CenturyLink Inc.
Technical Publication

Protection of CenturyLink Facilities Serving Electrical Supply Locations

PUB 77321
Issue E
January 2019

NOTICE

This publication describes telecommunication services provided by CenturyLink that extend into electrical supply locations. Services that enter electrical supply locations may require special protection.

CenturyLink assumes no responsibility for any costs incurred by a supplier in conforming to the contents of this publication. Further, conformance to this publication does not constitute a guarantee of a given supplier's equipment and/or its associated documentation.

CenturyLink reserves the right, without prior notice, to revise this publication for any reason.

Throughout this publication, the term CenturyLink signifies CenturyLink Inc.

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2019

Comments

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Telephone Number _____

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1.0 Introduction

1.1 General

This document describes telecommunications services and facility designs provided by CenturyLink that extend into electrical supply locations. Electrical supply locations may include services directed into power generation facilities, substations, cell sites residing on substation ground grids, cell sites in close proximity to substations, and cell sites residing on high voltage transmission towers. This special high voltage protection, as designed by CenturyLink, will provide personnel and equipment safety while insuring the continuity of service. The provision of these services generally follows the recommendations of IEEE 487™ DOT series of documents "IEEE Standard for the Electrical Protection of Communications Facilities Serving Electric Supply Locations©

IEEE-487 ™ General Considerations© -Section 3.1 defines:

Electric supply locations: Any building, separate space, or site in which electric supply equipment is located that may be subjected to the effects of ground potential rise (GPR) from power system fault currents. This definition includes generation, transformation, conversion, switching, and delivery facilities.

High-voltage environment (HVE): A location requiring caution because it may experience a ground potential rise (GPR) from power line fault currents and/or lightning strike energy.

1.2 Purpose

The purpose of this document is to describe telecommunication service types provided on CenturyLink facilities that extend into electrical supply locations and any design requirements for high voltage protection.

These services will require high voltage protection whenever hazardous voltages of 1000V peak- asymmetrical or greater appear on those facilities due to ground potential rise (GPR) and/ or induction caused by faults in the customer's electric power system. Special high voltage protection is designed to isolate or neutralize hazardous voltages. The protection objectives on CenturyLink services and facilities at these locations are as follows:

- To minimize electrical hazards to personnel engaged in construction, operation, maintenance and use of telecommunications services.
- To limit electrical damage to telecommunications equipment, cable and wire facilities.
- To provide the required service continuity and integrity of telecommunication transmission as specified by the customer and approved by a CenturyLink Electrical Protection Engineer.

NOTE: This offering requires special high voltage protection at the customer's premises and may require special high voltage protection at the CenturyLink Central Office whenever the fault-produced GPR/ induction equals or exceeds 1000 volts peak-asymmetrical.

2.0 Responsibilities

2.1 Responsibility of CenturyLink

CenturyLink, working in conjunction with the customer, shall determine the proper methods of protection required to achieve the objectives set forth in Section 4 (Protection Service Types). The method of protection for all service requests in these specific locations shall be coordinated by CenturyLink and must be compatible with the protection provided for the most critically important service at that location. *See Section 4.2*
ALL services/circuits provided by CenturyLink that terminate in an electrical supply location **must** be protected by specialized high voltage protection equipment, regardless of circuit ownership

Where economically feasible, newly constructed substations will only be served with an all dielectric optical fiber cable when CenturyLink provides the high voltage isolation.

It is expressly declared that metallic facilities are in continually decreasing supply, and CenturyLink is not obligated to continue to make such facilities available. Metallic facilities are offered only where existing facilities and operating conditions permit.

CenturyLink reserves the right to treat special high voltage protection on an individual case basis, dependent on the type of facilities available.

Note: CenturyLink reserves the right to Lock-Out/ Tag-Out (*a safety procedure used in the industry that requires hazardous conditions to be "isolate"*) any electrical supply location it deems to be unsafe for any reason pending a review by a CenturyLink Electrical Protection Engineer. This is to ensure the safety of CenturyLink and customer personnel who work on the telecommunication facilities serving the electrical supply location. CenturyLink also reserves the right to suspend any service without adequate special high voltage protection until adequate protection is provided.

2.1.1 CenturyLink Owned High Voltage Protection Equipment

In states where tariffs have provisions for high voltage protection, the customer requesting service may request CenturyLink to provide the high voltage protection equipment. CenturyLink will install a complete high voltage protection service delivery facility. CenturyLink will maintain these facilities fully for the life of the telecommunication circuit(s) serving the electrical supply location or the co-located wireless provider.

2.2 Responsibility of the Customer Requesting Service

The customer shall be responsible for providing to CenturyLink a completed Form RG31-0048, "Request for Electrical Information for Electrical Supply Locations," (see Exhibit 5-1, pages 1-2, on pages 29-30 of this document which includes the following):

- Exhibit 5-1, page 1 is the front of Form RG31-0048 with numbered blocks used for directions on how it is to be completed.
- Exhibit 5-1, page 2 is the instructions for filling out Form RG31-0048.

Note: The Form RG31-0048 shall be signed by an authorized power company representative for the electrical supply location or a licensed electrical PE in the state the site is located.

2.2.1 Additional Responsibilities

The customer requesting service shall be required to provide

- A non-metallic conduit structure from the electrical supply location- to the public right of way and at least 10 feet beyond the location ground grid.
- An equipment mounting platform (non-metallic NEMA cabinet, plywood back board, H Frame, etc.).
- Local power from DC batteries or local AC power from a UPS or inverter system.
- A local ground source.

2.2.2 Customer Owned High Voltage Protection Equipment

The customer requesting service, working with the owner of record, may provide the high voltage protection equipment. An optical fiber based facility is CenturyLinks preferred method of protection.
For hybrid optical fiber based facilities, CenturyLink will meet the customer outside the calculated 300 volt point of the zone of influence when the GPR exceeds 17kV Peak Asymmetrical. For sites below 17kV Peak Asymmetrical, the CFJ can be located outside the ZOI or outside the substation fence as long as the entire hybrid system is located on the station ground grid. This meet point will be considered the Demarc for this location. (See Section 8 of this document for complete details.)
For copper-based facilities, CenturyLink will place a high dielectric strength copper cable, associated cable termination equipment and may interposition the service extended Demarc.

For outdoor applications, the customer may purchase and place a turnkey environmental cabinet equipped with a lightning arrestor and high voltage isolation jack panel. In this case CenturyLink will place the high dielectric strength copper cable and terminate the cable to the isolation jack panel. The jack panel will serve as a high voltage test point and main Demarc. An extended Demarc point may be interpositioned on the station side of the customers high voltage interface for services at this location.

Note: For all customer provided high voltage protection equipment CenturyLink only offers Class "C" service due to CenturyLink not having end to end ownership and responsibility.

2.3 Responsibility of Owner of Record

The structure owner is considered the "Owner of Record" for all telecommunication services delivered to an electrical supply location. All service provision requirements directed to the site regardless of circuit ownership, such as a sub-lease tenant, is the responsibility of the owner of record. Wireless providers collocated in or near an electrical supply location may have the same responsibilities as the Owner of Record

Many state tariffs mandate any changes in an electrical supply location will require written notification from the location owner, along with a revised Form RG31-0048. These changes shall be provided as they occur to permit reevaluation and redesign of the existing high voltage protection.

3.0 State Tariffs

Some state tariffs provide for additional billing for circuits terminating in electrical supply locations. These costs will be a monthly surcharge placed on each circuit requiring high voltage protection provided by CenturyLink. In most cases, customer provided high voltage isolation equipment will not be subject to any additional surcharges. For customer provided hybrid optical fiber systems that are line powered, there may be an additional monthly surcharge for providing this line power.

There are several states within CenturyLinks serving territory that have tariffs specific to high voltage protection surcharges.

For access to CenturyLink Tariffs, click HERE

3.1 Special Construction Cost:

Every state tariff has provisions for special construction costs. The CenturyLink engineer having responsibility for the electrical supply location will determine any special construction costs applicable for placing facilities into any location requiring high voltage protection. Special construction costs may be assessed for new construction, re-termination or re-arrangements of facilities.

4.0 Protection Service Types

Protection services which CenturyLink offers are identified according to the following types:

Type 1 - Services requiring either DC transmission or AC and DC transmission, used for Basic Exchange Telephone Service and/ or Private Line Access Service (DDS, ADSL)
Type 2 - Private Line Access Service requiring (AC/DC) voice band or (DC) narrowband transmission, used for pilot wire protective relaying or (DC) tripping respectively.
Type 3 - Private Line Access Service requiring (AC) voice band/ data transmission only, used for tele-metering, supervisory control, data, etc.
Type 4 - Private Line Access Service requiring (AC) voice band transmission only, used for audio tone protective relaying.

4.1 Service Performance Objective Classifications

Interruptions or outages of telecommunications circuits serving electric supply locations (substations etc.) may occur for physical reasons such as cable damage due to extraordinary heavy storm loading, a vehicle striking and breaking a utility pole, a cable cut, a lightning strike, or any other man made or natural disaster. Circuit failures caused by manmade/natural events cannot be prevented and CenturyLink expressly states that provision of the service provided in this section cannot preclude such service outages.
Interruptions or outages due to the effects of ground potential rise (GPR) in the customer's power generating, transmission and/ or distribution systems are minimized through the installation and maintenance of high voltage protection service which is designed to operate in a fault- produced electrical environment.
Service performance objective (SPO) classifications have been established for the purpose of permitting the customer to specify the performance objectives for most types of telecommunications services provided to power stations.
SPO classifications are offered to provide various degrees of service continuity during power system faults.

SPO Classifications are:

Class A - Non-interruptible service performance (must function before, during and after the power fault condition) for services requiring AC transmission only. Class A service cannot tolerate even a momentary service interruption. Non- tolerable service interruptions include both loss of dependability (failure to deliver a valid trip or control signal) and loss of security (delivery of a false trip or control signal).

Class B - Self-restoring interruptible service performance (must function before and after the power fault condition) for any service. Class B service can tolerate a service interruption for the duration of a power system fault, but service continuity must be restored immediately after the fault without requiring any repair personnel activity.

Class C - Normal service which does not require special high voltage protection. Interruptible service performance (can tolerate a station visit to restore service) for power stations with a GPR less than 1000V peak-asymmetrical. Class C service cannot be provided in conjunction with Class A or Class B service.

Note: For all customer provided high voltage protection equipment CenturyLink only offers Class "C" service due to CenturyLink not having end to end ownership and responsibility.

Note: Class 'A' circuits should originate and terminate within the same wire center. Class 'A' circuits may be transmitted on digital and or optical fiber facilities which may introduce latency issues and time delays on circuit tripping. **CenturyLink no longer offers Class A service on new circuit requests.**

DEFINITIONS CLASS A OR B SERVICE

SERVICE TYPE AND PERFORMANCE OBLECTIVE CLASSIFICATION/ USOC* FOR COPPER CABLE BASED SERVICE DELIVERY
*TYPE or service refers to circuit usage
*CLASS of service refers to reliability of HVP during a power fault

TYPE 1 CLASS B SERVICE (Phone, Tie Trunks, Trunks, Radio Control, DC Alarms, Telegraph, ISDN, DDS and ADSL)

All circuits used for talking and ADSL plus DC telemetering and telegraph.
Services which require both AC and/ or DC transmission and which can tolerate momentary interruptions during a power fault. (Must function before and after a power fault)

2 Wire USOC HVC 4 wire USOC HVD #4 Wire USOC HVA

TYPE 2 CLASS B SERVICE (DC Tripping, Pilot Wire Relay) (Class A performance not available)

Normally a metallic cable pair end to end, but it can be a DC telegraph channel. (Metallic facilities are offered where existing facilities and operating conditions permit.)
Services which require both AC and/ or DC transmission and which can tolerate momentary interruptions during a power fault. (Must function before and after a power fault)

2 Wire USOC HVE #4 Wire USOC HVB

TYPE 3 CLASS A SERVICE (Data, Telemetering, SCADA)

Critical non type 4 circuits which require class A performance
Service for AC transmission only which cannot tolerate even momentary interruption (Must function before, during and after a power fault.)

