

always be securely connected at the ground end before connection is made to the conductor. Grounds must always be removed by first detaching the connection at the conductor and, then, detaching the connection at the ground end. When grounding to a steel structure, the ground must not be applied to a flat surface unless an appropriate flat surface clamp is used.

- 4.4.7 CNP does not ground Customer-owned substation equipment except for work being performed by CNP.

#### 4.5 Switching 345kV Facilities Equipped with Ferroresonance Protection

- 4.5.1 Ferroresonance protection is installed whenever a wound potential transformer (PT) is connected to 345kV and the possibility of a ferroresonance condition occurring exists. If applicable, the Customer will implement specific procedures for switching 345kV equipment that has ferroresonance protection installed.

**Procedures will include the following:**

Place the sync handle in position for the last breaker that will be opened.

Monitor the potential lights on all three phases before and after the last breaker is opened.

1. If one or more of the lights do not dim immediately but gets brighter:
  - immediately close the last breaker opened to reenergize the bus
  - investigate the ferroresonance protection
2. If all three lights dim immediately:
  - reset the targets (flags) on the ferroresonance protection relays
3. If relay targets did not operate:
  - investigate the ferroresonance protection circuit

#### 4.6 Terminology for Switching Orders

Time - Military time, or 24 hour clock, based on prevailing Central Time.

Check Ring for Close - Verify by visual inspection that all devices in the ring are in the closed position.

Remove / Roll Loads - Remove all loads connected to a power transformer. This may be done by tripping applicable low side breakers or by rolling load to an adjacent transformer and tripping applicable low side breakers.

Trip - Initiate and complete an opening operation on a device.

Close - Initiate and complete a closing operation on a device.

Hold Tag - A tag placed on a device to indicate it shall not be operated. The tag will indicate the party who placed the tag.

Trip and Hold - Trip device, physically or mechanically (e.g., affix padlock) disable device from closing, and place a Hold Tag on the device.

Check for Trip and Hold - Verify by visual inspection that a device is in the trip position and place a Hold Tag on the device.

Secure Against Operation (SAO) - Physically, mechanically, and/or electrically disable a device (e.g., a motor operated disconnect switch) to prevent it from operating.

Secondary Potential Fuse (SPF) - Remove and tag fuses on the secondary side of potential devices to prevent the possibility of back energizing isolated equipment.



4.7 Switching Order

**SWITCHING**

**ORDER #** \_\_\_\_\_

**SUBSTATION** \_\_\_\_\_

**EQUIPMENT** \_\_\_\_\_

**OUT**

**RESTORE**

**DISP** \_\_\_\_\_ **DISP.** \_\_\_\_\_

**TIME** \_\_\_\_\_ **TIME** \_\_\_\_\_

**DATE** \_\_\_\_\_ **DATE** \_\_\_\_\_

**EXEC. BY** \_\_\_\_\_ **EXEC. BY** \_\_\_\_\_

**TIME** \_\_\_\_\_ **TIME** \_\_\_\_\_

**CLEARANCE #** \_\_\_\_\_

**ISSUED**

**RELEASED**

**DISP.** \_\_\_\_\_ **DISP.** \_\_\_\_\_

**TIME** \_\_\_\_\_ **TIME** \_\_\_\_\_

**DATE** \_\_\_\_\_ **DATE** \_\_\_\_\_

**ISSUED TO** \_\_\_\_\_

**NUMBER OF MEN** \_\_\_\_\_ **AND GROUNDS** \_\_\_\_\_

**ON** \_\_\_\_\_

**INSTRUCTIONS**

\_\_\_\_\_  
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**SWITCHING PROCEDURES DISCUSSED WITH ALL MEMBERS OF CREW:**      Y      N

**CREW INITIALS** \_\_\_\_\_



#### 4.8 Transmission Switching Check List

4.8.1 The following basic procedures are for the day of the switching after the outage has been scheduled with and authorized by the RTO System Scheduler (713-207-2196). This applies to the customer substation that is directly interconnected with CNP's transmission system.

- Call the RTO System Controller at 281-894-0491 and request a Switching Order
  - Provide name, company affiliation, and telephone number
  - Provide Substation ID
  - Describe reason for request
  - Fill out Switching Order
    - Record the Switching Order number
    - Record start time provided by the RTO System Controller
    - Record the RTO System Controller's name
    - Record the instructions to take equipment OUT
    - Repeat the instructions
- Execute the Switching Order placing Hold Tags where appropriate
- Call the RTO System Controller when the instructions have been completed
  - Report the actual completion time
  - Record the completion time provided by the RTO System Controller on Switching Order
  - Request a Clearance if necessary
    - Provide the number of personnel in the crew
    - Provide the number of and location of grounds
- Verify apparatus is de-energized with a hot line indicator
- Install protective grounds when required
- Perform work
- Remove protective grounds if installed
- Call the RTO System Controller to request to RESTORE equipment
  - Report whether more than one Hold Tag is on any device
  - Provide Clearance number if applicable
    - Provide the number of personnel in the crew clear of the apparatus
    - Provide the number of grounds removed
  - Provide the Switching Order number
  - Fill out Switching Order
    - Record start time provided by the RTO System Controller
    - Record the RTO System Controller's name
    - Discuss performing Switching Order instructions in reverse order
- Alert all personnel to move to a safe distance from apparatus being energized
- Execute the Switching Order removing Hold Tags where appropriate
- Call the RTO System Controller when restoration has been completed
  - Report the actual completion time
  - Record the completion time provided by the RTO System Controller on Switching Order





## 6 Unplanned Outages

### 6.1 Unplanned Outages

- 6.1.1 ERCOT Protocols require that CNP notify ERCOT of all unplanned transmission outages.
- 6.1.2 The Customer will contact the RTO System Controller as soon as possible whenever any unplanned tripping of any high voltage (60kV and higher) circuit breaker occurs. CNP crews will be dispatched when high voltage circuit breakers remain open in the customer substation that is directly interconnected with CNP's transmission system. CNP crews will reset relay targets except in emergency situations. A "Forced Outage Check List" form is included in this document.
- 6.1.3 CNP crews are not dispatched when high voltage circuit breakers remain open in a remote, non-CNP, substation connected to a Customer's substation but not directly interconnected with the CNP system. In such a case, the Customer will discuss and evaluate the event with the RTO System Controller. The Customer will notify the RTO System Controller prior to any switching.
- 6.1.4 In the event of an unplanned generation outage, the Customer or his designated representative will advise CNP's RTO System Controller as soon as possible.

### 6.2 Unplanned Outages of 345kV Facilities Equipped with Ferroresonance Protection

- 6.2.1 Ferroresonance protection is installed whenever a wound potential transformer (PT) is connected to a 345kV and the possibility of a ferroresonance condition occurring exists. If applicable, the Customer will implement specific procedures for unplanned tripping of 345kV equipment that has ferroresonance protection installed. Procedures will include the following.
  - Visually inspect the potential transformer lights on all three phases
  - If one or more of the lights are bright and not dim
    - Open all the breaker disconnect switches to isolate the potential transformers
    - Disconnect/Remove the PT(s) from service on the phases with the bright lights
  - If one or more of the lights are dark and not dim
    - Open all the breaker disconnect switches along the affected bus
    - Disconnect/Remove the PTs from service on the phases with the dark lights
  - If remote monitoring of potential transformer voltages indicated a ferroresonance condition occurred
    - Open all the breaker disconnect switches to isolate the potential transformers
    - Disconnect/Remove the PT(s) from service on the phases that indicated ferroresonance
  - If all three lights are dim
    - Reset the targets on the ferroresonance protection relays
  - If relay targets do not indicate proper action
    - Investigate the ferroresonance protection circuit



### 6.3 Emergency Switching

6.3.1 In emergency situations, switching may be performed prior to a CNP crew arriving at a Customer's incoming substation. A qualified person, authorized by the Customer, may operate breakers and switches based upon switching instructions provided by the RTO System Controller. Prior to switching, all relay trip targets will be reset after the Customer has recorded them and reported them to the RTO System Controller. All personnel will move to a safe distance from apparatus being energized prior to switching. An "Emergency Switching Check List" form is included in this document.

#### 6.3.2 UNPLANNED OUTAGE CHECK LIST

6.3.3 The following basic procedures are for whenever any unplanned tripping of any transmission service voltage breaker occurs.

- Call the RTO System Controller Hot Line at 281-894-1625
- Provide the following information to the RTO System Controller
  - Your name, company affiliation, and telephone number
  - Substation ID
  - Nature of the problem
  - Time of outage
  - Status of all breakers and switches (i.e., open, closed, tagged)
  - Cause of the event if known
  - Fault location and faulted equipment if known
  - Fires and their proximity to energized equipment
  - Plant and substation entry constraints (e.g., chemical releases)
- Record the RTO System Controller's name
- Investigate and provide the following information to the RTO System Controller
  - Cause of the event if found during investigation
  - Fault location and faulted equipment if found during investigation
  - Number of trip operations for each breaker (i.e., change in breaker veeder reading)
  - Relay trip targets - Do not reset targets
- Discuss outage with CNP crews
- CNP crews record and reset relay trip targets
- CNP crews record breaker veeder readings
- Resolve outage and complete any necessary corrective action
  - Call the RTO System Controller at 281-894-0491 to request to RESTORE equipment
  - Record the instructions to RESTORE equipment
  - Repeat the instructions
- Execute the instructions
- Call the RTO System Controller when instructions have been completed

BY: \_\_\_\_\_ DATE: \_\_\_\_\_



#### 6.4 EMERGENCY SWITCHING CHECK LIST

6.4.1 The following basic procedures are for emergency situations. Contact the RTO System Controller at one of the following telephone numbers.

- Call the RTO System Controller Hot Line at 281-894-1625
- Provide the following information to the RTO System Controller
  - Your name, company affiliation, and telephone number
  - Substation ID
  - Nature of the problem
  - Time of outage
  - Status of all breakers and switches (i.e., open, closed, tagged)
  - Cause of the event if known
  - Fault location and faulted equipment if known
  - Fires and their proximity to energized equipment
  - Plant and substation entry constraints (e.g., chemical releases)
  - Relay trip targets
- Record the RTO System Controller's name
- Record the instructions to RESTORE equipment
- Reset relay trip targets
- Execute the instructions
- Call the RTO System Controller at 281-894-0491 when instructions have been completed

BY: \_\_\_\_\_ DATE: \_\_\_\_\_.

#### 6.5 Other Emergency Conditions

6.5.1 Customer substations are an integral part of the interconnected transmission system and disabling them has an impact on the electrical grid. In certain emergency situations, Customer's may evacuate or shut down their facility. In such cases, the Customer shall endeavor to keep the portion of their substation that is directly connected to the transmission grid in service, unless specifically directed otherwise by ERCOT or CNP's RTO System Controller or other responsible personnel.



## 7 Generation Operation

### 7.1 Applicability

- 7.1.1 This section applies only if the Customer operates electric generating facilities and participates in the wholesale transmission market. The Customer will follow the ERCOT Operating Guides and ERCOT Protocols or other regulatory requirements that apply to their facilities

### 7.2 Unit Operation

- 7.2.1 Where CNP owns the interconnecting substation and there is not an in-line breaker to synchronize a generating unit, the Customer will have control of CNP's substation breakers that are functioning as generator breakers. CNP will have operational control of the disconnect switches associated with these breakers.
- 7.2.2 The Customer will have generation control personnel on duty at the generating unit site at all times that the generating units are on-line.
- 7.2.3 The Customer or Customer's representative will notify the RTO System Controller (281-894-0491) immediately before a unit is synchronized and connected to CNP's transmission system. The Customer will report forced unit outages.
- 7.2.4 The Customer will operate units to support the transmission system voltage by regulating reactive power output up to levels demonstrated in the ERCOT tests as required in the ERCOT Protocols. The Customer will maintain the ERCOT specified voltage level unless otherwise directed by the RTO System Dispatcher or ERCOT. If ERCOT specifies a maximum voltage in addition to the recommended level, the Customer will maintain the maximum voltage only during light system load conditions. If the ERCOT does not specify a voltage level, the Customer will provide reactive support based on instructions provided by ERCOT or the RTO System Dispatcher.
- 7.2.5 The Customer's voltage regulators, speed governors and power system stabilizers, if required by ERCOT, will be in service whenever generating units are on-line. The Customer will immediately notify the ERCOT Real Time Desk whenever a voltage regulator, speed governor or power system stabilizer is taken out of service or placed back in service. The Customer will maintain settings as close as practical to five percent speed regulation.
- 7.2.6 The Customer will maintain generating units on-line during system under-frequency conditions to the standards set forth in Section 2.6.2 of the current ERCOT Operating Guides: [www.ercot.com/mktrules/guides/noperating/cur](http://www.ercot.com/mktrules/guides/noperating/cur) .

