.35	114.43	0.15	1.17	1.25	147.00	114.47
	3a	22122	22093	0	0.05	0.03	1.35	145.85	1.68	3.30	1.54	0.00	0.29	107.59	3.32	1.55	1.35	145.82	108.17
	3b	22123	22094	0	0.05	0.04	1.69	192.37	2.98	3.15	2.01	0.00	0.40	168.49	3.16	2.02	1.69	192.20	169.62
	3c	22124	22095	0	0.00	0.03	1.24	146.32	2.31	0.15	1.16	0.00	0.33	114.08	0.15	1.17	1.24	146.41	114.75
I	2	24002	24002	0	0.00	1.23	0.00	0.00	105.11	0.00	0.00	1.36	116.90	0.00	0.00	1.23	1.36	116.90	105.11

500 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Displacements - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Node #	X-Dir. Only	Y-Dir. Only	XYZ-Dir. Combined		
			X (in)	Y (in)	X (in)	Y (in)	Z (in)
A	2	2005	1.47	1.39	1.47	1.39	0.00
B	2	5013	0.48	0.73	0.48	0.73	0.00
C	2	8012	4.71	1.80	4.71	1.79	0.00
D	2	11005	1.80	1.51	1.80	1.51	0.00
E	2a	14015	0.00	0.00	1.54	1.51	0.00
	2b	14019	0.00	0.00	1.64	2.81	0.02
F	2a	17071	8.43	3.52	8.42	3.52	2.78
	2b	17068	8.21	3.52	8.21	3.52	2.74
G	2	20009	13.85	3.81	13.85	3.81	0.00
H	1a	22058	0.02	0.05	0.89	2.41	0.01
	1b	22054	0.02	0.04	0.84	1.48	0.00
	2a	22014	0.00	0.00	3.09	3.40	0.03
	2b	22010	0.00	0.00	2.82	1.78	0.00
	3a	22102	0.02	0.05	0.91	2.44	0.01
	3b	22098	0.02	0.04	0.86	1.49	0.00
I	2	24005	1.54	2.54	1.54	2.54	0.00

Note: Red text indicates displacements greater than 6"

500 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Member Forces at Base - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	2	2001	2001	0	0.00	1.46	0.00	0.10	316.59	0.15	0.00	1.57	323.28	0.36	0.15	1.46	1.57	322.02	316.71
B	2a	5010	5002	1	0.64	19.44	0.46	0.00	0.00	0.51	16.43	0.78	0.00	0.00	0.82	25.19	1.10	0.00	0.00
	2b	5011	5003	1	0.64	19.44	0.46	0.00	0.00	0.51	16.43	0.78	0.00	0.00	0.84	26.59	0.90	0.00	0.00
	2c	5012	5004	1	0.00	0.01	0.86	0.00	0.00	1.02	32.82	0.00	0.00	0.00	1.02	32.79	0.86	0.00	0.00
C	2	8001	8001	0	0.00	3.26	0.00	0.18	731.15	0.15	0.00	2.54	445.15	0.24	0.15	3.26	2.52	442.25	731.19
D	2	11001	11001	0	0.00	1.49	0.00	0.13	324.26	0.39	0.01	1.66	348.32	1.23	0.39	1.49	1.65	346.44	324.44
E	2a	14051	14044	0	0.01	1.66	0.00	0.71	386.34	6.29	0.01	5.34	393.69	1.19	6.29	1.66	5.36	394.76	386.57
	2b	14001	14002	0	0.01	0.00	2.68	584.16	0.44	5.71	1.75	0.01	1.13	308.53	5.72	1.74	2.68	583.91	309.88
F	2a	17033	17003	0	18.64	2.00	3.22	0.00	0.00	14.69	0.03	2.08	0.00	0.00	24.59	1.99	3.83	0.00	0.00
	2b	17010	17002	0	18.64	1.21	5.22	0.00	0.00	14.61	0.77	0.03	0.00	0.00	23.56	1.39	5.21	0.00	0.00
	2c	17042	17040	0	18.47	1.25	4.62	0.00	0.00	14.63	0.78	0.03	0.00	0.00	23.87	1.49	4.61	0.00	0.00
	2d	17001	17001	0	19.15	1.76	3.19	0.00	0.00	14.71	0.03	2.06	0.00	0.00	24.03	1.76	3.68	0.00	0.00
G	2	20001	20001	0	0.01	7.61	0.00	0.19	2375.76	0.56	0.00	3.14	713.77	0.88	0.56	7.61	3.14	713.96	2375.31
H	1a	22103	22086	0	0.47	2.46	0.93	81.12	596.01	2.98	0.90	2.57	303.36	103.76	3.02	2.89	2.89	311.01	648.20
	1b	22100	22085	0	0.47	3.45	0.94	77.44	593.43	2.97	0.80	3.78	337.55	92.52	2.97	3.40	3.78	330.52	589.54
	2a	22051	22042	0	0.03	2.55	0.02	1.18	574.16	6.38	0.01	3.99	340.85	0.93	6.37	2.54	4.01	338.54	573.42
	2b	22048	22041	0	0.03	3.21	0.02	5.85	595.14	7.33	0.03	5.36	502.47	3.07	7.32	3.22	5.36	504.31	597.00
	3a	22155	22130	0	0.43	2.46	0.90	79.51	595.97	2.98	0.90	2.57	303.19	104.95	3.03	2.37	3.08	344.83	597.57
	3b	22152	22129	0	0.43	3.46	0.97	85.35	594.04	2.97	0.79	3.78	337.95	90.99	3.09	3.89	4.21	371.68	644.59
I	2	24001	24001	0	0.00	1.41	0.00	0.36	316.44	0.45	0.00	2.32	517.80	0.12	0.45	1.41	2.31	514.64	316.48