2 Wire USOC HVF 4 Wire USOC HVG

TYPE 3 CLASS B SERVICE (Data, Telemetering, SCADA)

All tone signals 300 Hz to 5 MHz and high capacity Digital (DS-1 Rate)
Services for AC transmission only which can tolerate momentary interruptions (Must function before and after a fault)

2 Wire USOC HVH 4 Wire USOC HVJ

TYPE 4 CLASS A SERVICE (Audio Tone Protective Relaying)

Protective Relaying or Transfer Trip only (Voice Grade 12 when intralata)
Service for AC transmission only which cannot tolerate even momentary interruption (Must function before, during and after a power fault.)

2 Wire USOC HVK 4 Wire USOC HVL

 # Services limited to maximum ground potential rise (GPR) of 4 KV RMS-11 VS. (Refer to Electrical Protection Engineer before selecting.)

CLASS C SERVICE

Interruptible service performance (can tolerate visit to restore service).
If ground potential rise (GPR) is less than 1000 volts peak-asymmetrical, no protection is required, and Class C service may be requested. This shall be determined by a CenturyLink Electrical Protection Engineer

Exhibit 4-1 Design Information for Power Industry Channels

USOC'S FOR OPTICAL FIBER BASED SERVICE

P1QXF: CENTURYLINK PROVIDED FIBER TRANSPORT SYSTEM OPTICAL ETHERNET OR DS-3 LEVEL SERVICE DELIVERY

P1QTA: CENTURYLINK PROVIDED FIBER PROTECTION ISOLATION EQUIPMENT SERVING HIGH VOLTAGE LOCATIONS - USING HYBRID OR ALL DIELECTRIC FIBER FOR NON-FIBER BASED SERVICES

VPQ: PROTECTION ISOLATION EQUIPMENT - CUSTOMER PROVIDED FIBER

VPQSP: HIGH VOLTAGE PROTECTION EQUIPMENT - CUSTOMER PROVIDED FIBER - SPAN POWER - CO TO CPE ELECTRICAL TO OPTICAL CONVERSION EQUIPMENT - DS1 SERVICE ONLY, OVER METALLIC FACILITIES

DM2EB: MISCELLANEOUS DATA EQUIPMENT - ENVIRONMENTAL CABINET

Note: Any services delivered utilizing a CenturyLink provided hybrid fiber system may have both copper cable based and optical fiber based USOCs applied to each circuit.

Exhibit 4-1 (continued)
Design Information for Power Industry Channels

4.2 Service Offerings

The following customer option matrix identifies intra-lata service offerings with service performance objective classifications and the associated universal service order code (USOC).

TYPE/ CLASS	SERVICE CODES	USOC (NOTES 1 & 2)										
		HVA	HVB	HVC	HVD	HVE	HVF	HVG	HVH	HVJ	HVK	HVL
1	LS			X								
1	BA			X								
1	SG			X								
1	CS			X								
2	PV		X			X						
2	PW		X			X						
1	TC	X		X								
1	TT	X		X								
3	PA								X	X		
1	PL			X	X							
1	RT			X	X							
3	VM						X	X				
3	VM								X	X		
1	OS			X								
1	IT				X							
1	TA				X							
1	TL				X							
3	FD						X	X				
3	FD								X	X		
4	PR										X	X
3	SS						X	X				
3	SS								X	X		
1	LA	X										
3	MT								X			
1	DP	X			X							
1	DQ	X			X							
1	DR	X			X							
1	DW	X			X							
3	DA									X		
1	FX			X								
1	FT			X								
1	OP			X								
3	DH									X		
1	UC			X	X							
1	UD			X	X							
3	UE								X			
3	UG						X	X				
3	UG								X	X		
3B	UH									X		
1	US	X			X							
1	UY	X		X								
1	UZ			X	X							
1	YB				X							
1	YG				X							
1	IB			X								

Figure 4-2
Intralata Service Offerings Matrix (1 of 2)

N- Not available for all applications.
This is applied on an individual case basis. **X** Available USOCs for these services.

NOTE 1: The following USOCs are used with 2-Wire services: HVC, HVE, HVF, HVH and HVK. The remaining USOCs are used with 4-Wire services.

NOTE 2: USOC codes HVA and HVB are limited to services with a maximum ground potential rise of 4.0 kV RMS and a maximum accumulated volt second requirement of 11.

NOTE 3: C and D conditioning options are not affected by high voltage protection.

NOTE 4: Not all available service codes are on this list. Other services and special assemblies will be handled on an individual case basis.

Figure 4-2
Intralata Service Offerings Matrix (2 of 2)

The following customer option matrix identifies inter-lata service offerings with service performance objective classifications and the associated universal service order code (USOC).

TYPE/ CLASS SERVICE	SERVICE DESIGNATOR CODES (SERVICE CODE)	USOC (NOTES 1 & 2)										
		HVA	HVB	HVC	HVD	HVE	HVF	HVG	HVH	HVJ	HVK	HVL
1B	VG1 (LB)			X	X							
1B	VG2 (LC)	S		X	X							
1B	VG3 (LD)	S		X	X							
1B	VG4 (LE)				X							
3A	VG5 (LF)						X	X				
3B	VG5 (LF)								X	X		
3A	VG6 (LG)							X				
3B	VG6 (LG)									X		
1B	VG7 (LH)	S		X	X							
1B	VG8 (LJ)	S		S	S							
1B	VG9 (LK)	S			X							
3A	VG10 (LN)						X	X				
3B	VG10 (LN)								X	X		
3A	VG11 (LP)						X	X				
3B	VG11 (LP)								X	X		
4A	VG12 (LR)										X	X
1B	VGW (SE/SF)	S		S	S							
3B	VGB (LZ)								X	X		
1B	LS1 (NT)			X								
1B	LS2 (NU)			X								
2B	MT3 (NV)					X						
1B	TG1 (NW)	X		X								
1B	TG2 (NY)			X	X							
1B	FGA (SB)	S		S	S							
1B	FGB (SD)	S		S	S							
1B	FGC (Msg Tk)	S		S	S							
1B	FGD (Msg Tk)	S		S	S							
1B	AP1 (PE)			X								
1B	AP2 (PF)			X								
1B	AP3 (PJ)			X								
1B	AP4 (PK)			X								
1B	DA1 (XA)	X			X							
1B	DA2 (XB)	X			X							
1B	DA3 (XG)	X			X							
1B	DA4 (XH)	X			X							
1B	DA6 (XD)	X			X							
3B	HC1 (HC)									X		

Figure 4-3
Inter-lata Service Offerings Matrix (1 of 2)

S-Signaling is involved (e.g. loop-start, ground-start, E&M, etc.)

See the Protocol portion of the Network Interface Code.

X-Any Protocol portion of the Network Interface Code is permissible.

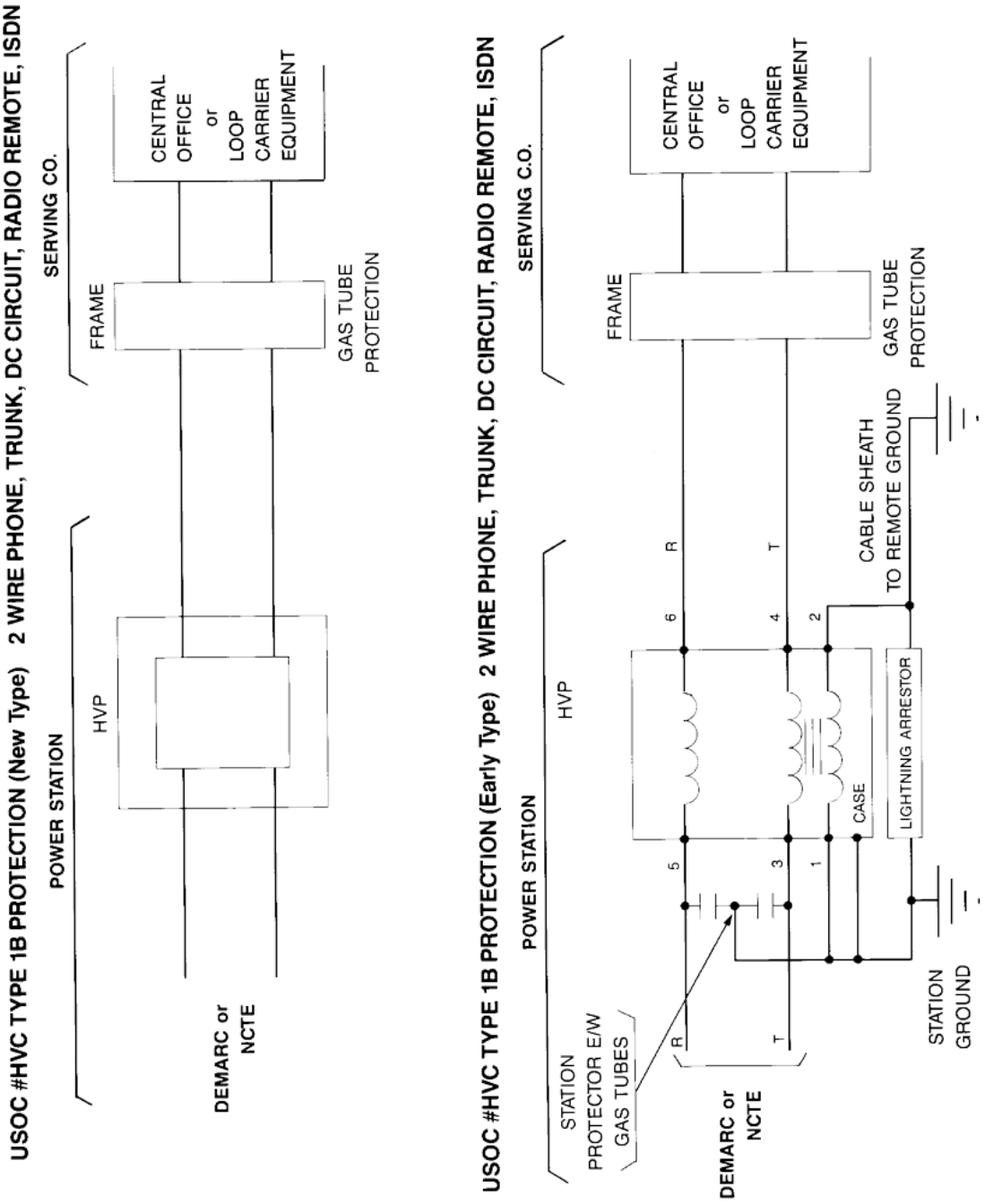
NOTE 1: The following USOCs are used with 2-Wire Network Interface Codes: HVC, HVE, HVF, HVH and HVK. The remaining USOCs are used with 4-Wire Network Interface Codes.