## 8 Protective Relay Settings

### 8.1 Settings for Relays Installed for the Protection and Automatic Reclosing of CNP Transmission Lines

- 8.1.1 CNP will calculate and implement all settings for customer owned relays installed for the protection and automatic reclosing of CNP transmission lines and for customer owned relays installed to prevent back-energizing CNP's system from



generation installed on the low side of Customer power transformers. On a case-by-case basis, CNP may issue settings for other Customer owned relays. The relay settings implemented by CNP for the Customer's owned relays will be provided to the Customer upon request.

## 8.2 Applicable Relay Settings

8.2.1 The Customer will provide CNP with the settings of Customer owned relays that trip or close any Customer owned high voltage (60kV and higher) circuit breakers. The Customer will provide to the Transmission Accounts representative any proposed settings changes for such relays for CNP's review.

## 8.3 Communications Connections to Electronic Devices

8.3.1 An electronic device that can directly or indirectly trip a circuit breaker connected to a CenterPoint Energy transmission circuit is not allowed to be monitored via routable protocol communication (i.e. Ethernet) or dial-up communication. Monitoring of this electronic device for metering data or event data (or any communications processor connected to this electronic device) is only allowed via a serial port (Modbus, DNP3 or SEL Fast Meter). Control command(s) are not allowed through the serial port.

# 9 Equipment Additions, Replacement, Upgrades and Removal

## 9.1 Notify CNP of Equipment Changes

9.1.1 The Customer must notify the Transmission Accounts representative with sufficient notice to meet the timeline and data reporting requirements in Table 2 below when equipment additions or removals are planned or when high voltage equipment or associated equipment requires modification or replacement.

9.1.2 The Customer will provide equipment and installation per applicable CNP specifications and bill of materials. The Customer will provide necessary details (e.g., drawings, specifications, and manufacturer type and catalog number) for CNP's review. All CNP comments must be incorporated or resolved before any equipment or materials are procured or any work is begun.

9.1.3 ERCOT Protocols require that all changes to equipment rated at 60 kV and above be communicated by CNP to ERCOT prior to the in-service date as specified in Table 2 below.

9.1.4 ERCOT shall only approve energization requests when the transmission element is satisfactorily modeled in the ERCOT Network Operations Model.

## 9.2 Modification, Repair, and Replacement of Customer Equipment

9.2.1 CNP will notify the Customer of problems in their facilities of which CNP becomes aware. The Customer will provide any needed equipment modifications, repairs, or replacement within an appropriate time frame. The Customer will replace equipment that CNP demonstrates is no longer maintainable. On a case-by-case basis, the Customer and CNP will develop the responsibilities for the modification, repair, and replacement of this equipment.



9.2.2 Industry experience may dictate that certain equipment be modified, repaired, or replaced due to manufacturing defects or unacceptable failure rates and consequences. The Customer will, within an appropriate time frame, modify, repair, or replace equipment based on manufacturer issued product service advisories or CNP issued advisories.

### Customer Substation Equipment Additions, Relocations, Upgrades and/or Removals

When installing, relocating, or upgrading transmission system equipment, Customers must contact their appropriate CenterPoint Energy Transmission Accounts representative with sufficient notice to meet the timelines and data requirements shown below. ERCOT Nodal Protocols section 3.10.1 requires that all changes to transmission equipment energized at 60 kV and above be communicated by CNP to ERCOT using the Network Operations Model Change Request (NOMCR) process as summarized below:

Table 2

Target Physical Equipment In-Service Month	Deadline to Submit to RTO	Timeline to Submit initial information to Transmission Accounts Rep
Month of January	Sept. 1	June 1 (prior year)
Month of February	Oct. 1	July 1 (prior year)
Month of March	Nov. 1	August 1 (prior year)
Month of April	Dec. 1	September 1 (prior year)
Month of May	Jan. 1	October 1 (prior year)
Month of June	Feb. 1	November 1 (prior year)
Month of July	Mar. 1	December 1 (prior year)
Month of August	Apr. 1	January 1
Month of September	May 1	February 1
Month of October	June 1	March 1
Month of November	July 1	April 1
Month of December	Aug. 1	May 1

(1) CNP will require the following information to meet the deadlines shown above. The NOMCR data requirements include, but are not limited to (per Nodal Protocol 3.3.2.1):

- Completed project expected in-service date
- equipment ratings
- device nomenclature will be provided by CNP
- Engineering drawings showing the final configuration.
- Construction sequence with expected energization dates for each piece of equipment.
- Identification of SCADA data points
- Additional data as may be determined by ERCOT



## Transmission & Substation Outage and Clearance Coordination Procedures

- (2) Known outage requests must be submitted by Real Time Operations with the NOMCR's for each expected energization date.
- (3) **ERCOT shall only approve energization requests when the Transmission Element is satisfactorily modeled in the ERCOT Network Operations Model.**

## 10 Equipment Maintenance

### 10.1 CNP Maintenance

- 10.1.1 CNP will perform periodic testing of certain Customer equipment if the equipment is installed for the protection of CNP transmission lines. This includes power line carrier tuning and testing of wave traps, tuners, and carrier sets and calibration and testing of relays and fiber optic communication equipment. CNP will perform periodic calibration and testing of SCADA (Supervisory Control and Data Acquisition) transducers that provide real time data to CNP. CNP may designate additional Customer equipment for maintenance by CNP. CNP will label equipment maintained by CNP.
- 10.1.2 CNP will endeavor to coordinate CNP maintenance with the Customer's maintenance outages.
- 10.1.3 CNP transmission line outages are required for CNP to perform testing of applicable Customer wave traps.
- 10.1.4 Outages of approximately ten hours duration for certain Customer facilities are required for CNP's periodic maintenance of any CNP high voltage metering instrument transformers. Transformer outages are required for metering instrument transformers installed on the high side of transformers. A total separation from CNP's system may be required for certain substation configurations.

### 10.2 Customer Maintenance

- 10.2.1 The Customer will perform periodic inspections and preventive maintenance on all structures and equipment owned by the Customer except for equipment designated by CNP for maintenance by CNP. The Customer will not perform preventive maintenance on the equipment maintained by CNP. The Customer will maintain equipment logs and test reports, which will be provided to CNP upon request.
- 10.2.2 Depending upon ownership, equipment maintained by the Customer may include the following: line surge arresters, potential and current transformers not owned by CNP, coupling capacitors, coupling capacitor potential devices, switches (including auxiliary contacts and motors if installed), breakers (bushings, mechanism, tanks), transformers (bushings, surge arresters, main tank, load tap changer, alarms), relays not tested by CNP, and DC Battery system equipment.
- 10.2.3 The Customer will notify the RTO System Scheduler at least ten (10) working days in advance before performing maintenance on potential or current transformers connected to CNP meters.



### 10.3 Monthly Inspections

10.3.1 The Customer will perform monthly inspections to include the following as applicable.

- Visual inspection of outdoor equipment including inside control cabinets
- Verify oil levels
- Verify transformer nitrogen blanket pressure
- Verify transformer fan operation
- Verify breaker compressor or hydraulic pump operation
- Drain condensate from breaker mechanism air tanks
- Verify operation of control house heating and air conditioning

### 10.4 Quarterly, Semi-annual Testing and Inspection

10.4.1 CNP recommends Total Combustible Gas (TCG) testing once every three months on transformers equipped with a nitrogen blanket.

10.4.2 Infrared thermography of high voltage equipment is recommended once every six months.

### 10.5 DC Battery System

10.5.1 The Customer will perform periodic DC battery system equipment inspections and maintenance to include the following as applicable.

- Every Month
  - Visually inspect batteries (corroded connections, leaks, cracked cases)
  - Visually inspect chargers
  - Verify and correct water levels
  - Record and verify float voltage
  - Record and verify ground reference voltage
- Every Six Months
  - Clean battery surfaces
  - Check charger ventilation
  - Record and verify cell voltages
  - Perform cell impedance testing
  - Measure connection resistance
  - Record and verify specific gravity reading on a single pilot cell
  - Verify float and equalize voltage settings
  - Verify proper operation of chargers and alarms
  - Verify proper operation of high voltage shutdown circuits

## 10.6 Functional Testing

10.6.1 The Customer and/or CNP will perform functional trip testing following substation additions or modifications. Each high voltage breaker will be tripped and closed from the breaker control switch at least once every year. This breaker tripping, as well as functional trip testing, may be coordinated with the switching required for maintenance outages. The Customer will notify the RTO System Scheduler, by Noon Wednesday of the week prior to the planned maintenance before performing functional testing and allow CNP to witness the testing.

10.6.2 High voltage circuit breakers equipped with dual trip coils that use a common actuating shaft (e.g., Allis Chalmers, Westinghouse) require special functional testing. The Customer will perform a test on each breaker by applying trip voltage simultaneously to both trip coils. If the breaker does not immediately trip, the voltage must be quickly removed to avoid damaging the coils. After verifying the wiring, the Customer will appropriately label the control wiring. The Customer's maintenance procedures will include tagging and properly reconnecting trip coil wiring. The Customer will perform this test whenever a trip coil is replaced or breaker control wiring is modified.

## 10.7 Special Inspection and Testing

10.7.1 Industry experience may dictate that certain equipment requires special inspection and testing due to manufacturing defects or unacceptable failure rates and consequences. The Customer will perform special inspection and testing based on manufacturer issued product service advisories and CNP issued advisories.

## **11 Plant Design Considerations**

### **11.1 Emergency Systems**

11.1.1 Continuous electric service from utility power systems cannot be guaranteed even for facilities that are connected to a large number of transmission lines. The possibility exists that a total power outage or separation from the utility system may occur. It is important to consider this when plant emergency systems are designed.

### **11.2 Automatic Reclosing**

11.2.1 CNP utilizes automatic reclosing of high voltage circuit breakers following unplanned tripping of CNP transmission lines. CNP endeavors to intentionally delay the initial reclose attempt by at least one second. The Customer is responsible for the separation of necessary motors or other equipment within one second of the tripping.

### **11.3 System Voltage**

11.3.1 Electric service from a utility power system cannot be guaranteed against fluctuations. A common fluctuation is a voltage sag that occurs during the time of a fault. The large majority of faults on a utility transmission system are single line-to-ground faults. With automatic reclosing of circuit breakers, several voltage sags can occur within a one-minute period. Most voltage sags from faults on transmission systems have a very short duration of less than ten cycles with high-speed fault clearing. Another common fluctuation is a transient voltage oscillation that occurs each time a capacitor bank is energized. Equipment, such as motor contractors, adjustable speed drives, programmable logic controllers, and high intensity discharge lamps, can be sensitive to these short duration voltage sag and transient voltage oscillation.

11.3.2 It is important to consider voltage sag "ride-through" for equipment applied to critical processes where nuisance tripping can cause a whole process to shut down. Plant power systems and equipment control systems can be designed or modified to ride-through the most common voltage sags and transient voltage oscillations on utility power systems. CNP will provide additional information upon request.

### **11.4 Electrical Protection Coordination Studies**

11.4.1 Customers typically perform plant electrical protection coordination studies from time to time. The Customer may contact a Transmission Accounts representative to request the available CNP system fault current and system impedance at the Customer's facility.

### **11.5 Substation Design Specifications**

11.5.1 The Customer can contact a Transmission Accounts representative to request current CNP specifications and applicable bills of material for new substations and substation equipment additions and replacement.