500 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Terminal Pad Forces - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	2	2004	2005	1	0.00	0.51	0.00	0.01	15.92	0.15	0.00	0.53	14.78	0.02	0.15	0.51	0.53	14.75	15.92
B	2	5009	5013	1	0.00	0.46	0.00	0.01	61.65	0.06	0.00	0.51	45.27	0.05	0.06	0.46	0.50	45.34	61.66
C	2	8011	8012	1	0.00	0.43	0.00	0.01	9.24	0.15	0.00	0.89	44.53	0.01	0.15	0.43	0.88	44.42	9.24
D	2	11004	11005	1	0.00	0.74	0.00	0.01	27.24	0.39	0.00	0.67	22.02	0.05	0.39	0.74	0.67	22.01	27.22
E	2a	14030	14015	1	0.00	0.00	0.62	7.02	0.01	0.31	1.30	0.00	0.04	43.49	0.31	1.30	0.62	7.03	43.45
	2b	14011	14019	1	0.00	0.00	0.43	2.54	0.00	0.57	0.61	0.00	0.00	5.70	0.56	0.61	0.43	2.54	5.69
F	2a	17079	17071	1	0.00	0.02	0.79	84.54	0.25	4.54	1.51	0.00	0.10	143.68	4.53	1.77	0.79	84.50	144.94
	2b	17054	17069	0	0.02	0.01	1.21	62.64	0.39	2.14	0.94	0.00	0.09	149.69	2.26	1.22	1.21	62.66	149.61
G	2	20007	20009	1	0.01	7.50	0.00	0.25	30.14	0.56	0.00	2.99	246.70	0.04	0.56	7.50	2.99	247.31	30.10
H	1a	22059	22058	1	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.06	0.00	0.01	0.02	0.01	0.06
	1b	22078	22054	1	0.00	0.01	0.66	3.97	0.34	0.14	0.49	0.02	0.27	17.40	0.14	0.49	0.65	3.80	17.28
	2a	22007	22014	1	0.00	0.00	1.07	5.78	0.00	0.09	0.28	0.00	0.00	2.81	0.09	0.28	1.07	5.78	2.83
	2b	22026	22010	1	0.00	0.00	0.89	3.32	0.05	0.10	2.69	0.00	0.01	88.44	0.10	2.70	0.89	3.32	88.38
	3a	22111	22102	1	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.06	0.00	0.01	0.02	0.01	0.06
	3c	22130	22098	1	0.00	0.01	0.66	3.97	0.34	0.14	0.49	0.02	0.29	17.40	0.15	0.49	0.66	4.16	17.53
I	2	24004	24005	1	0.00	0.48	0.00	0.02	5.10	0.45	0.00	1.63	31.28	0.01	0.45	0.48	1.62	31.19	5.10