NOTE 2: USOC codes HVA and HVB are limited to services with a maximum ground potential rise of 4.0 kV RMS and a maximum accumulated volt second requirement of 11.

NOTE 3: C and D conditioning options are not affected by high voltage protection.

Figure 4-3
Inter-lata Service Offerings Matrix (2 of 2)

The following 13 pages are detailed service description design configuration drawings with the associated USOCs:



Exhibits 4-4 and 4-5

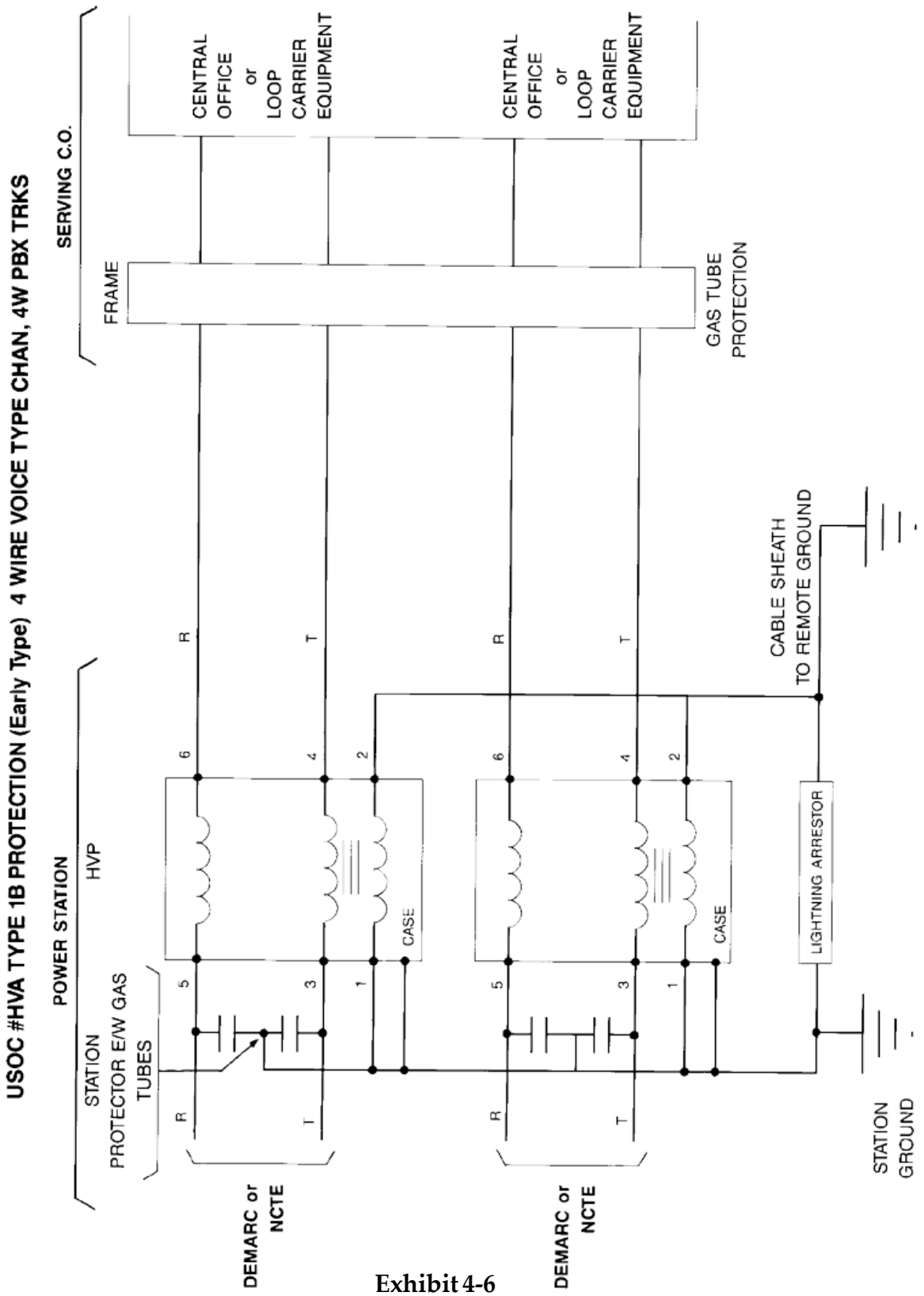

USOC #HVA TYPE 1B PROTECTION (Early Type) 4 WIRE VOICE TYPE CHAN, 4W PBX TRKS
POWER STATION
HVP
STATION PROTECTOR E/W GAS TUBES
SERVING C.O.
FRAME
CENTRAL OFFICE or LOOP CARRIER EQUIPMENT
CENTRAL OFFICE or LOOP CARRIER EQUIPMENT
GAS TUBE PROTECTION
CABLE SHEATH TO REMOTE GROUND
LIGHTNING ARRESTOR
CASE
CASE
R
T
R
T
R
T
R
T
6
4
2
5
3
1
6
4
2
5
3
1
DEMARC or NCTE
DEMARC or NCTE
STATION GROUND

Exhibit 4-6

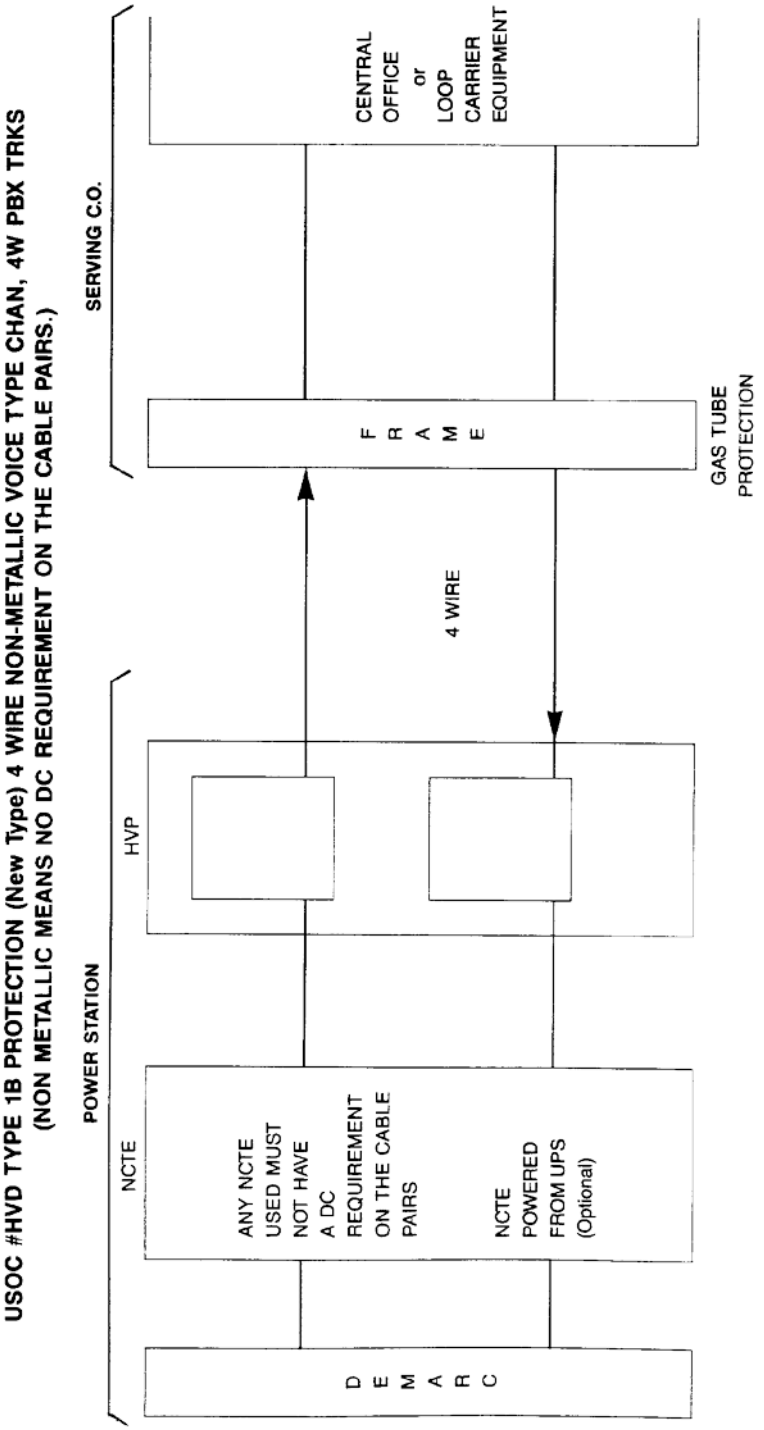

USOC #HVD TYPE 1B PROTECTION (New Type) 4 WIRE NON-METALLIC VOICE TYPE CHAN, 4W PBX TRKS
(NON METALLIC MEANS NO DC REQUIREMENT ON THE CABLE PAIRS.)
SERVING C.O.
POWER STATION
CENTRAL OFFICE or LOOP CARRIER EQUIPMENT
FRAME
GAS TUBE PROTECTION
HVP
4 WIRE
NCTE
ANY NCTE USED MUST NOT HAVE A DC REQUIREMENT ON THE CABLE PAIRS
NCTE POWERED FROM UPS (Optional)
DEMARC