**Exhibit "G"**  
**Attached Drawings**

**PAGES CONTAINING CRITICAL ENERGY  
INFRASTRUCTURE INFORMATION (CEII) REDACTED  
FOR PUBLIC FILING.**

**Exhibit "H"**  
**Specification for Customer 138 kV Substation Design**

**5-8-2006 Addendum to**  
Spec. No. 007-231-14 Rev. 14 7-22-2005  
**SPECIFICATION FOR**  
**CUSTOMER 138 kV SUBSTATION DESIGN**  
**CENTERPOINT ENERGY**  
**SUBSTATION OPERATION DEPARTMENT**  
**P.O. BOX 1700 HOUSTON, TEXAS 77251**

Date	Original Version	Revision	Comments
5-8-06	a. Table of Contents (TOC) b. REFERENCE DRAWINGS not included in this document	a. Added missing TOC items 4 & 8 b. Added drawings to end of this document	a. Updated Table of Contents b. Reference drawings included

**SPECIFICATION  
FOR  
CUSTOMER  
138 kV SUBSTATION  
DESIGN**

**CENTERPOINT ENERGY  
SUBSTATION OPERATIONS DEPARTMENT  
P.O. BOX 1700 HOUSTON, TEXAS 77251**

**REFERENCE DRAWINGS:** Latest revision of  
CenterPoint Energy 004-241-01, Customer-Owned Substation Line Termination Standard  
CenterPoint Energy 171-190-06, 138 kV Standard, Instrument Transformer Standard  
CenterPoint Energy 581-500-01, 138 kV Potential Transformer Schematic and Wiring Diagram

**REFERENCE DOCUMENT:** Latest revision of  
Operation of a Customer Owned Substation on CenterPoint Energy's Transmission System

**REFERENCE SPECIFICATIONS:** Latest revision of  
CenterPoint Energy 007-231-78, Specification for Cogenerator Connected to CenterPoint Energy Trans. System  
CenterPoint Energy 007-400-02, Specification for Remote Telemetry of a Customer-Owned Facility

**REFERENCE STANDARDS:** Latest revision of

AASHTO	IEEE C57.12.00
ACI 318	IEEE C57.13
AISC, "Manual of Steel Construction"	IEEE C2 (NESC)
ASCE 10	IEEE Std. 80
ANSI C12.1	IEEE Std. 519
ANSI C37.32	IEEE Std. 837
ANSI C37.06	IEEE Std. 1119
IEEE C37.04	IEEE Std. 998
IEEE C37.40	IEEE Std. 142
IEEE C37.60	NEMA CC 1

<b>CENTERPOINT ENERGY HOUSTON, TEXAS</b>									
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14	7-22-2005	Change to 4000A and other updates	Var	Var	DRS				
<b>NO</b>	<b>DATE</b>	<b>ITEMS REVISED</b>	<b>BY</b>	<b>CH</b>	<b>APP</b>	SPECIFICATION NO. 007 231 14			

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# CenterPoint Energy SPECIFICATION FOR CUSTOMER 138 KV SUBSTATION DESIGN

## 1. SCOPE

- 1.1. This specification covers design criteria for 138 kV customer-owned substations connected to the CenterPoint Energy Houston Electric, LLC (CenterPoint Energy) transmission system.

## 2. GENERAL

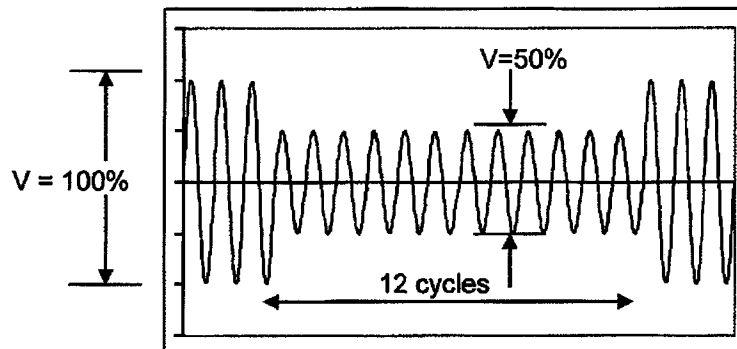
- 2.1. Any customer that is approved by CenterPoint Energy to receive service from the CenterPoint Energy 138 kV transmission system is required to provide a substation capable of accepting that service from CenterPoint Energy. The customer's substation becomes an integral part of the CenterPoint Energy transmission system network and therefore has a significant impact on overall system reliability. Consequently, the customer is obligated not only to meet present CenterPoint Energy specifications, but also to modify the substation in the future as the CenterPoint Energy transmission system continues to evolve. When deemed necessary by CenterPoint Energy, changes may be needed to conform to industry standards, transmission system characteristics, and CenterPoint Energy practices or to take advantage of technological advances which will maintain the present reliability of the substation.
- 2.2. All equipment shall be in accordance with designated standards of this specification, the American National Standards Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), the American Society of Civil Engineers (ASCE), the American Institute of Steel Construction (AISC), National Electrical Manufacturing Association, (NEMA) and the American Concrete Institute (ACI). In the event of conflicting requirements, the order of precedence shall be this specification, ANSI, IEEE, ASCE, AISC, NEMA and ACI Standards. All electrical clearances shall comply with the latest version of the National Electric Safety Code (NESC).
- 2.3. This specification is not intended to be totally comprehensive. To ensure the efficient coordination between CenterPoint Energy and the customer during the design and construction of the customer's substation, CenterPoint Energy requires that engineering documents be submitted to CenterPoint Energy for review before certain equipment is ordered or construction begins. All items requiring CenterPoint Energy review are listed in Article 15.0 of this specification and shall be submitted in writing to the designated Project Coordinator, or designated representative.
- 2.4. Any deviations from this specification or CenterPoint Energy reviewed project drawings shall require written acceptance by the responsible CenterPoint Energy Project Coordinator.
- 2.5. All labor and equipment shall be furnished by the customer unless otherwise noted in this specification.
- 2.6. Unless otherwise stated in this specification:
  - 2.6.1. CenterPoint Energy will provide only functional reviews of complete and final drawings and schematics,
  - 2.6.2. CenterPoint Energy will not verify or correct customer's point-to-point wiring, and
  - 2.6.3. CenterPoint Energy will require specific tests which are to be conducted by the customer to verify the proper operation and coordination of the substation's protection and control equipment.
- 2.7. CenterPoint Energy reserves the right to refuse to energize any service which fails to meet this specification.

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- 2.8. The customer will coordinate the operation of their high voltage facilities with CenterPoint Energy's Real Time Operations Division per CenterPoint Energy's "Transmission & Substation Outage and Clearance Coordination Procedures" document.
- 2.9. It is the customer's responsibility to comply with the applicable laws, ordinances, codes, rules, and regulations established by the appropriate government entities.
- 2.10. Because the customer's substation becomes an integral part of the CenterPoint Energy transmission system network CenterPoint Energy requires access to the substation 7 days-a-week, 24 hours-a-day, 365 days-a-year. Access to the substation by CenterPoint Energy personnel should be considered when determining the location and plant operating procedures.

### 3. CENTERPOINT ENERGY SYSTEM CHARACTERISTICS

- 3.1. CenterPoint Energy's phase rotation is designated C-B-A counterclockwise and the customer shall phase his equipment accordingly. Connection of the customer's H<sub>1</sub>-H<sub>2</sub>-H<sub>3</sub> power transformer leads to CenterPoint Energy's C-B-A, B-A-C or A-C-B, respectively, is recommended.
- 3.2. The steady-state nominal system voltage is 138 kV +/- 5%, wye effectively grounded. Transient conditions exceeding this range may be encountered. See Sub-articles 3.4, 4.6 and 7.1.4 for additional relevant information.
- 3.3. Frequency, which ERCOT is responsible for maintaining, is nominally 60 Hz. Refer to ERCOT (www.ercot.com) Operating Guides and Protocols for information regarding frequency regulation.
- 3.4. The customer's equipment "voltage dip ride through" design criteria, that CenterPoint Energy suggests the customer utilize when designing and selecting plant equipment is illustrated in figure 3.1.



"V" represents the phase-to-neutral voltage at the customer's "load side" of a delta-wye transformer for a phase-to-ground fault at the "high side" of the transformer.

Figure 3.1

- 3.5. Multiple shot, staggered, relay supervised, automatic reclosing is utilized on the CenterPoint Energy transmission system. The first automatic reclosing attempt on CenterPoint Energy transmission line will occur a minimum of one second after the fault has cleared. The number of automatic reclosing attempts varies, but the total duration of the automatic reclosing sequence is typically one minute. The customer shall accordingly coordinate operation and protection of electric motors, computers and other plant equipment.

### 4. ELECTRICAL DESIGN CRITERIA



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4.1. The minimum acceptable electrical design characteristics are listed below:

Bus, Switch and Insulator Impulse Level                      650 kV BIL in a non-contaminated area  
 750 kV BIL or 650 kV BIL with extra creep in a  
 contaminated area

Note: CenterPoint Energy shall make determination of contaminated or non-contaminated area.

Transformer Winding Impulse Level                              550 kV BIL

Bus and Switch Insulator Leakage Distance                      132 in. creep (equivalent to 750 kV BIL or extra  
 creep 650 kV BIL)

Apparatus Bushing Leakage Distance  
 (circuit breakers, bushings, transformer  
 bushings, etc.)    92 in. creep (equivalent to 650 kV BIL)

Phase to Ground Clearance    52 in. (Metal to Metal)

Phase to Phase Bus Spacing  
 (including vertical spacing at crossover  
 point of high and low bus)    63 in. (Metal to Metal)

Phase to Phase Bushing Spacing (138 kV)                      84 in. (Center Line to Center Line)

Phase to Phase Horizontal Spacing  
 at Incoming Line Dead End Structure                              144 in. (Center Line to Center Line, regardless of  
 the line angle)

4.2. "Full loop" (ring bus or breaker-and-a-half) or "loop tap" are standard substation configurations allowed by CenterPoint Energy.

4.3. For "full loop" substations, "loop tap" substations or substations arranged for future "loop" service, the continuous current rating of all equipment in the substation "loop" and incoming transmission line positions (transmission line disconnect switches, line traps, etc.) shall be 4,000 A minimum, unless otherwise specified by CenterPoint Energy. For substations with four or more 138 kV transmission lines, the continuous current rating of equipment in the substation may be required to be greater than 4,000 A. The 138 kV substation shall be designed for a short circuit current of 63 kA rms symmetrical, with X/R ratio of 15.

4.4. A key interlock system is not permitted on 138 kV equipment.

4.5. The customer's connected load and equipment shall be designed and operated to adhere to the recommended harmonic limits of IEEE Std. 519.

4.6. The CenterPoint Energy flicker limit criteria for 138 kV customers is as follows:

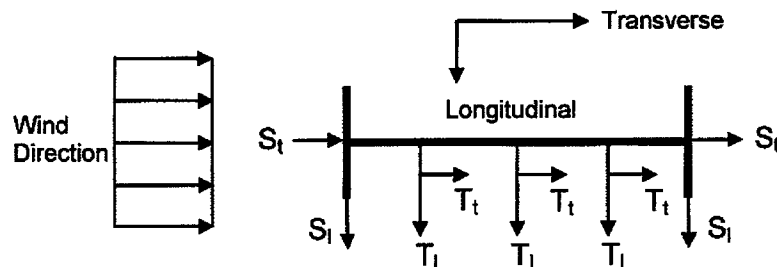
4.6.1. The operation of customer's equipment (starting of motors, furnaces, etc.) shall not produce a voltage dip greater than 2.0% at the customer's high side bus with one transmission line segment directly associated with the electrical supply to the customer substation out-of-service.

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- 4.6.2. If the starting of the customer's equipment produces a voltage dip greater than 1.5% at the customer's high side bus with all transmission line segments in-service, the customer shall contact CenterPoint Energy for further evaluation.
- 4.7. The substation ground mat shall be designed for a short circuit current of 63 kA rms symmetrical with X/R ratio of 15 and duration of 0.25 seconds and comply with IEEE Std. 80 and IEEE C2 (NESC). Ground mat connections shall comply with IEEE Std. 837.
- 4.8. The substation direct lightning stroke shielding design shall comply with IEEE Std. 998.