500 kV Bay - Time History Analysis (IEEE 693) - 0.5 g
Insulator Forces at the Base - SYSTEM MODEL with RIGID BUS

Equipment Label	Phase #	Frame #	Associated Node #	At Frame End	X-Dir. Only					Y-Dir. Only					XYZ-Dir. Combined				
					Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in	Axial kips	Shear 2 kips	Shear 3 kips	Moment 2 kip-in	Moment 3 kip-in
A	2	2002	2002	0	0.00	1.20	0.00	0.03	109.12	0.15	0.00	1.25	103.65	0.11	0.15	1.20	1.25	103.54	109.07
B	2	5004	5001	0	0.00	2.07	0.00	0.07	277.64	0.06	0.00	2.87	406.46	0.44	0.06	2.07	2.87	406.17	277.83
C	2	8006	8006	0	0.00	2.95	0.00	0.06	394.77	0.15	0.00	2.14	193.72	0.11	0.15	2.96	2.12	192.81	394.79
D	2	11002	11002	0	0.00	1.12	0.00	0.03	136.80	0.39	0.00	1.41	113.82	0.37	0.39	1.12	1.40	113.74	136.59
E	2a	14024	14012	0	0.00	0.00	1.16	136.86	0.04	0.31	1.74	0.00	0.37	185.16	0.31	1.73	1.16	136.83	185.72
	2b	14023	14011	0	0.00	0.00	1.41	176.50	0.07	8.44	2.97	0.00	0.12	268.64	8.42	2.98	1.41	176.53	268.53
	2c	14022	14010	0	0.00	0.00	1.17	134.56	0.04	7.66	2.12	0.00	0.11	168.60	7.64	2.13	1.17	134.60	168.55
F	2	17027	17061	0	0.01	5.77	0.04	3.30	1224.82	1.10	0.02	5.39	742.79	2.19	2.91	5.76	5.41	744.71	1223.63
G	2	20008	20006	0	0.01	7.50	0.00	0.19	1691.41	0.56	0.00	2.99	431.98	0.61	0.56	7.50	2.99	431.86	1691.09
H	1a	22070	22049	0	0.05	0.02	1.33	142.38	1.59	3.32	1.54	0.02	2.49	107.95	3.30	1.53	1.32	141.49	107.52
	1b	22071	22050	0	0.05	0.03	1.58	194.62	2.79	3.16	2.01	0.02	2.92	168.05	3.15	1.99	1.57	193.85	167.12
	1c	22072	22051	0	0.00	0.02	1.19	146.24	1.75	0.15	1.16	0.04	4.20	114.17	0.15	1.15	1.19	145.78	113.59
	2a	22018	22005	0	0.01	0.00	1.59	162.49	0.16	15.58	3.89	0.00	0.05	324.71	15.58	3.88	1.59	162.52	324.35
	2b	22019	22006	0	0.01	0.00	1.93	227.06	0.24	16.43	5.53	0.00	0.07	513.14	16.43	5.52	1.93	227.07	512.61
	2c	22020	22007	0	0.00	0.00	1.42	175.83	0.29	0.10	3.03	0.00	0.14	346.87	0.10	3.03	1.42	175.80	346.75
	3a	22122	22093	0	0.05	0.02	1.33	142.37	1.50	3.31	1.54	0.02	2.58	107.92	3.33	1.55	1.33	143.37	108.33
	3b	22123	22094	0	0.04	0.03	1.58	194.62	2.63	3.16	2.01	0.02	2.96	168.01	3.17	2.02	1.59	195.49	168.86
	3c	22124	22095	0	0.00	0.02	1.19	146.23	1.83	0.15	1.16	0.04	4.80	114.15	0.15	1.17	1.20	146.82	114.80
I	2	24002	24002	0	0.00	1.20	0.00	0.08	113.87	0.45	0.00	2.05	196.01	0.04	0.45	1.20	2.05	195.77	113.89