Exhibit 4-7

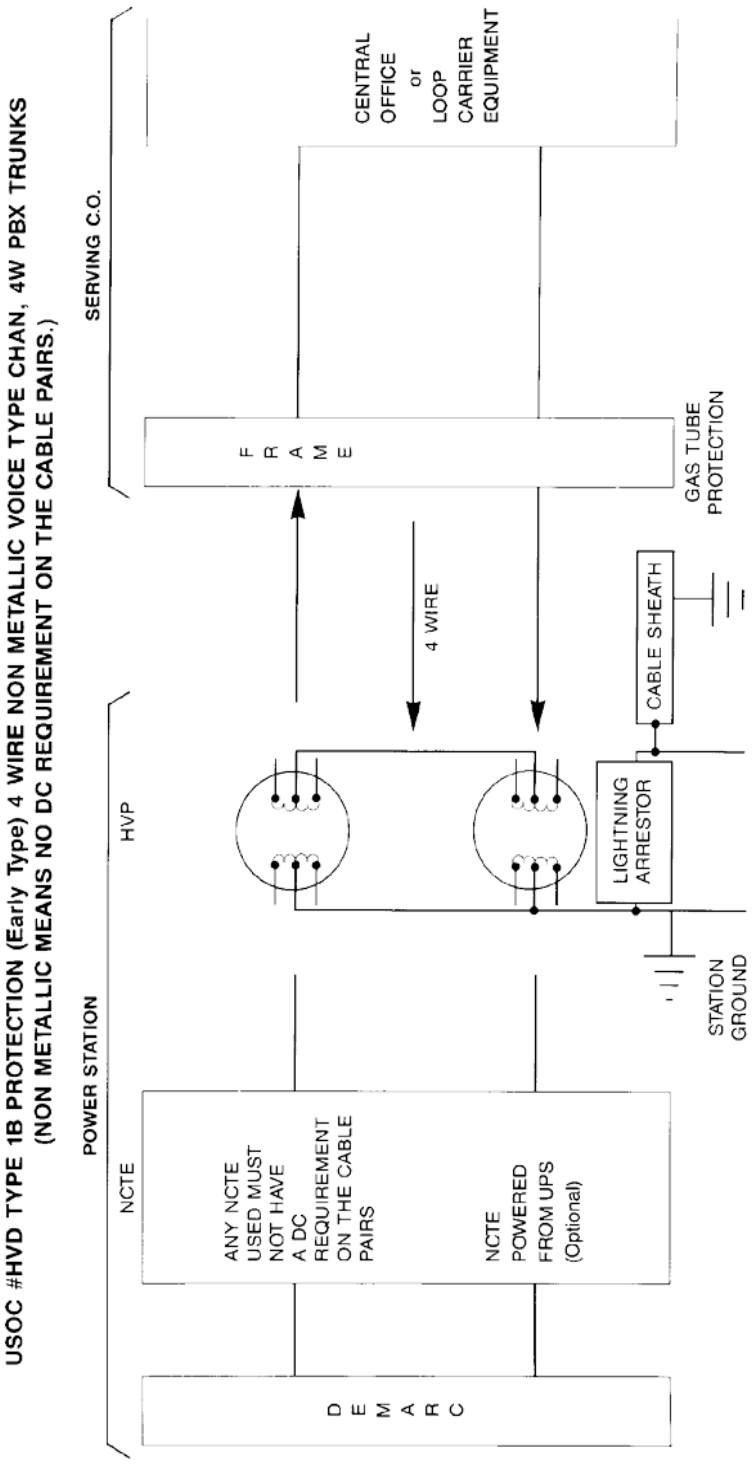

USOC #HVD TYPE 1B PROTECTION (Early Type) 4 WIRE NON METALLIC VOICE TYPE CHAN, 4W PBX TRUNKS
(NON METALLIC MEANS NO DC REQUIREMENT ON THE CABLE PAIRS.)
POWER STATION
SERVING C.O.
NCTE
HVP
ANY NCTE USED MUST NOT HAVE A DC REQUIREMENT ON THE CABLE PAIRS
NCTE POWERED FROM UPS (Optional)
DEMARC
FRAME
CENTRAL OFFICE or LOOP CARRIER EQUIPMENT
4 WIRE
LIGHTNING ARRESTOR
CABLE SHEATH
GAS TUBE PROTECTION
STATION GROUND

Exhibit 4-8

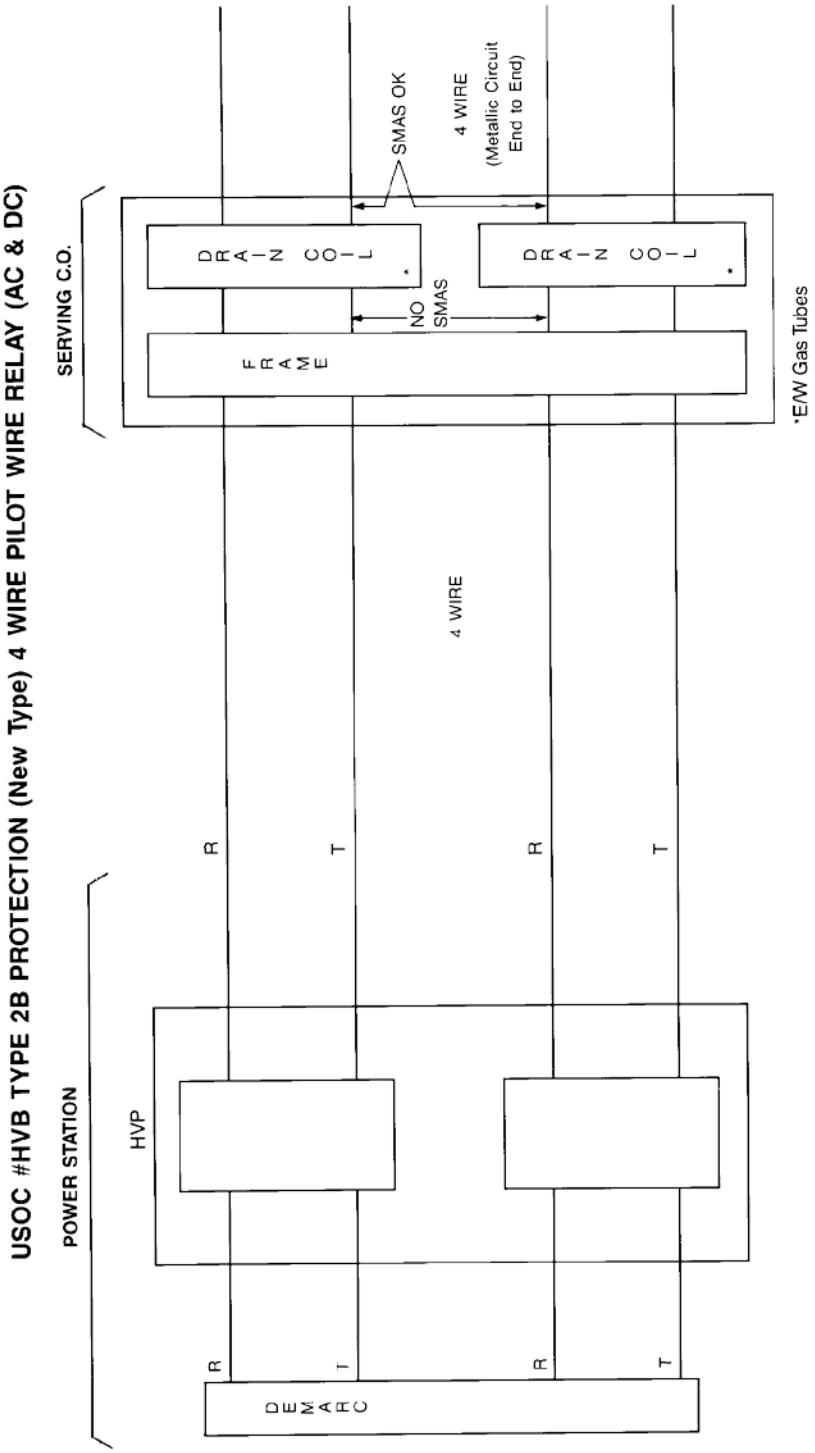

USOC #HVB TYPE 2B PROTECTION (New Type) 4 WIRE PILOT WIRE RELAY (AC & DC)
SERVING C.O.
POWER STATION
SMAS OK
4 WIRE
(Metallic Circuit
End to End)
NO
SMAS
DRAIN COIL
DRAIN COIL
FRAME
4 WIRE
HVP
R
T
R
T
R
T
R
T
DEMARC
*E/W Gas Tubes

Exhibit 4-9

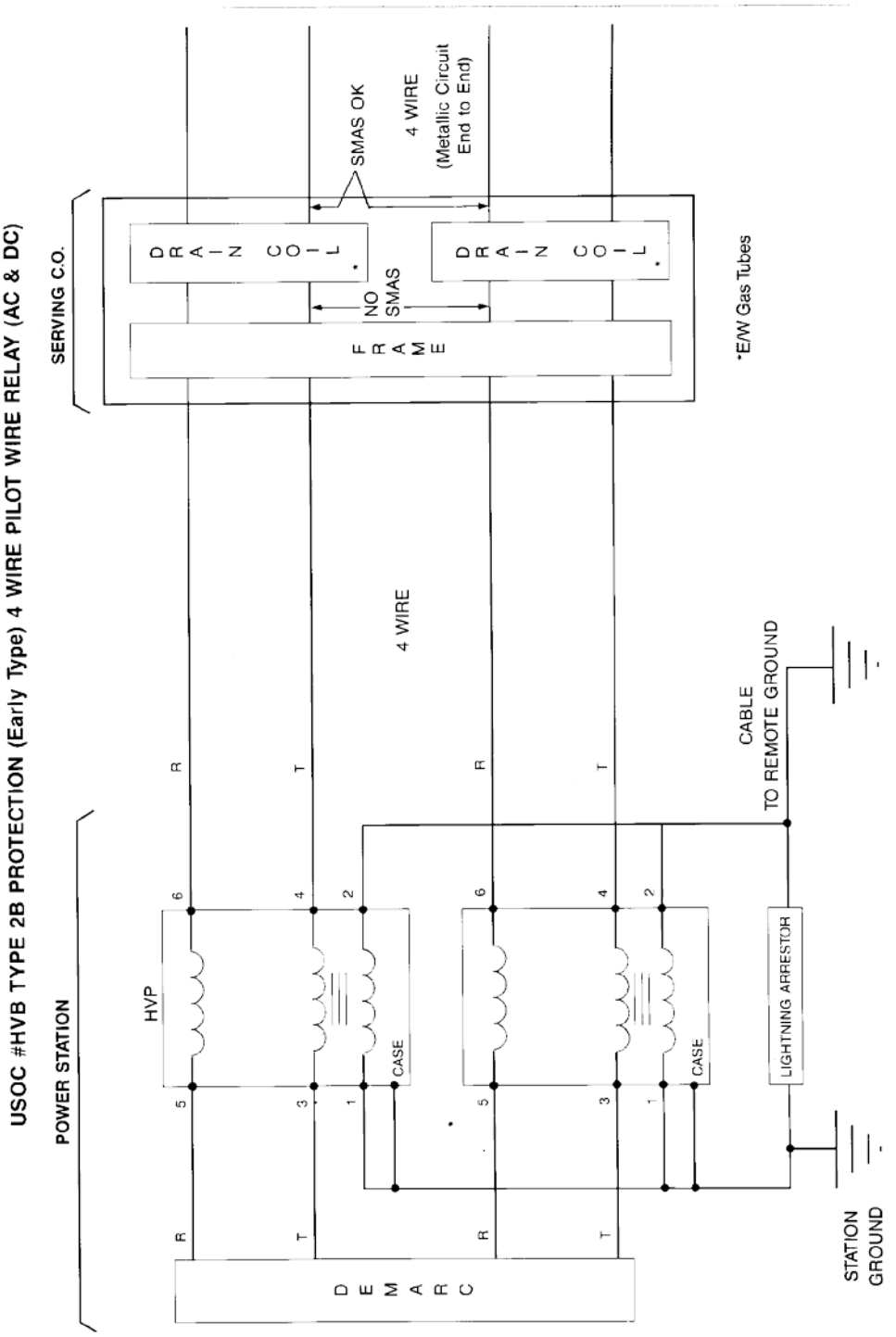
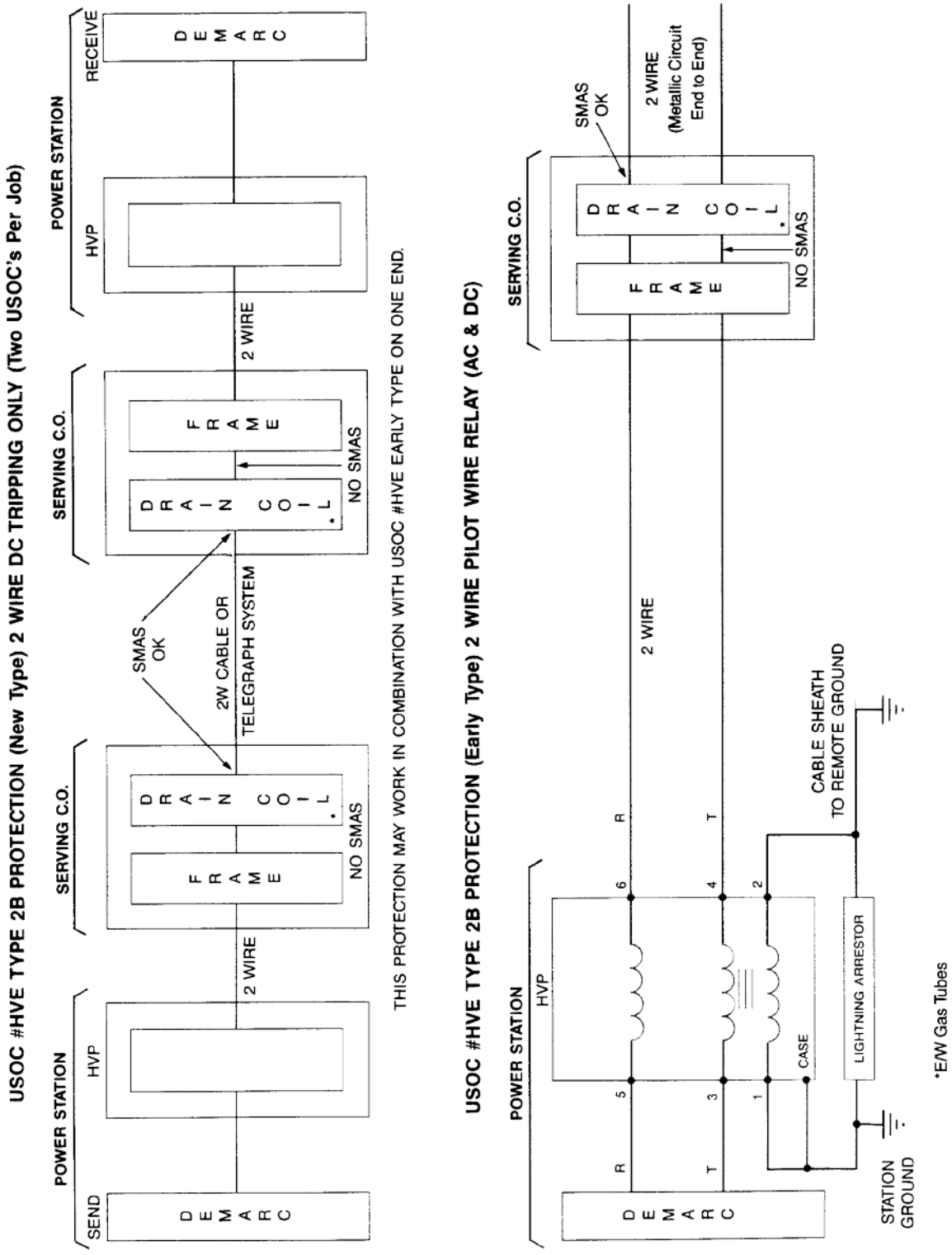