**5. STRUCTURAL AND MECHANICAL DESIGN CRITERIA**

- 5.1. The customer shall provide a complete structural and foundation design package for the dead-end structures (supporting the CenterPoint Energy transmission lines connected to the customer's 138 kV substation) and the instrument transformer stands in accordance with Article 15.0. The design package shall be signed and sealed by a registered professional engineer and shall include design references/codes, computer analysis, member design, connection design, foundation design, structural and foundation drawings, and all other information that documents the design of the structure(s).
- 5.2. Design shall be based upon loadings realistically combined to cause the most unfavorable effect upon the structure or component. Refer also to Sub-Article 5.4 and 5.5.5.
- 5.3. Structures shall meet the Strength Requirements of IEEE C2 (NESC), Section 26, for grade B construction.
- 5.4. The minimum acceptable structural design loading criteria shall be the more severe of the following two cases:
  - 5.4.1. Case 1 - Combined Ice and Wind Loading: Reference specification IEEE C2 (NESC); minimum allowable strength factors per Section 26, Table 261-1A or Table 261-1B; loading requirements per Section 25, Rule 250.B and Table 250-1; and loading components to be applied to the structure shall be according to Fig.5.1.



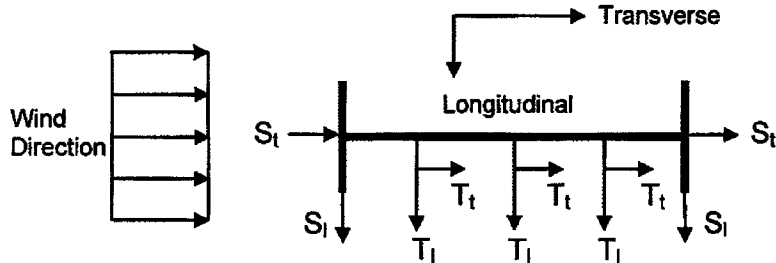
Wind and Ice loads are specified in Section 25 of ANSI/IEEE C2

<p><b>Static Wire</b>                  S<sub>l</sub> = 6.00 kips/wire longitudinally                  S<sub>t</sub> = 3.00 kips/wire transversely                  S<sub>v</sub> = 0.50 kips/wire vertically</p>	<p><b>Conductor Wire</b>                  T<sub>l</sub> = 10.0 kips/phase longitudinally                  T<sub>t</sub> = 5.00 kips/phase transversely                  T<sub>v</sub> = 1.50 kips/phase vertically</p>
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CASE 1 - Combined Ice and Wind Loading – Overhead View.  
 Static wire and conductor wire loading component (Overload capacity factors not included.)  
**Figure 5.1**

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5.4.2. Case 2 - Extreme Wind Loading: Reference specification; IEEE C2 (NESC) Section 25, Rule 250.C; minimum allowable strength factors per IEEE C2 (NESC), Section 26, Rule 260.C; and magnitude and direction of static wire and conductor wire loading components to be applied to the structure shall be according to Fig.5.2.



For Case 2 the following shall apply:  
 Basic Wind speed determined from wind map in, Exposure category C, Importance factor 1.0, Design wind pressure equation and coefficients per IEEE C2 (NESC) Rule 250.C in latest version.

Static Wire	Conductor Wire
Sl = 6.00 kips/wire longitudinally	Tl = 15.0 kips/phase longitudinally
St = 3.00 kips/wire transversely	Tt = 7.50 kips/phase transversely
Sv = 0.50 kips/wire vertically	Tv = 1.50 kips/phase vertically

CASE 2 - Extreme Wind Loading – Overhead View.  
 Static wire and conductor wire loading component: (Overload capacity factors not included.)  
 Refer to Sub-Article 8.1.2.4.1  
**Figure 5.2**

5.5. DEAD-END STRUCTURES

5.5.1. In the absence of specifically defined criteria by CenterPoint Energy, the following design criteria shall be used as default design values for dead-end structures.

5.5.1.1. The conductor height at attachment shall be 35 feet above the finished substation grade.

5.5.2. Customer shall design all attachment points to ensure that sufficient electrical clearance is maintained to the customer’s structure ground and equipment. CenterPoint Energy will extend the load carrying conductor to the first item of customer’s equipment or bus and will furnish, own and maintain all necessary fittings for terminating the line conductors including the tower fittings, suspension insulators, dead-end clamps and line conductor terminal fittings with NEMA standard four-hole flat pads (0.5625 in. diameter holes, 1.75 in. centers) for attachment to the first item of equipment or bus in the customer’s substation. CenterPoint Energy will also furnish stirrup clamps or other similar devices (such as a bar on the NEMA pad for ACSS conductors) on the line conductors as required for connection of surge arresters and potential transformers.

5.5.3. Customers shall provide pull-off plates (0.625 in. minimum thickness) for terminating the line conductors and which have a 0.8125 in. diameter chamfered hole at the center of a 1.50 in. radius rounding of the end of the plate. In addition, the customer shall provide pull-off plates (0.375 in. minimum thickness) for terminating the static wires and which have a 0.8125 in. diameter chamfered hole on a 1.50 in. radius rounding of the end of the plate. All pull-off plates must satisfy Equation 4.6-1 and 4.6-2 in ASCE 10. Details for division of ownership shall be in accordance with CenterPoint Energy Drawing 004-241-01.

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- 5.5.4. The height of the dead-end structure's conductor attachment shall be in accordance with the National Electric Safety Code (IEEE C2) or 35 ft whichever is greater, unless otherwise specified by CenterPoint Energy. The static wire height at attachment shall be at a sufficient elevation and position to provide a shield angle to the outside conductors of 30° and 45° between two adjacent static wires (see IEEE Std.142).
- 5.5.5. The installation of fiber optic cable may be required for transmission protective relaying and/or control purposes. The fiber optic cable installations will normally be installed underground. However, should an overhead installation be required, additional loadings will be imposed on the customer's dead end structure. Additional design information concerning the fiber optic cable will be supplied by CenterPoint Energy when fiber optic cable is to be used. Typically the connection for the fiber optic cable is at least 8 ft from the nearest conductor.

### 5.6. INSTRUMENT TRANSFORMER STANDS

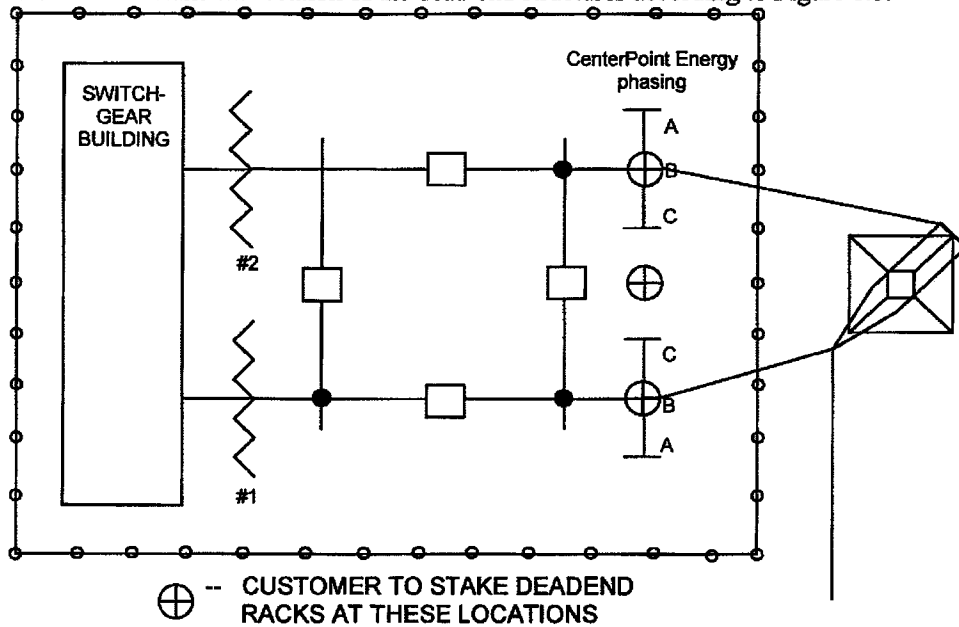
When high side metering is utilized, the customer shall provide stands for mounting CenterPoint Energy furnished instrument transformers and design and build foundations to support the stands. The design shall be in accordance with Sub-Articles 5.1 - 5.4 of this specification. The necessary design parameters are indicated on CenterPoint Energy Drawing 171-190-06.

## 6. SITE CRITERIA

- 6.1. Site preparation and plot plan drawings shall be submitted to CenterPoint Energy for comment. Facilities that must be shown on this drawing include dimensions of the substation site, access roadways, space between the substation and access roadways, walks, culverts and ditches. Refer to Article 15.0

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6.2. The customer shall stake the location of the dead-end structures according to Figure 6.1.



Staking Requirements for Typical Customer Substation  
Figure 6.1

- 6.3. An all weather access roadbed shall be provided to the substation capable of supporting heavy construction vehicles. The areas in substations that need to support heavy vehicular traffic should conform to AASHTO H20 loading.
- 6.4. Access for CenterPoint Energy to attach line conductors to the dead-end structures shall be provided by either:
  - 6.4.1. A 25 ft wide, level, and unobstructed access outside the substation site from a main road to the CenterPoint Energy right-of-way and in front of the dead-end structures with fencing a maximum of 20 ft from the attachment point of the dead-ends and a 13 ft (minimum) wide gate for access into the substation.
  - 6.4.2. A 25 ft wide access inside the substation from the substation access gate (20 ft wide minimum) to the front of the dead-ends with fencing a minimum of 25 ft from the attachment point.
- 6.5. Access and space shall be provided for installation and future replacement of high voltage equipment including metering instrument transformers.

**7. HIGH VOLTAGE EQUIPMENT**

**7.1. POWER TRANSFORMERS**

- 7.1.1. Power transformers shall conform to IEEE C57.12.00. In addition, sudden pressure and low oil level should be connected for alarming and tripping.
- 7.1.2. Power transformers shall have a minimum of two 600:5 A multi-ratio current transformers (CT's) per 138 kV bushing. Each CT shall have IEEE C57.13 accuracy C400 or better. Where

## CenterPoint Energy SPECIFICATION FOR CUSTOMER 138 KV SUBSTATION DESIGN

applications require additional CT's and/or different ratios, CenterPoint Energy shall provide ratios to support equipment purchase schedule. The secondary resistance of power transformer bushing CT's shall not exceed 0.0025  $\Omega$  per turn. CT secondary rated continuous current shall be 10 A minimum. Rating Factor (R.F.) shall equal 2.0.

- 7.1.3. High side surge arresters shall be provided in accordance with Sub-Article 7.4.
- 7.1.4. The customer shall determine the need for, and if applicable, settings for a tap changer for de-energized operation and/or on-load tap changer. CenterPoint Energy recommends automatic on-load tap changer.

### 7.2. CIRCUIT BREAKERS

- 7.2.1. Circuit breakers shall be of the three-pole, outdoor type, 138 kV nominal, in accordance with ANSI C37.06 and IEEE C37.60, C37.04 and C37.40.
- 7.2.2. Continuous current rating of 138 kV circuit breakers shall be 4,000 A, with a three phase symmetrical short circuit interrupting capability of 63 kA rms symmetrical. For substations with four or more 138 kV transmission lines, circuit breakers may be required to have a higher continuous rating. The rated interrupting time of the circuit breakers shall be three cycles or less. In some applications, the installation of TRV shaping capacitors may be required in order to achieve the circuit breaker interrupting capability of 63 kA rms symmetrical for line faults. CenterPoint Energy shall determine the placement of TRV shaping capacitors, when required.
- 7.2.3. Each 138 kV circuit breaker shall be equipped with two 4,000:5 A multi-ratio CT's per 138 kV bushing. Each CT shall have an accuracy of C800 on the 3,000:5 A tap in accordance with IEEE C57.13. The secondary resistance of circuit breaker bushing CT's shall not exceed 0.0025  $\Omega$  per turn. CT secondary rated continuous current shall be 10 A minimum. Rating Factor (R.F.) shall equal 2.0.
- 7.2.4. Two trip coils shall be provided with independent 125 VDC control circuits. If both trip coils operate a single armature, both coils shall be designed or marked in such a way as to prevent their being connected in a manner that would result in the breaker not tripping in the event that both coils are energized simultaneously.
- 7.2.5. Trip and close DC currents shall not exceed 15 A per coil and shall not be less than 4 A per coil.
- 7.2.6. Trip circuits shall not be fused inside the circuit breaker control cabinet.
- 7.2.7. Surge suppression shall be provided on each trip and close coil. Reference CenterPoint Energy Specification, 007-400-02.
- 7.2.8. The circuit breaker operating mechanism shall be both mechanically and electrically trip-free in any position. For oil circuit breakers, a latch check switch shall be provided.
- 7.2.9. Circuit breakers with air closing mechanisms shall have stored energy for 5 close-open operations. Circuit breakers with spring closing mechanisms shall have the spring charging motor circuit connected to a 125 VDC battery source utilizing a DC supply cable dedicated for this purpose. Voltage rollover from AC to DC shall not be installed for the spring charging motor circuit for circuit breakers.
- 7.2.10. Gas circuit breakers shall have low gas pressure alarm and close inhibit contacts.

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- 7.2.11. Circuit breaker internal time delay circuitry for reclosing shall not be utilized. External time delayed automatic reclosing, when utilized, shall be wired/connected directly to the circuit breaker close circuit. External time delay for reclosing circuit is to be provided by other relays.
- 7.2.12. CenterPoint Energy recommends that the control circuitry of circuit breakers be equipped for operation response monitoring.

### 7.3. AIR BREAK SWITCHES

- 7.3.1. Transmission line disconnect switches and all disconnect switches in the substation "loop" shall be of the outdoor, three pole, gang operated type rated 138 kV nominal, 4,000 A continuous, 164 kA peak withstand minimum, unless otherwise specified by CenterPoint Energy. For substations with four or more 138 kV transmission lines, contact CenterPoint Energy for the required rating of switches. The switch air gap BIL shall coordinate with the BIL rating of the switch insulators.
- 7.3.2. Transmission line disconnect switches are required for "full loop" substations or "loop tap" substations converted to "full loop".
- 7.3.3. "Loop tap" substations must be configured and designed with equipment to permit switching for the scheduled outage of either transmission line section without interrupting service to the customer's load. An interrupting device attached to a disconnect switch in a "loop tap" substation for transmission line load breaking, loop switching or line dropping is not acceptable.
- 7.3.4. Two auxiliary "a" contacts shall be provided on the disconnect switch between transformers in a three circuit breaker, two transformer substation and the disconnect switch between lines in a two circuit breaker substation.

### 7.4. SURGE ARRESTERS

- 7.4.1. All surge arresters shall be metal oxide varistor type 108 kV class minimum, with a maximum continuous over voltage (MCOV) rating of 88 kV minimum. The minimum required energy absorption capability is 7 kilojoules/ kV of MCOV rating. The minimum required pressure relief capability is 63 kA rms symmetrical.
- 7.4.2. To allow for grading / leakage current monitoring, CenterPoint Energy recommends that surge arresters be mounted on plates using insulated spacers and associated hardware. The insulated ground conductor from the bottom flange of the arrester must be isolated from any other ground until it passes the point where a tong ammeter reading can be taken. The independent, insulated ground leads should be adequately marked to indicate A, B, and C phases.

### 7.5. COUPLING CAPACITORS AND LINE TUNERS

- 7.5.1. CenterPoint Energy shall specify vendor and vendor style number for the coupling capacitor devices and line tuners.

### 7.6. LINE TRAPS

- 7.6.1. CenterPoint Energy shall specify vendor and vendor style number for line trap devices.

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**8. CONTROL HOUSE**

- 8.1. The control house shall be a permanent, weatherproof structure constructed on a concrete foundation and scheduled for completion well in advance of the remainder of the substation to allow for adequate check out and testing. The ambient conditions inside the control house shall not exceed 32°C (90°F) and 85% relative humidity. Fluorescent lighting shall be provided.
- 8.2. TELEPHONE CIRCUITS:
  - 8.2.1. A touch tone telephone, connected to a commercial, full business direct (IFB) line shall be installed in the control house as soon as practical upon completion of the house. The location of the telephone shall be such that the front of protective relay panels is visible from the telephone. Intercoms and intra-company telephones are not acceptable for this purpose.
  - 8.2.2. A separate, dedicated telephone line shall be installed in the control house to be utilized for remotely interrogating metering for revenue billing purposes. An intra-company telephone line with direct inward dialing is acceptable.
  - 8.2.3. If CenterPoint Energy Supervisory Control and Data Acquisition (SCADA) equipment is installed, additional telephone circuits may be required. Refer to CenterPoint Energy specification 007-400-02 for details.
- 8.3. Wall space for metering cabinets shall be provided in accordance with Sub-Article 9.1.3.1.
- 8.4. If line relaying with power line carrier and/or fiber optic communication is utilized, space for the power line carrier transmitter/receiver sets and/or fiber optic fiber optic cable distribution box shall be provided.
- 8.5. If CenterPoint Energy Supervisory Control and Data Acquisition (SCADA) equipment is installed space for the SCADA set and intertie panel shall be provided in accordance with Sub-Article 13.1.
- 8.6. A separate 120 V AC, 20 A circuit shall be provided to each of the following: (a) the metering cabinet, (b) the power line carrier transmitter/receiver sets location, and (c) the SCADA intertie panel cabinet, if installed.
- 8.7. One single-phase, three wire, 240 V, 30 A outlet shall be located in the substation control house (Crouse Hinds #AR 321 or equivalent) for relay testing equipment.

**9. METERING EQUIPMENT**

**9.1. METERING**

- 9.1.1. CenterPoint Energy's metering practices conform to ANSI C12.1. Any part of the metering system that is installed by the customer or his agent shall also conform to ANSI C12.1 at minimum, unless otherwise directed by CenterPoint Energy.
- 9.1.2. The customer shall submit a one-line diagram of the proposed substation configuration to CenterPoint Energy in accordance with Article 15.0 of this specification. CenterPoint Energy will designate on the one-line diagram the location of all metering instrument transformers (including, without limitation, quantity, transformation ratios, voltage class - high side or low side and ratings). The metering instrument transformers shall be connected to the transformer low side or to the 138 kV substation bus by the customer as specified by CenterPoint Energy.



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- 9.1.3. Metering cabinets shall be located inside an environmentally controlled house.
  - 9.1.3.1. Wall space 3.0 ft wide and 8.0 ft high measured from the floor with 4.0 ft front clearance shall be provided for installation of each metering cabinet which will be furnished by CenterPoint Energy and installed by the customer. The number of metering cabinets will be determined by the metering scheme to be used.
  - 9.1.3.2. Customers requesting metering pulses shall provide all conduit and wiring necessary to connect to a junction box provided by CenterPoint Energy and mounted on the metering installation.
  - 9.1.3.3. The customer shall provide a conduit from the telephone board to the metering cabinet.
- 9.1.4. CenterPoint Energy personnel will make all meter connections. For metering equipment details, consult the CenterPoint Energy project representative.
- 9.1.5. When high side metering is used, a "full loop" customer shall provide two "a" contacts from the tie breaker and a single "a" contact for each side breaker. A two-breaker "loop tap" customer shall provide two "a" contacts from the tie switch and a single "a" contact from each side breaker. These contacts shall be routed from their associated relay panels to the metering location for rollover of the metering potential to a second set of potential transformers
- 9.1.6. Where low side metering is used, the customer shall provide space for CenterPoint Energy specified instrument transformers in their switchgear.
- 9.1.7. When lowside metering is utilized, 138 kV coupling capacitor potential devices shall be provided and installed by the customer in accordance with Sub-Article 7.5, when specified by CenterPoint Energy.

9.2. SWITCHGEAR MOUNTED METERING INSTRUMENT TRANSFORMERS

- 9.2.1. CenterPoint Energy shall specify all instrument transformers used for CenterPoint Energy metering.
  - 9.2.1.1. The switchgear manufacturer shall purchase and install the CenterPoint Energy specified instrument transformers and the customer shall invoice CenterPoint Energy for the actual cost of the metering instrument transformers.
  - 9.2.1.2. Original certified test data shall be provided to CenterPoint Energy for each instrument transformer supplied.
- 9.2.2. Metering current transformers (CT's) shall be located in the incoming main breaker cubicle. The CT's shall be installed by the customer.
- 9.2.3. Metering potential transformers (PT's) shall be located in roll-out boxes. The PT's shall be installed by the customer.
  - 9.2.3.1. The secondary windings shall be used only for CenterPoint Energy metering.
  - 9.2.3.2. PT's shall be equipped with 1 A, current limiting primary fuses.

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- 9.2.4. The customer shall install a 1.5 in. rigid galvanized steel conduit with pull strings from each instrument transformer cubical to the meter cabinet.
- 9.2.5. CenterPoint Energy personnel shall supply wiring and make all secondary instrument transformers connections.
- 9.2.6. The customer shall supply copper ground wire from the customer's switchgear to the CenterPoint Energy meter cabinet.

9.3. 138 kV METERING INSTRUMENT TRANSFORMERS

- 9.3.1. CenterPoint Energy will furnish all 138 kV instrument transformers used for CenterPoint Energy revenue metering.
- 9.3.2. CenterPoint Energy personnel will mount the instrument transformers on stands provided by the customer in accordance with Article 15.0 of this specification. The customer shall furnish flexible connections from the substation bus to the instrument transformers with NEMA CC 1 standard four-hole terminals (0.5625 in. diameter holes on 1.75 in. centers). CenterPoint Energy personnel will bolt the flexible connections to the instrument transformers.
- 9.3.3. The customer shall install both flexible and rigid galvanized steel conduit with pull string from the instrument transformer stands to the metering cabinet location.
  - 9.3.3.1. At the instrument transformer stands, 1.50 in. steel conduit shall be used to connect the individual instrument transformers to a common junction box. The 1.50 in. conduit shall terminate within 12 in. from the top of each pedestal. A 2.00 in. conduit shall be used from the common junction box located at the instrument transformer stands to the metering cabinet.
  - 9.3.3.2. All 2.00 in. steel conduits shall terminate at the base of the primary metering cabinet. No more than four conduits are to be terminated in a metering cabinet. Contact CenterPoint Energy if additional conduits are required.
  - 9.3.3.3. Flexible metallic conduit shall be used to complete the installation to the instrument transformers and the metering cabinets.
- 9.3.4. Potential transformers (PT's) located in the 138 kV substation yard shall be furnished and installed by CenterPoint Energy and rated 80,500/115-67.08 V for use on 138 kV grounded neutral system in accordance with IEEE C57.13.
  - 9.3.4.1. The PT's shall have two secondary windings. The "X" winding will be used for relaying, SCADA and the customer's equipment. The "Y" winding will be used only for CenterPoint Energy metering.
  - 9.3.4.2. The secondary windings shall be separately fused at the PT junction box to provide circuit isolation and short circuit protection; except that neutrals shall not be fused (brass or copper dummy fuses required).
  - 9.3.4.3. CenterPoint Energy shall supply and install color-coded cable to connect the PT's "Y" winding to the meter location. CenterPoint Energy shall install and connect customer-supplied cable between each PT "X" winding and the common junction box. If customer does not supply this cable then CenterPoint Energy will install CenterPoint Energy supplied

## CenterPoint Energy SPECIFICATION FOR CUSTOMER 138 KV SUBSTATION DESIGN

cable and color code. The PT cable shall be connected as shown on CenterPoint Energy drawing 581-500-01.

- 9.3.4.4. The PT primary shall be wye connected with a solid ground connection at the PT location. The PT secondary windings shall be wye connected with one neutral conductor carried to the relay panel and another neutral conductor carried to the meter box, as shown on CenterPoint Energy Drawing 581-500-01. These neutral conductors shall be grounded at the relay panel and meter box only.
- 9.3.5. Metering current transformers (CT's) located in the 138 kV substation yard shall be furnished and installed by CenterPoint Energy.
  - 9.3.5.1. CenterPoint Energy personnel will furnish and install the control cable from the CT's to the metering cabinet in the customer supplied steel conduit and will make all CT secondary connections.
- 9.3.6. The customer shall provide a copper bond wire from the ground mat to the case of each instrument transformer. The wire shall be sized equal to the ground mat. CenterPoint Energy will terminate and connect the wire to the instrument transformer case.