USOC #HVB TYPE 2B PROTECTION (Early Type) 4 WIRE PILOT WIRE RELAY (AC & DC)
POWER STATION
SERVING C.O.
DEMARC
FRAME
DRAIN COIL
NO SMAS
SMAS OK
4 WIRE
(Metallic Circuit End to End)
*E/W Gas Tubes
HVP
CASE
LIGHTNING ARRESTOR
CABLE
TO REMOTE GROUND
STATION GROUND
R
T

Exhibit 4-10



Exhibits 4-11 and 4-12

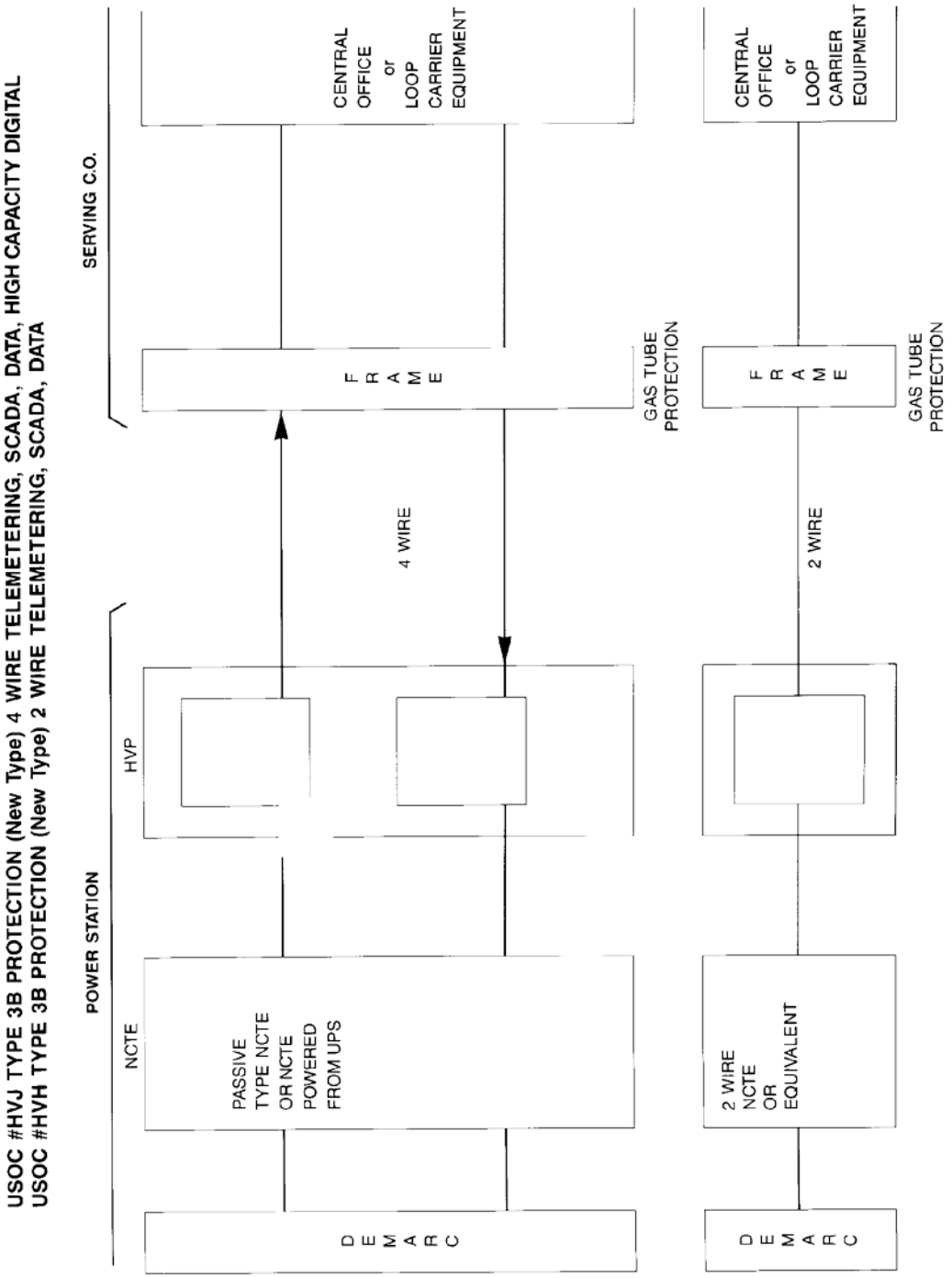

USOC #HVJ TYPE 3B PROTECTION (New Type) 4 WIRE TELEMETERING, SCADA, DATA, HIGH CAPACITY DIGITAL
USOC #HVH TYPE 3B PROTECTION (New Type) 2 WIRE TELEMETERING, SCADA, DATA
POWER STATION
SERVING C.O.
NCTE
HVP
PASSIVE TYPE NCTE OR NCTE POWERED FROM UPS
4 WIRE
FRAME
CENTRAL OFFICE or LOOP CARRIER EQUIPMENT
GAS TUBE PROTECTION
DEMARC
2 WIRE NCTE OR EQUIVALENT
2 WIRE

Exhibit 4-13

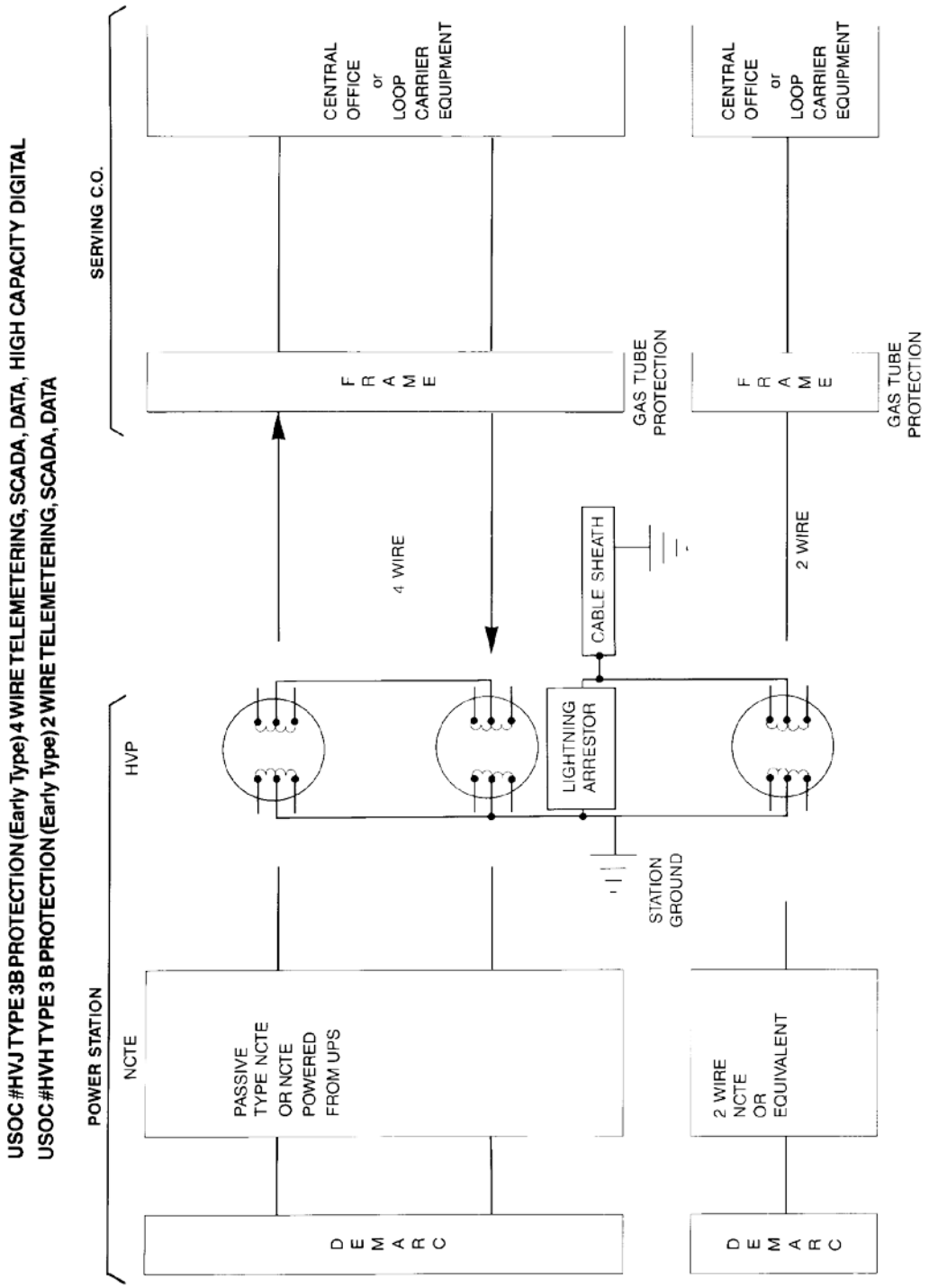

USOC #HVJ TYPE 3B PROTECTION (Early Type) 4 WIRE TELEMETERING, SCADA, DATA, HIGH CAPACITY DIGITAL
USOC #HVH TYPE 3 B PROTECTION (Early Type) 2 WIRE TELEMETERING, SCADA, DATA
POWER STATION
SERVING C.O.
NCTE
HVP
PASSIVE TYPE NCTE OR NCTE POWERED FROM UPS
2 WIRE NCTE OR EQUIVALENT
D E M A R C
F R A M E
CENTRAL OFFICE or LOOP CARRIER EQUIPMENT
GAS TUBE PROTECTION
4 WIRE
2 WIRE
CABLE SHEATH
LIGHTNING ARRESTOR
STATION GROUND

Exhibit 4-14

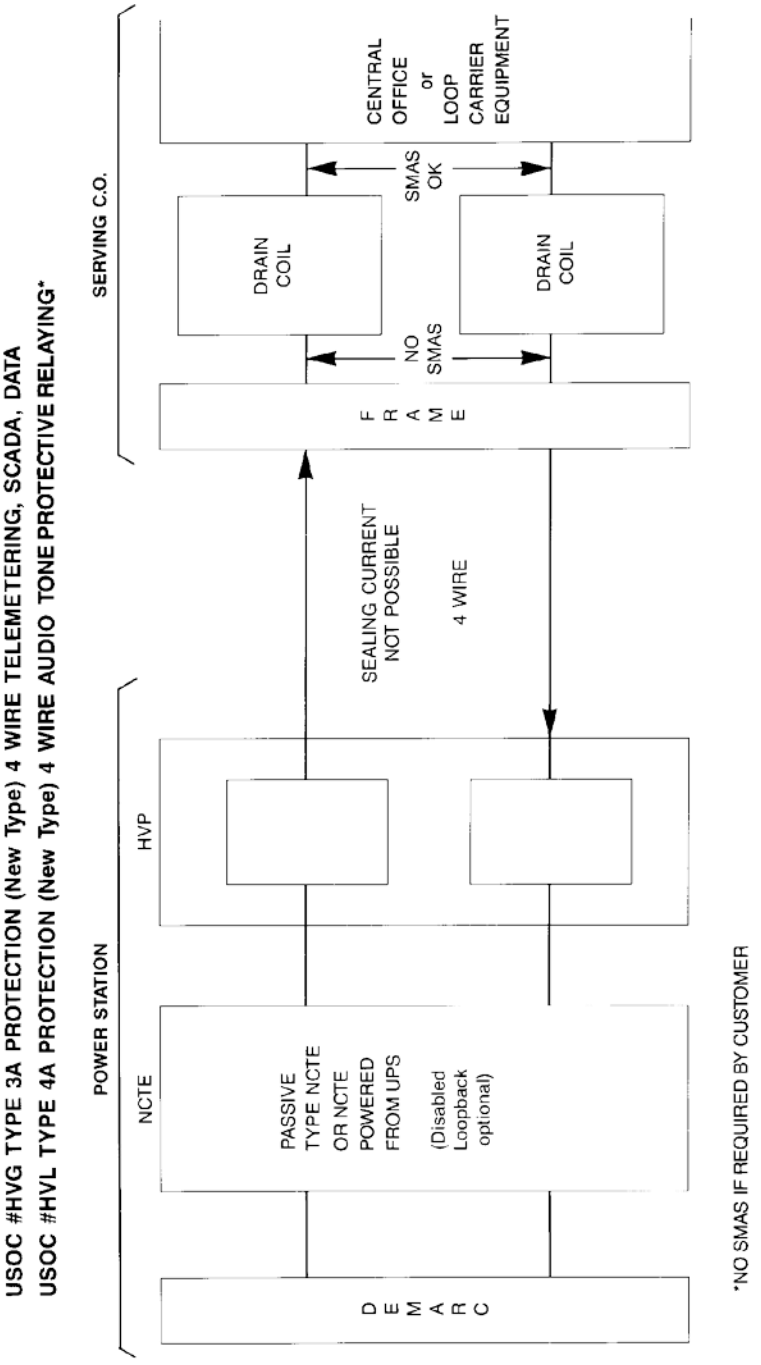
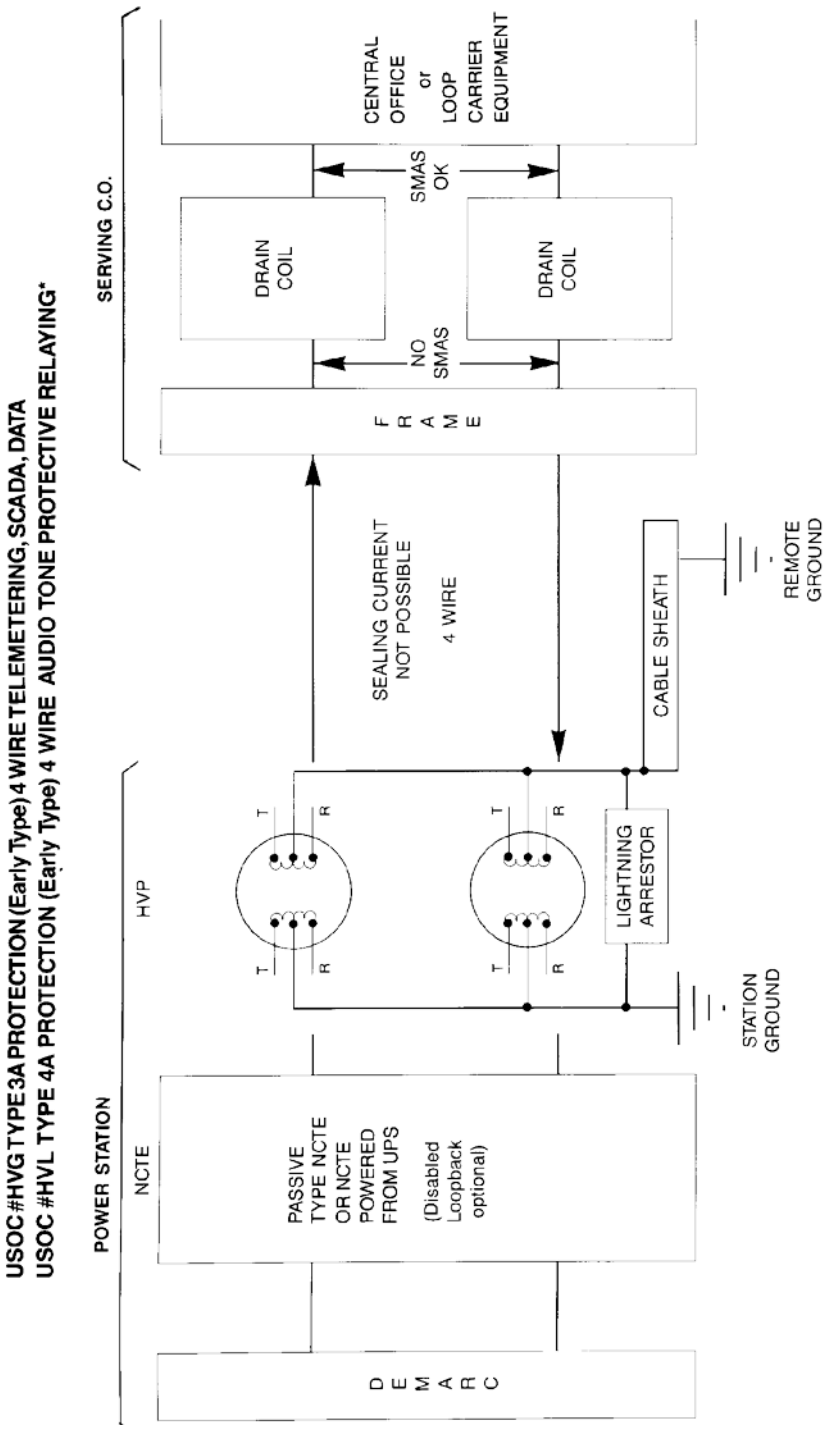

USOC #HVG TYPE 3A PROTECTION (New Type) 4 WIRE TELEMETERING, SCADA, DATA
USOC #HVL TYPE 4A PROTECTION (New Type) 4 WIRE AUDIO TONE PROTECTIVE RELAYING*
POWER STATION
SERVING C.O.
NCTE
HVP
PASSIVE TYPE NCTE OR NCTE POWERED FROM UPS
(Disabled Loopback optional)
SEALING CURRENT NOT POSSIBLE
4 WIRE
DRAIN COIL
DRAIN COIL
NO SMAS
SMAS OK
CENTRAL OFFICE or LOOP CARRIER EQUIPMENT
DEMARC
FRAME
*NO SMAS IF REQUIRED BY CUSTOMER