### 10. FUSING

- 10.1. Bussman type KWN-R fuses shall be used for fusing of 138 kV potential transformers (PT's) secondary relaying and metering circuits of less than 250 V AC as follows:
  - 10.1.1. 138 kV PT's secondary "X" winding shall be fused with 30 A fuses at the PT junction box in the yard except that neutrals shall not be fused (brass or copper dummy fuses required).
  - 10.1.2. 138 kV potential PT's secondary "Y" windings shall be fused with 60 A fuses at the PT junction box in the yard except that neutrals shall not be fused (brass or copper dummy fuses required).
  - 10.1.3. 15 A fuses shall be used for protective relaying potential branch circuits when specified by CenterPoint Energy.
  - 10.1.4. 6 A fuses shall be used for instrumentation potential branch circuits.
- 10.2. Bussman type KWN-R fuses shall be used for fusing of 138 kV coupling capacitor voltage transformers (CCVT's) secondary relaying and instrumentation circuits of less than 250 V AC as follows:
  - 10.2.1. Coupling capacitor voltage transformers secondary windings shall be fused with 6 A secondary fuses at the CCVT junction box in the yard except that neutrals shall not be fused.
  - 10.2.2. 3 A fuses shall be used for protective relaying potential branch circuits when specified by CenterPoint Energy and for instrumentation potential branch circuits.
- 10.3. Bussman type KWN-R fuses shall be used for fusing of relaying DC circuits of less than 250 V DC as follows:
  - 10.3.1. The trip circuit connection from the control house panel to each 138 kV breaker trip coil shall be fused with a 15 A panel mounted fuse located on the appropriate control house panel.

## CenterPoint Energy SPECIFICATION FOR CUSTOMER 138 KV SUBSTATION DESIGN

- 10.3.2. 30 A fuses shall be used for the CenterPoint Energy SCADA control positive.
- 10.4. The voltage drop from the control house to the trip circuit at the circuit breakers shall not exceed 10% of rated battery voltage under normal operating conditions.

### 11. PROTECTIVE RELAYING

- 11.1. Protective relaying will normally consist of primary and backup schemes. Whenever possible, the relays associated with the primary scheme shall be connected to a different set of CT's than the relays associated with the backup scheme. The DC circuit associated with the primary relaying scheme shall be connected to a different DC circuit than the DC circuit associated with the backup relaying scheme. The primary and backup schemes shall energize different trip coils in the same breaker.
- 11.2. CenterPoint Energy will furnish typical AC and DC schematics and minimum required bill of materials for the transmission line relaying schemes to ensure coordination with other transmission relaying. The customer shall indicate line relaying schemes (when the substation design requires so) and proposed relaying schemes for 138 kV bus and transformer protection on a substation relaying & metering one-line diagram. Once CenterPoint Energy has reviewed these schemes, the customer shall submit the appropriate relaying drawings and bill of materials to CenterPoint Energy for functional review. After these drawings and bill of materials are reviewed by CenterPoint Energy, the customer shall order the appropriate equipment and install these schemes. CenterPoint Energy personnel will calculate set points, apply the settings and test the transmission line relays after the customer has completed the installation and has satisfactorily performed the system operational tests provided in Article 17.0. The customer shall calculate set points for the 138 kV bus and transformer protection relays and submit this information to CenterPoint Energy for review. After CenterPoint Energy has reviewed the 138 kV bus and transformer protection set points the customer will apply the settings and test the relays after the customer has completed the installation and satisfactorily performed the system operational tests provided in Article 17.0. IT SHALL BE CUSTOMERS RESPONSIBILITY TO PERFORM ANY POINT-TO-POINT WIRING CHECKS.
- 11.3. CenterPoint Energy will determine the automatic reclosing scheme, and furnish typical AC and DC schematics and bill of materials to implement the scheme. The customer shall prepare drawings and bill of materials (which must be submitted to CenterPoint Energy for review) based on this information. Once the drawings and bill of materials are reviewed by CenterPoint Energy, the customer shall order the appropriate equipment and install the automatic reclosing scheme. CenterPoint Energy personnel will calculate set points, apply the settings and test the automatic reclosing scheme relays after the customer has completed the installation and has satisfactorily performed the system operational tests provided in Article 17.0. IT SHALL BE CUSTOMERS RESPONSIBILITY TO PERFORM ANY POINT-TO-POINT WIRING CHECKS.
- 11.4. The following are specified for bus and transformer protection:
- 11.4.1. Bus protection shall include primary and backup instantaneous bus relaying.
- 11.4.2. Power transformers should be protected by a differential relay, which shall be connected to the power transformer high side bushing current transformers. Low side circuit breaker bushing current transformers to be positioned so as to minimize the area of protection.
- 11.4.3. The three-line AC schematic showing transformer differential relay connections should clearly indicate polarity markings on all CT's and power transformer windings so that delta connections can be easily verified.

## CenterPoint Energy SPECIFICATION FOR CUSTOMER 138 KV SUBSTATION DESIGN

- 11.4.4. Power transformers should also be protected by transformer overload relaying which shall be connected to a different power transformer high side bushing CT than the transformer differential relay. The transformer overload relaying should have instantaneous and inverse-time overcurrent elements.
- 11.4.5. Power transformer sudden pressure and oil level devices should be connected for alarming and tripping.
- 11.4.6. Two auxiliary tripping relays should be used in the protection scheme for each transformer.
- 11.5. When deemed necessary by CenterPoint Energy, local breaker failure relaying will be required. CenterPoint Energy will furnish typical AC and DC one line diagrams, schematics, and bill of materials for the local breaker failure relaying. CenterPoint Energy personnel will calculate set points, apply the settings and test the breaker failure scheme relays after the customer has completed the installation and has satisfactorily performed the system operational tests provided in Article 17.0. IT SHALL BE CUSTOMERS RESPONSIBILITY TO PERFORM ANY POINT-TO-POINT WIRING CHECKS.
- 11.6. The following are specified for control cable connections:
  - 11.6.1. Connections from one panel to another panel should be made from the terminal blocks on one panel to terminal blocks on the other panel (rather than directly from device to device).
  - 11.6.2. Control cables should be color-coded and clearly marked to facilitate wire checking and troubleshooting.
  - 11.6.3. CT control cables shall be grounded only at the relay panels on the non-polarity side of the wye-connected CT.
- 11.7. CenterPoint Energy encourages the use of Sequence of Events Recorders (SER's) and Digital Fault Recorders. The application of these systems involves trade-offs between the desire to monitor and record as much information as possible and the need to minimize the number of devices in protective relaying circuits to ensure reliable operation. Any customer planning to install one of these systems is encouraged to discuss their application philosophy with CenterPoint Energy early in the project and to show these devices in the appropriate relaying and SCADA AC and DC schematics when those drawings are submitted for CenterPoint Energy review.
- 11.8. The following are specified for protective relay communication channel:
  - 11.8.1. If line relaying with power line carrier communication is utilized, the carrier transmitter/receiver sets shall be located inside the substation control house. The associated power line carrier coaxial cable utilized for connecting the line tuner to the carrier set location shall be type RG-8/U with a polyethylene jacket (Belden type YR-23384 coaxial or Belden 9888 triaxial).
  - 11.8.2. When power line carrier communication is utilized, CenterPoint Energy shall determine the frequency for the carrier sets. CenterPoint Energy shall provide automatic carrier testers. CenterPoint Energy may relocate existing carrier sets to coordinate frequencies.
  - 11.8.3. If line relaying with fiber optics communication is utilized, the customer is required to provide a raceway for the fiber optic cable installation from the transmission line protective relay requiring fiber optic communication (relays located in the substation control house) to the base

## CenterPoint Energy SPECIFICATION FOR CUSTOMER 138 KV SUBSTATION DESIGN

of the first CenterPoint Energy transmission line structure outside the substation. See Sub-Article 5.5.5 for cases where fiber optic cable comes in overhead. A dedicated raceway (conduit) is required however; a dedicated inner duct installed in existing cable trenches or unused existing conduit is acceptable. The relays may to be installed in a separate cabinet or in the power line carrier cabinet, if the cabinet has the necessary depth and space available. If existing facilities are available, the customer is requested to submit drawings (sketches) showing the proposed routing and construction details. CenterPoint Energy shall be responsible for supplying, pulling and splicing of the fiber optic cable.

The following guidelines are provided:

- 11.8.3.1. Flexible steel conduit 1.50 in. diameter, from the splice box (box provided and mounted by CenterPoint Energy at the base of the first CenterPoint Energy transmission structure outside of the substation) to the end of the underground conduit provided by the customer.
- 11.8.3.2. Below grade conduit shall be a minimum 1.50 in. diameter PVC, Schedule 40 with "pull line" (continuous fiber polyolefin, 200 lbs. tensile strength) installed. Conduit shall be at least 18.00 in. below grade, with a protective concrete barrier. Minimum bending radius shall be 24.00 in.
- 11.8.3.3. Pull boxes at grade level shall be provided along the cable route at intervals not more than 300 ft or two 90° bends. A cable pull box in the raceway is required just inside the substation fence. Pull box shall be 30 in. x 60 in. x 30 in. (Quazite Style No. PG3060BB30 and PG3060HA).
- 11.8.3.4. The customer shall provide 52 in. x 19 in. x 12 in. rack space close to the fiber optic relay to accommodate a fiber optic cable distribution box. CenterPoint Energy will provide and install the fiber optic cable distribution box.
- 11.8.3.5. In cases where railroad tracks exist between the substation and the first CenterPoint Energy structure, CenterPoint Energy will give site-specific requirements.
- 11.8.3.6. Customer shall submit drawings and other documents as necessary showing the routing and construction details of the conduit according to Article 15.0.
- 11.8.3.7. Actual designs shall be reviewed by CenterPoint Energy before construction starts.

## **12. UNDER-FREQUENCY LOAD SHEDDING**

- 12.1. The transmission customer shall be responsible for installing protective relays to ensure under-frequency load shedding as may be required by the ERCOT automatic firm load shedding requirements. The ERCOT automatic firm load shedding schedule is a 5% load block at 59.3 Hz, an additional 10% load block at 58.9 Hz and an additional 10% load block at 58.5. The under-frequency relays connected to each load will operate with a fixed time delay of no more than 30 cycles. Total time from the time when frequency first reaches one of the values specified above to the time load is interrupted should be no more than 40 cycles, including all relay and breaker operating times. Also, the customer shall make provisions to ensure no additional load is imposed on the CenterPoint Energy transmission system during an under-frequency load shedding condition. Verification of the implementation of this requirement shall be in accordance with Article 15.0 of this specification.

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**13. REMOTE TELEMETRY**

- 13.1. A Supervisory Control and Data Acquisition (SCADA) cabinet shall be located inside substation control house for system observation. The customer shall provide a 36 in. x 36 in. floor space for the SCADA cabinet. The height of this cabinet is 90 in. Front and rear access shall be provided.
- 13.2. For further requirements, refer to CenterPoint Energy specification 007-400-02, "Specification for Remote Telemetry of a Customer-Owned Facility."

**14. GENERATION**

- 14.1. Customers desiring to install and/or operate generation rated more than 10 MW shall make application with ERCOT as outlined at the ERCOT website (www.ercot.com). Generators shall comply with the ERCOT Operating Guides, the ERCOT Protocols, and CenterPoint Energy's engineering specifications and requirements.
- 14.2. For customers desiring to install and/or operate generation rated at 10 MW or less and connected to the low voltage side of the 138 kV substation the requirements for relay and generation /load islanding schemes are as follows:
  - 14.2.1. The transmission customer shall be responsible for installing protective relays to ensure the customers generators do not become a sustained source of fault current for a fault on the CenterPoint Energy transmission system. In addition, customer generation shall not keep any portion of the CenterPoint Energy transmission system energized in the event that a portion of the CenterPoint Energy transmission system along with the customer's facilities becomes isolated from the rest of the CenterPoint Energy system. The transmission customer shall be responsible for installing protective relays to ensure the customer's generation does not interfere with the automatic reclosing system associated with the CenterPoint Energy transmission system. CenterPoint Energy will inform the customer of required changes to the automatic reclosing system at other substations associated with the CenterPoint Energy transmission system as a result of the operation of the customer's generators in parallel with the CenterPoint Energy transmission system.
  - 14.2.2. The transmission customer shall be responsible for installing controls to synchronize the customer's generators with the CenterPoint Energy's system.
  - 14.2.3. The transmission customer shall not intentionally impose additional load on the CenterPoint Energy transmission network during an under frequency disturbance (i.e., 59.95 to 57.5 Hz).
  - 14.2.4. Customer may island their load from CenterPoint Energy in only the following manner:
    - 14.2.4.1. All generators remain on line (i.e., operating in parallel with the transmission network) between 62.5 Hz and 57.5 Hz.
    - 14.2.4.2. Measure frequency locally and initiate islanding scheme with provisions to ensure no additional load is imposed on the CenterPoint Energy transmission system.
    - 14.2.4.3. Compare local frequency with telemeter frequency from other locations in CenterPoint Energy system and initiate islanding scheme when these frequencies indicate the customer has become separated from the rest of the CenterPoint Energy system. The customer shall make provisions to ensure no additional load is imposed on the CenterPoint Energy transmission system.