Exhibit 4-15


USOC #HVG TYPE 3A PROTECTION (Early Type) 4 WIRE TELEMETERING, SCADA, DATA
USOC #HVL TYPE 4A PROTECTION (Early Type) 4 WIRE AUDIO TONE PROTECTIVE RELAYING*
SERVING C.O.
POWER STATION
HVP
NCTE
PASSIVE TYPE NCTE OR NCTE POWERED FROM UPS
(Disabled Loopback optional)
DEMARC
FRAME
DRAIN COIL
DRAIN COIL
NO SMAS
SMAS OK
CENTRAL OFFICE or LOOP CARRIER EQUIPMENT
SEALING CURRENT NOT POSSIBLE
4 WIRE
T
R
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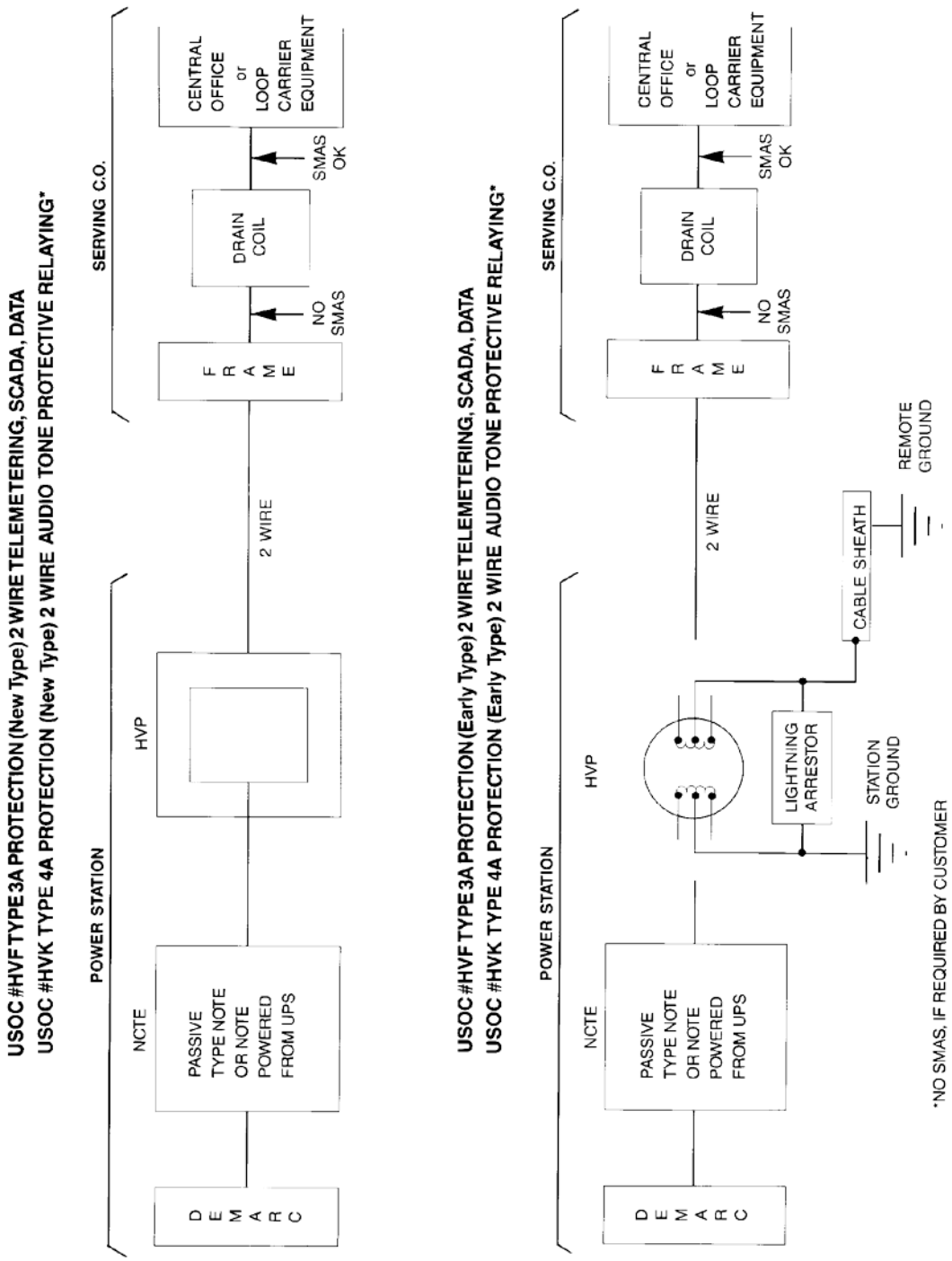
LIGHTNING ARRESTOR
CABLE SHEATH
STATION GROUND
REMOTE GROUND
*NO SMAS IF REQUIRED BY CUSTOMER

Exhibit 4-16



Exhibits 4-17 and 4-18

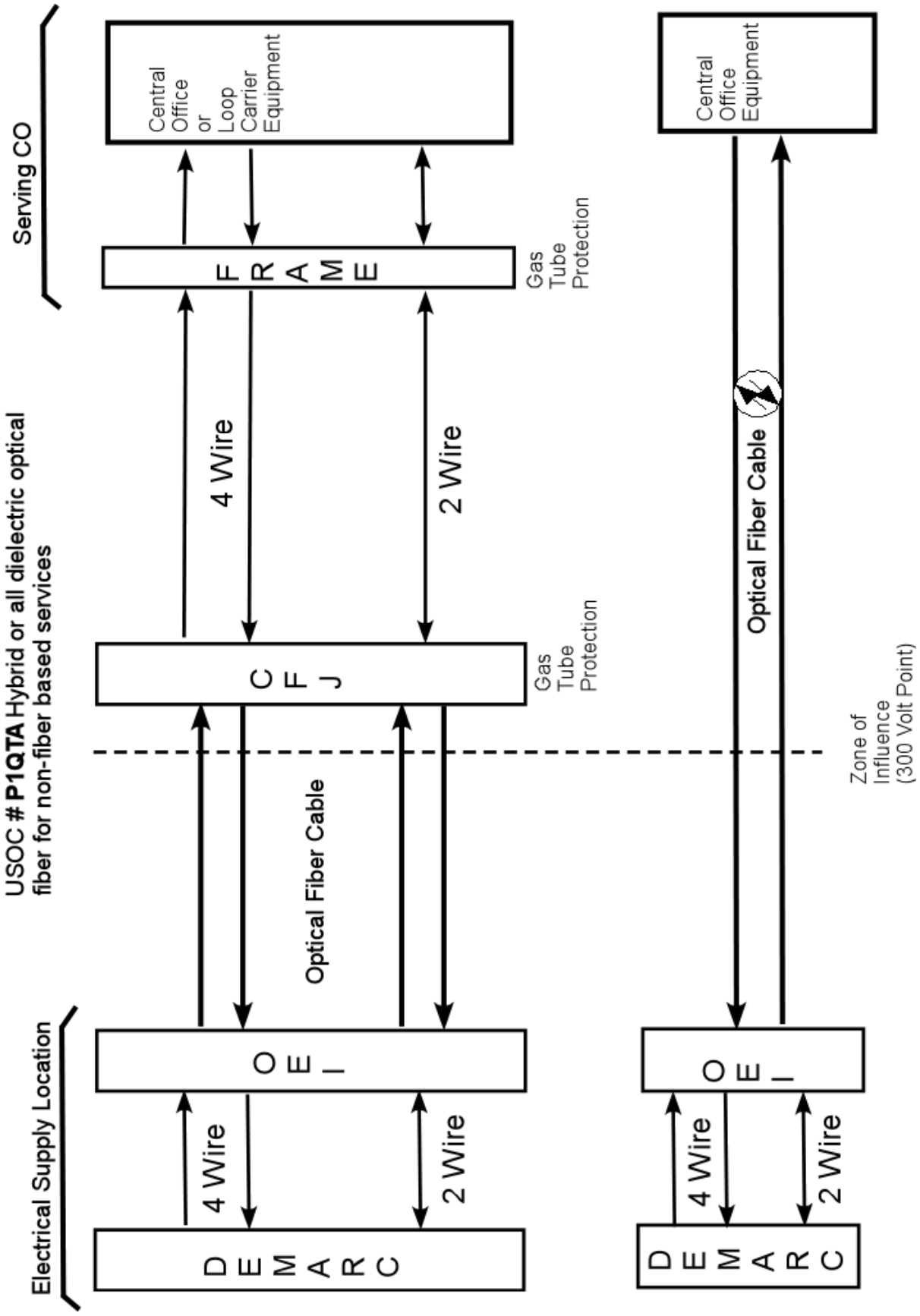

Serving CO
Central Office or Loop Carrier Equipment
Central Office Equipment
F R A M E
Gas Tube Protection
4 Wire
2 Wire
USOC # P1QTA Hybrid or all dielectric optical fiber for non-fiber based services
C F J
Gas Tube Protection
Optical Fiber Cable
Optical Fiber Cable
Zone of Influence (300 Volt Point)
Electrical Supply Location
O E I
4 Wire
2 Wire
D E M A R C
O E I
4 Wire
2 Wire
D E M A R C

Exhibit 4-19

5.0 Form RG31-0048, Request for Electrical Information for Electrical Supply Locations

Request for Electrical Information for Electrical Supply Locations

CUSTOMER INFORMATION

Page _____ of _____

(1) CUSTOMER			
(2) LOCATION A - STATION NAME		(3) ADDRESS	(4) TEL NO.
(5) LOCATION B - STATION NAME	(FOR POINT TO POINT)	ADDRESS	TEL NO.

GROUND POTENTIAL RISE (GPR) FAULT DATA

(6) FAULT CIRCUIT X/R RATIO	(7) EARTH RETURN FAULT CURRENT (RMS)	(8) GRID IMPEDANCE	(9) GRID AREA	(10) GROUND POTENTIAL RISE (RMS)
LOCATION A	AMPS	OHMS	SQ. FT.	Volts

SERVICE CLASSIFICATION	(Definitions of type and Class are located in section 4 of the CenturyLink Tech Pub 77321. If Class C is requested, leave Class item blank.)	
LOCATION A	TYPE	CLASS

(11) **PROPOSED - CUSTOMER PROVIDED - HIGH VOLTAGE ISOLATION TERMINAL EQUIPMENT**

MAKE	MODEL	FACILITIES INTERFACE CODE

(12 to 15)
CHANNEL TYPE

		EXISTING	NEW	FUTURE
	2 W Phone, 2W Trunk, DC Circuits, ISDN (Type 1 Service)			
	Tie Line, Trunk Radio Remote, Etc. (Type 1 Service)			
	2 Wire ____ 4 Wire			
	Digital Data Service (Type 1 Service)			
	Pilot Wire Relay (Type 2 Service)			
	D.C. Tripping			
	AC Tones W/O Signaling and High Capacity Digital (DS1)			
	Telemeteing, SCADA Data (Type 3 Service)			
	High Capacity Digital (DS1) (Type 3/5 Service)			
	Audio Tone Protective Relaying (Type 3 Service			

(16) ENGINEER OR REPRESENTATIVE

(NOTE: MUST HAVE ATTACHED SKETCH OF THE POWER STATION SHOWING PRESENT AND FUTURE POWER TRANSMISSION ROUTES)

SIGNATURE	TELEPHONE NUMBER	ADDRESS
Printed Name		
	Date	

rev 05/2016

INSTRUCTIONS FOR RG31-0048

1. Customer Name
2. Power Station Name
3. Power Station Address
4. Power Station Phone Number
5. Other end of requested service if applicable. Use additional forms for multi-point circuit locations.
6. X/R (inductive reactance to resistance) ratio for worst case fault current.
7. Worst case fault current passing through the grid resulting in a Ground Potential Rise (GPR).
8. Grid impedance in relation to remote earth. See IEEE 367 section 4.3
9. Area covered by station ground grid in square feet.
10. Ground Potential Rise (Voltage RMS)
11. If customer provided high voltage protection, list Manufacturer make and model of equipment.
12. Check appropriate boxes for requested service.
    - **Class A** circuit continues to operate before, during and after a fault.
    - **Class B** circuit continues to operate before and after a fault.
    - **Class C** circuit operates before a fault but may fail during a fault and requires manual reset.

    NOTE: CenturyLink no longer offers Class A service on new circuit requests.
13. Existing number of services of each type now at the location.
14. Number of services of each type being requested.
15. Projected future services of each type expected at this location.
16. A signature and date is <u>required</u> from the engineer providing the information or a representative of the company requesting the service.
    Please include phone number and address of person signing form

NOTE: This form supersedes CenturyLink POWER STATION REQUEST FOR TELECOMMUNICATIONS (form 100D) and or RG31-0048 predated 2012

6.0 GROUND POTENTIAL RISE (GPR) and ZONE of INFLUENCE (ZOI)

6.1 Overview

Electric supply locations, in the event of a power system ground fault, can present safety and operational hazards to telephone personnel, facilities & equipment and customer service. The telephone outside plant [OSP] cable facilities serving customers in and adjacent to electrical supply locations may require treatment and special protection.

6.2 Ground Potential Rise (GPR)

In the event of an electrical power line to ground fault, increased amperage at the fault will generate return currents, a portion of which will flow from the electrical fault location back through the earth to the electric supply location ground grid causing a ground potential rise (GPR). This means that the earth ground reference is elevated to a high voltage condition at the electric supply location with respect to remote earth for the duration of the electrical fault.