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Verification of the implementation of the above requirements shall be in accordance with Article 15.0 of this specification.

### **15. DRAWING COMPLIANCE REVIEW & COMMENTS**

15.1. The following engineering documents shall be submitted in the order shown below for CenterPoint Energy comments, functional review, and compliance with CenterPoint Energy specifications in accordance with Sub-Articles 15.2 through 15.6:

- 15.1.1. Substation plot plan. The plan must indicate the geographical base lines, center line of dead-end structure and height of conductor pull off on the dead-end structure with coordinates. (See Article 6.0).
- 15.1.2. Relay and metering one-line diagram. CenterPoint Energy shall indicate incoming 138 kV transmission lines, power line carrier frequencies (if applicable), location and ratings of metering instrument transformers (high side or low side), CenterPoint Energy designations for circuit breakers, switches, power transformers, generators (if applicable) and the CenterPoint Energy assigned 6-character substation identification. The drawing shall then be revised to show the information provided by CenterPoint Energy and resubmitted to the CenterPoint Energy Project Coordinator. (See Articles 9.0 and 11.0).
- 15.1.3. Plan, profile and section views of substation structures, including bus and bus supports with material callouts. (See Articles 4.0 and 5.0).
- 15.1.4. Final/complete relaying and SCADA one-line diagrams, including generator protection one-line diagram for customers with parallel generation. (See Article 10.0).
- 15.1.5. Information specified on the CenterPoint Energy "Customer Generation Data" form and "Generator Step-up Transformer Data" form if customer has parallel generation. Refer to CenterPoint Energy specification 007-231-78, Article 13.0.
- 15.1.6. Equipment specification for all major pieces of equipment such as power transformers, 138 kV circuit breakers, surge arresters, disconnect switches, coupling capacitors and line traps. (See Articles 4.0 and 7.0).
- 15.1.7. Foundation location plan. (See Articles 5.0 and 6.0).
- 15.1.8. Design calculations, drawings and associated documents for the substation dead-end structures, instrument transformer stands, and foundations shall be submitted 30 days prior to the scheduled fabrication start.
- 15.1.9. Relaying and SCADA AC and DC schematics, including AC and DC panel drawings. These drawings shall be submitted after the documents indicated in Sub-Article 15.1.2 have been approved.
- 15.1.10. Power transformer AC schematic, breaker schematics and CT curves.
- 15.1.11. Power transformer and 138 kV circuit breaker nameplate drawings.
- 15.1.12. Relaying, control and SCADA bill of material. These documents shall be submitted after the documents indicated in Sub-Article 15.1.4 have been approved.



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- 15.1.13. Cable and conduit list and routing layout.
- 15.1.14. Front and Back View of high voltage relay and control panels including interconnections.
- 15.1.15. Substation control house layout drawing. (See Article 8.0).
- 15.1.16. Detail (point-to-point) wiring diagrams shall be submitted, not for approval, but for use in accordance with Article 10.0.
- 15.1.17. Power transformer low side main breaker over current relay settings. Power transformer tap changer for de-energized operation set point (if applicable).
- 15.2. Three copies of the drawings indicated in Sub-Article 15.1, folded to 8.50 in. x 11.00 in., shall be submitted for review/comments to the CenterPoint Energy Project Coordinator. Certain types of engineering documents depend upon finalization of other documents. For example, relay panel drawings cannot be prepared until the relaying AC and DC schematics are finalized. Therefore, engineering documents shall be submitted for CenterPoint Energy comments or approval in the proper sequence.
- 15.3. Customer drawings should be 100% complete when given to CenterPoint Energy to review. If a functional review cannot be done, CenterPoint Energy shall comment on compliance with CenterPoint Energy specifications and return to Customer. The drawings shall then be resubmitted with CenterPoint Energy comments incorporated when 100% complete. The customer shall then proceed with drawing submittal in accordance with Sub-Article 15.4.
- 15.4. Customer drawings that are 100% complete and marked "For Approval" shall be functionally reviewed by CenterPoint Energy for compliance with CenterPoint Energy specifications. If additional comments are made by CenterPoint Energy on the 100% complete drawings, the customer may:
  - 15.4.1. Incorporate the CenterPoint Energy comments and resubmit these drawings for further review of compliance with CenterPoint Energy specifications, or
  - 15.4.2. Send a letter to the CenterPoint Energy Project Coordinator acknowledging that CenterPoint Energy comments were received and shall be incorporated into the "For Construction" drawings.
- 15.5. Should the customer disagree with comments by CenterPoint Energy, the customer shall send a letter to the CenterPoint Energy Project Coordinator explaining why revisions are not necessary.
- 15.6. Once all issues are resolved, the final set of drawings shall be marked "For Construction." After, the substation is energized two sets of complete "As Built" drawings of the substation shall be sent to the CenterPoint Energy Industrial Representative within one year.

**16. EQUIPMENT INSTALLATION**

- 16.1. The protective enclosure around the substation including gates and grounding shall be installed in accordance with the National Electrical Safety Code (IEEE C2), IEEE Std. 1119 and IEEE Std. 80.
- 16.2. CenterPoint Energy shall assign a 6-character substation identification to the customer's substation. CenterPoint Energy shall post the 6-character substation identification on the door of the substation

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control house and on the entrance gate of the substation. The 6-character substation identification shall be used to identify the customer's substation for any communications or correspondence.

- 16.3. The customer shall make all equipment installation checks required by Article 17.0 of this specification and shall make all required measurements and readings available to CenterPoint Energy personnel if requested.
- 16.4. CenterPoint Energy personnel will verify that the 138 kV switches operate correctly.
- 16.5. CenterPoint Energy will have the sole responsibility for calculating relay set points, applying relay setting and "out of case" testing of the following relays:
  - 16.5.1. Transmission line relaying and associated power line carrier equipment,
  - 16.5.2. Relays for 138 kV automatic reclosing, and
  - 16.5.3. Relays for 138 kV breaker failure protection when specified by CenterPoint Energy.

**Note:** The appropriate operation of protective relays and control circuits by performing trip and close testing from devices of Sub-Articles 16.5.1 through 16.5.3 above shall be conducted with CenterPoint Energy personnel present to direct and observe test (24 hr. advance notice required).

- 16.6. CenterPoint Energy will furnish locks which shall remain in series with customer locks for all 138 kV disconnect switches, substation control house doors and gates(s) to and from the substation.
- 16.7. The 138 kV circuit breakers, air switches and power transformers will be assigned numbers in accordance with CenterPoint Energy dispatching numbers. The numbers are to be shown on the one-line diagram and shall be marked on the circuit breaker tanks, switch handles and power transformers.
- 16.8. CenterPoint Energy will coordinate and provide the procedures for energizing the customer substation 138 kV equipment.

### 17. REQUIRED TESTS AND INSPECTIONS

- 17.1. During installation but prior to energizing the equipment, the customer shall perform the following tests and inspections. CenterPoint Energy will observe the tests below that are marked with an asterisk (\*).
  - 17.1.1. Diagnostic testing (e.g., insulation power factor, insulation resistance ("meggar"), etc.) of all equipment (e.g., arresters, coupling capacitors, etc.) including all tests as specified by manufacturer.
  - 17.1.2. CONTROL CABLES AND PANELS:
    - 17.1.2.1. Check continuity and perform insulation resistance test ("meggar") conductor to ground and conductor to conductor.
    - 17.1.2.2. Perform a point-to-point wiring check of protective relaying and control panels.
    - 17.1.2.3. Verify protective relaying control circuits by performing trip and close testing. See "Note" in Sub-Article 16.5.3. \*

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17.1.2.4. Pass current from CT's through relays. \*

17.1.3. POWER CABLES:

17.1.3.1. Check continuity and phasing sequence.

17.1.3.2. Perform insulation resistance test ("meggar") of cables.

17.1.3.3. High-pot.

17.1.4. CIRCUIT BREAKERS:

17.1.4.1. Inspect and adjust main switch assembly per manufacturer's instructions.

17.1.4.2. Inspect, adjust and lubricate operating mechanism per manufacturer's instructions.

17.1.4.3. Ratio check, excitation test, perform insulation resistance test ("meggar") and check polarity on all CT's. Leave unused CT's shorted and grounded on secondary terminals.

17.1.4.4. Check resistance of close, trip and trip free coils.

17.1.4.5. Saturate close and trip coils when practical.

17.1.4.6. Obtain minimum and nominal trip and close voltage and current.

17.1.4.7. Perform insulation resistance test ("meggar") of main contact assembly and bushings.

17.1.4.8. Make dielectric insulation and power factor tests on main contact assembly and bushings.

17.1.4.9. Perform insulation resistance test ("meggar") of control circuits conductor to ground.

17.1.4.10. Record all measurements and readings.

17.1.4.11. Make travel recordings to verify proper opening speed.

17.1.5. DISCONNECTS AND SWITCHES:

17.1.5.1. Check and adjust contact alignment and wipe. \*

17.1.5.2. Adjust operating linkage to obtain full open and close positions and tighten all clamps and set screws.

17.1.5.3. Check and tighten all electrical connections.

17.1.5.4. Lubricate linkage and bearings, if required.

17.1.5.5. Clean all grease from contacts.

17.1.6. BATTERIES AND CHARGER:

17.1.6.1. Assemble batteries per manufacturer's instructions.

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- 17.1.6.2. Coat all connections on battery terminals with no-oxide grease.
- 17.1.6.3. Tin all copper connections to battery terminal.
- 17.1.6.4. Install, connect and adjust charger per manufacturer's instructions.
- 17.1.6.5. Put batteries on equalize charge until the specific gravity of all cells is within the limits set by manufacturer.
- 17.1.6.6. Read and record the float voltage and specific gravity of each cell.

**18. RECOMMENDED TESTS AND INSPECTIONS**

18.1. During installation but prior to energizing the equipment, CenterPoint Energy recommends that the customer perform the following tests and inspections as a minimum. List is not considered to be exhaustive or all-inclusive.

- 18.1.1. For low side equipment, test relays, check transformer and bus automatic reclosing and check operation of flags when tripping through the panel with current.

Note: CenterPoint Energy will check high side relays, 138 kV transmission line protective relays and 138 kV circuit breaker automatic reclosing.

18.1.2. ALL SUBSTATION EQUIPMENT:

- 18.1.2.1. Clean rusted surfaces, prime all bare metal surfaces and touch up with paint matching the finish coat.

18.1.3. CONTROL WORK:

- 18.1.3.1. Wire check all cables to CT's and perform insulation resistance test ("meggar") of cables.
- 18.1.3.2. In the following order:
  - 18.1.3.2.1. Polarity check CT's.
  - 18.1.3.2.2. Ratio check CT's.
  - 18.1.3.2.3. Excitation test CT's.
  - 18.1.3.2.4. Insulation resistance test ("meggar") CT's.
- 18.1.3.3. Check cable connections to panels.
- 18.1.3.4. Wires check panels.

18.1.4. SWITCHGEAR:

- 18.1.4.1. Check bus work for continuity, phase sequence and adequate clearance.
- 18.1.4.2. Check all bolted bus connections.

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- 18.1.4.3. High-pot cable with 25 kV DC.
- 18.1.4.4. Insure that all exposed bus work is properly insulated.
- 18.1.4.5. Bridge all bus work.
- 18.1.4.6. Perform dielectric insulation and power factor tests on all bus work.
- 18.1.4.7. Check breaker-lifting devices for alignment and adjust limit switches, if necessary.
- 18.1.4.8. Adjust auxiliary and cell switches.
- 18.1.4.9. Check continuity for all AC, DC control and CT circuits.

18.1.5. TRANSFORMERS:

- 18.1.5.1. Visually inspect for internal shipping damage and check all internal connections.
- 18.1.5.2. Install bushing and accessories per manufacturer's instructions.
- 18.1.5.3. Inspect LTC compartment and adjust per manufacturer's instruction and check LTC operation.
- 18.1.5.4. Bridge primary and secondary windings on all tap positions.
- 18.1.5.5. Ratio check, excitation test, perform insulation resistance test ("meggar") and check polarity on all CT's. Leave unused CT's shorted and grounded on the secondary.
- 18.1.5.6. Vacuum fill per manufacturer's instructions.
- 18.1.5.7. Check for oil and gas leaks. (This may be done prior to vacuum filling).
- 18.1.5.8. Test oil before and after filling. (Maximum power factor, minimum dielectric strength, color, acidity and interfacial tension).
- 18.1.5.9. Test oil for dissolved combustible gas and moisture content.

Note: This test is to be performed 24 to 48 hours after the substation has been energized and periodically thereafter.

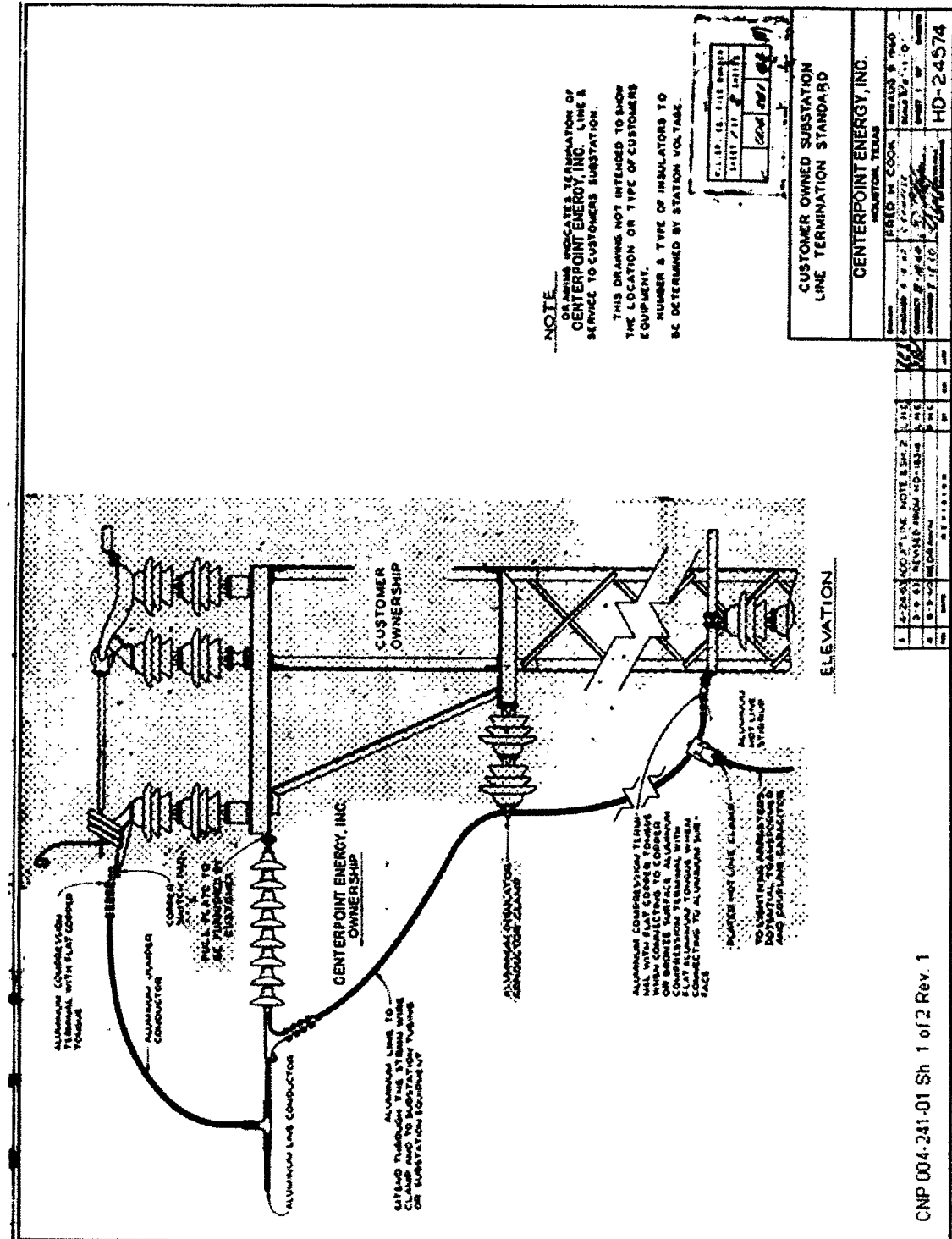
- 18.1.5.10. Check voltage regulating relay and controls.
- 18.1.5.11. Check cooling equipment and controls.
- 18.1.5.12. Check nitrogen-regulating equipment and adjust per manufacturer's instructions.
- 18.1.5.13. Check sudden pressure relay and associated circuits.
- 18.1.5.14. Check and connect desired alarm circuits.

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- 18.1.5.15. Perform insulation resistance test (“meggar”) and insulation power factor test of bushing and windings.
- 18.1.5.16. Check all bushings to bus connections.
- 18.1.5.17. Check all CT’s and control circuit connections.
- 18.1.5.18. Record all measurements and readings.
- 18.1.5.19. Check Core Ground.

**REFERENCE DRAWINGS**

CenterPoint Energy SPECIFICATION FOR CUSTOMER 138 KV SUBSTATION DESIGN



DATE: 08/13/05  
BY: [Signature]  
CHECKED: [Signature]  
APPROVED: [Signature]

CUSTOMER OWNED SUBSTATION  
LINE TERMINATION STANDARD

CENTERPOINT ENERGY, INC.  
HOUSTON, TEXAS

PROJECT: HD-18318  
SHEET NO: 115  
DATE: 8/13/05  
DRAWN BY: [Signature]  
CHECKED BY: [Signature]  
APPROVED BY: [Signature]

HD-24574

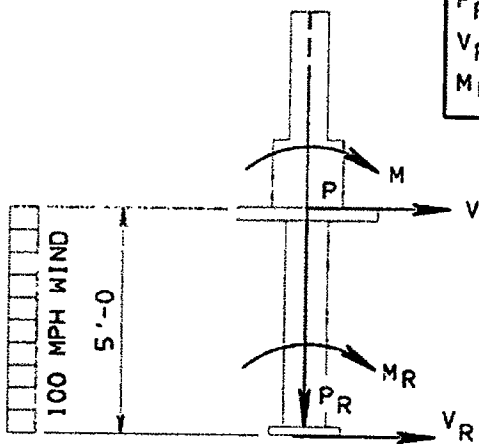
CenterPoint Energy SPECIFICATION FOR CUSTOMER 138 KV SUBSTATION DESIGN

USER: B\WILLIAMS1\NEW\PR FILE: 000-422 TIME: 10:14:51 AM DATE: Mon, Aug 8, 2005

**DESIGN CONDITIONS:**

1. LIMIT INSTRUMENT MOUNTING BOLT SPACING TO NO LESS THAN 15" CENTER TO CENTER.
2. SHOULD NOT EXCEED THESE VALUES:  
 $P = 2.5$  KIPS  
 $V = 0.7$  KIPS  
 $M = 44.3$  INCH KIPS

**FOUNDATION LOADS**  
 $P_R = 2.8$  KIPS  
 $V_R = 1.1$  KIPS  
 $M_R = 100.0$  INCH KIPS



**NOTE:**

CUSTOMER MUST MAINTAIN ALL NESC PHASE TO GROUND AND PHASE TO PHASE CLEARANCES.

**5'-0 HEIGHT**

DESIGN CRITERIA		
138KV STANDARD INSTRUMENT TRANSFORMER STAND		
CENTERPOINT ENERGY, INC.		
HOUSTON, TEXAS		
Drawn 1-24-94	REX	SCALE NTS
Checked 1-24-94	REX	SCALE 1 of 3 sheets
DESIGNED		DRAWING NUMBER
APPROVED		17119006

NO.	DATE	JOB NO.	REVISION	BY	CHK	APP

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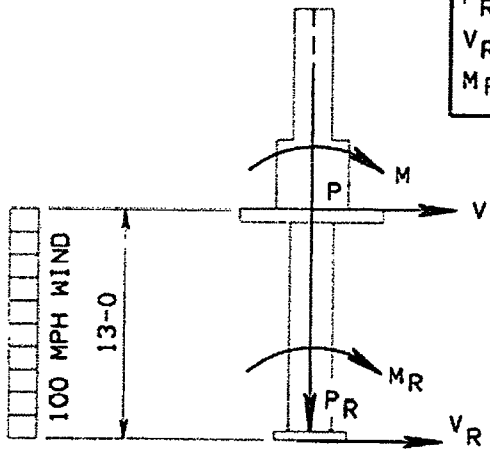
CenterPoint Energy SPECIFICATION FOR CUSTOMER 138 KV SUBSTATION DESIGN

USER: PHILLIAMS\NESC-PA FILE: 000v423 TIME: 10:14:42 AM DATE: Mon, Aug 8, 2005

**DESIGN CONDITIONS:**

1. LIMIT INSTRUMENT MOUNTING BOLT SPACING TO NO LESS THAN 15" CENTER TO CENTER.
2. SHOULD NOT EXCEED THESE VALUES:  
 $P = 2.5$  KIPS  
 $V = 0.8$  KIPS  
 $M = 50.0$  INCH KIPS

**FOUNDATION LOADS**  
 $P_R = 3.1$  KIPS  
 $V_R = 1.8$  KIPS  
 $M_R = 253.0$  INCH KIPS



**NOTE:**  
 CUSTOMER MUST MAINTAIN ALL NESC PHASE TO GROUND AND PHASE TO PHASE CLEARANCES.

**13'-0 HEIGHT**

DESIGN CRITERIA		
138KV STANDARD INSTRUMENT TRANSFORMER STAND		
CENTERPOINT ENERGY, INC. HOUSTON, TEXAS		
DESIGN 1-24-94	REK	SCALE NTS
ENGINEER 1-24-94	REK	SCALE 2 OF 4 SHEETS
CHECKED		DATE
APPROVED		11/11/90 05

NO.	DATE	JOB NO.	REVISION	BY	CHKD	APPD
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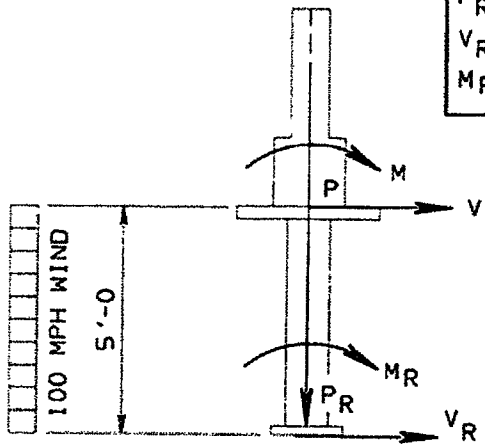
CenterPoint Energy SPECIFICATION FOR CUSTOMER 138 KV SUBSTATION DESIGN

USER: BULLIAMS1 NEWP8 FILE: 000x428 TIME: 10:14:43 AM DATE: Mon, Aug 8, 2005

**DESIGN CONDITIONS:**

1. LIMIT INSTRUMENT MOUNTING BOLT SPACING TO NO LESS THAN 15" CENTER TO CENTER.
2. SHOULD NOT EXCEED THESE VALUES:  
 $P = 4.7$  KIPS  
 $V = 0.9$  KIPS  
 $M = 66.0$  INCH KIPS

**FOUNDATION LOADS**  
 $P_R = 5.0$  KIPS  
 $V_R = 1.3$  KIPS  
 $M_R = 130.0$  INCH KIPS



**NOTE:**

CUSTOMER MUST MAINTAIN ALL NESC PHASE TO GROUND AND PHASE TO PHASE CLEARANCES.

**5'-0 HEIGHT HEAVY DUTY**

DESIGN CRITERIA		
138KV STANDARD INSTRUMENT TRANSFORMER STAND		
CENTERPOINT ENERGY, INC.		
HOUSTON, TEXAS		
DRAWN 1-24-94	REK	SCALE NTS
CHECKED 1-24-94	REK	SHEET 3 OF 4 SHEETS
DESIGNED		DRAWING NUMBER
APPROVED		711190 06

NO.	DATE	JOB NO.	REVISION	BY	CHK	COB	APP
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