6.3 Zone of Influence (ZOI)

The ZOI can be defined as any location outside the electric supply location ground grid where the GPR is calculated at 300 Volts or higher. The 300 Volt point location can *only* be determined by utilizing the information provided by the owner of the high voltage structure via issuance of the electrical supply location Request for Electrical Information form, RG31-0048. The ZOI shall be calculated/ verified by a CenturyLink Electrical Protection Engineer from the electrical data supplied on the request form.

6.4 Peak Asymmetrical Voltage

Using the power system X/R ratio provided on the RG31-0048 form, CenturyLink will determine the DC offset which will be used to calculate the Peak Asymmetrical AC Voltage (worst case scenario.) For **safety** and reliability, the peak asymmetrical voltage level will be used to help determine the correct facility type to be used to deliver the requested service into the electrical supply location.

Peak Asymmetrical Voltage levels and possible facility types are:

- **Less than 300 Volts AC**-Standard copper cable or service wire and standard station protection.

- **Between 301-999 Volts AC**- Recommended high dielectric strength copper cable and the customer will be given the option to install high voltage isolation equipment. High voltage protection equipment will be optional depending on service reliability required.

- **Between 1000-17,000 Volts AC**- High dielectric strength copper cable and high voltage isolation equipment or all dielectric (non-metallic) optical fiber cable alternative.

- **Over 17,000 Volts AC**- Copper cable facilities cannot be used. Only an all dielectric (non-metallic) optical fiber cable solution, either central office based or a hybrid copper to optical fiber system can be used. The customer requesting service can place their own optical fiber alternative for service delivery inside the 300 volt point of the ZOI.
  CenturyLink will direct the customer where to place their intermediate fiber cabinet for their copper to fiber junction (CFJ) on the public right-of-way. The customer will be responsible for placement and maintenance of their optical fiber equipment and the dielectric optical fiber cable. For the sake of safety, when available, CenturyLink will line-power the optical fiber equipment. There may be an additional charge. Tariff FCC-5 has been modified, effective 8/25/98, to allow for this.

6.4.1 Peak Asymmetrical Voltage Formula

The formula used to determine the peak asymmetrical ground potential rise (GPR) is:

$$GPR = I_{r\text{-}f} \times Z_g \times \sqrt{2} \times K_p$$

Where,
GPR is Ground Potential Rise
$I_{r\text{-}f}$ is earth return fault current
Z_g is grid impedance
K_p is the peak factor from the table on the next page

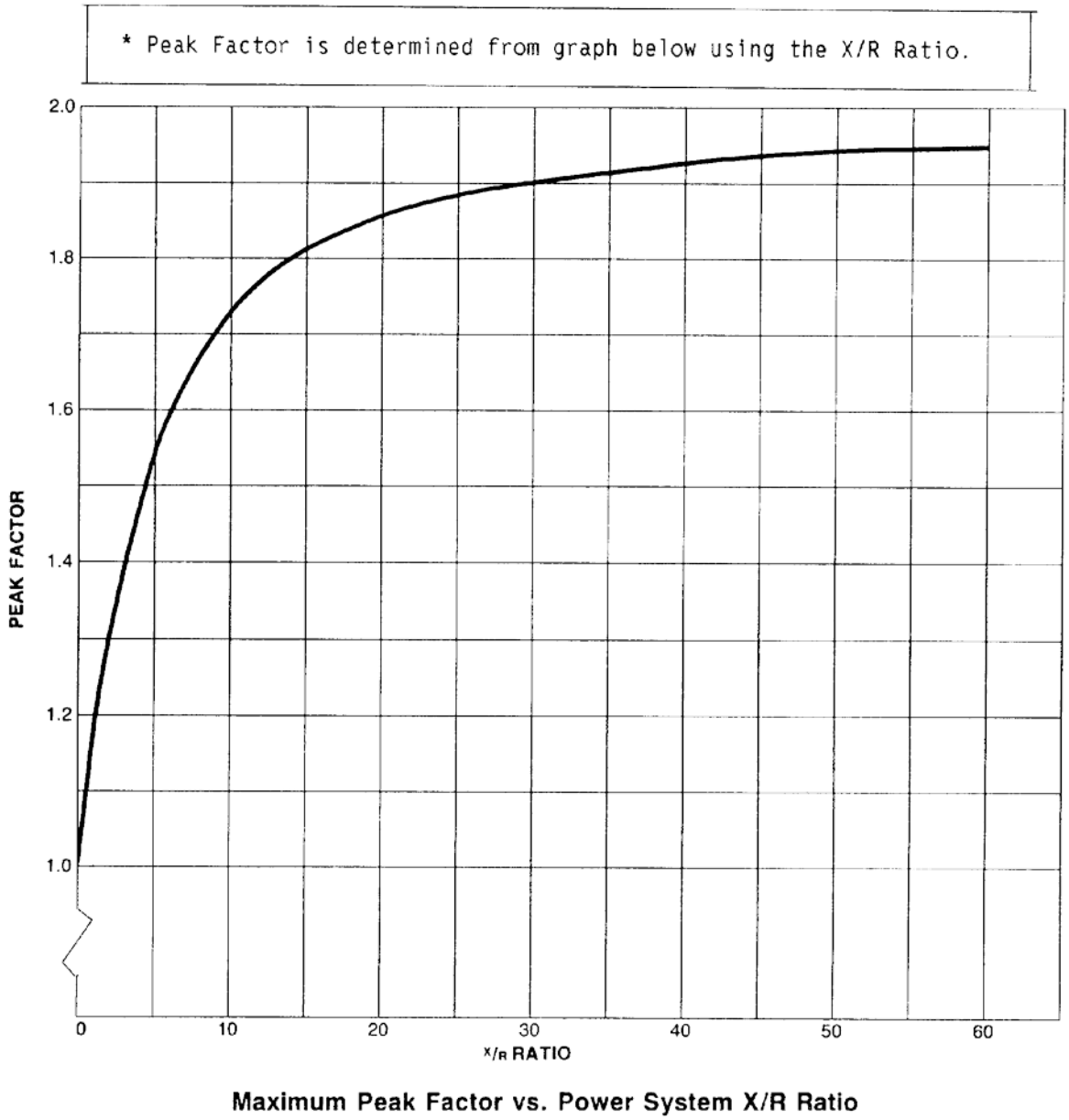


Figure 6-1 Ground Potential Rise (GPR)

NOTE:

If the X/ R ratio is not provided on Form RG31-0048, a value of 14 will be assumed.

6.5 Ground Potential Distribution From the Edge of the Electrical Supply Location (substation etc.) Ground Grid With Respect to Remote Earth

Graphs depicting the fraction of total ground potential rise (GPR) in relation to the distance from the edge of the grid are provided in Exhibits 6-2, 6-3, 6-4 and 6-5. These graphs will be used by CenturyLink to determine the physical distance from the edge of grid to the 300 volt point if actual test results, using fall of potential,(see IEEE 367® and IEEE 81.2®) were not provided.

The vertical axes of these graphs represent a fractional ratio of a selected voltage to the GPR. As a ratio, the type of voltage (RMS, peak, and peak asymmetrical) selected is of no consequence. CenturyLink uses 300 volts as the selected voltage to determine the minimum distance from the edge of the grid to the general purpose cable splice location.

Linear interpolation between graphs may be used to determine distances from the edge of grid areas not given.

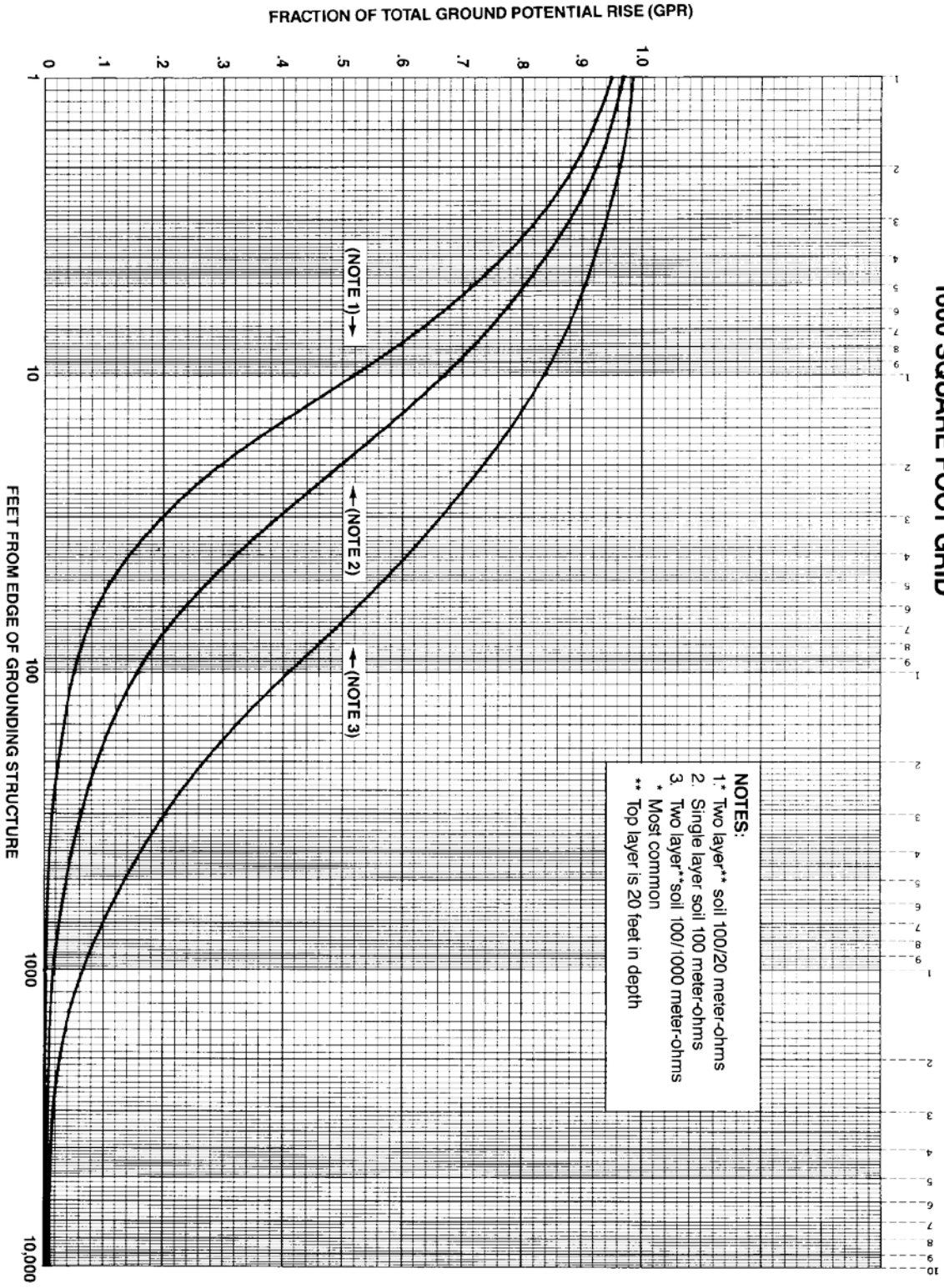


Exhibit 6-2 (GPR) 1600 Square Foot Grid

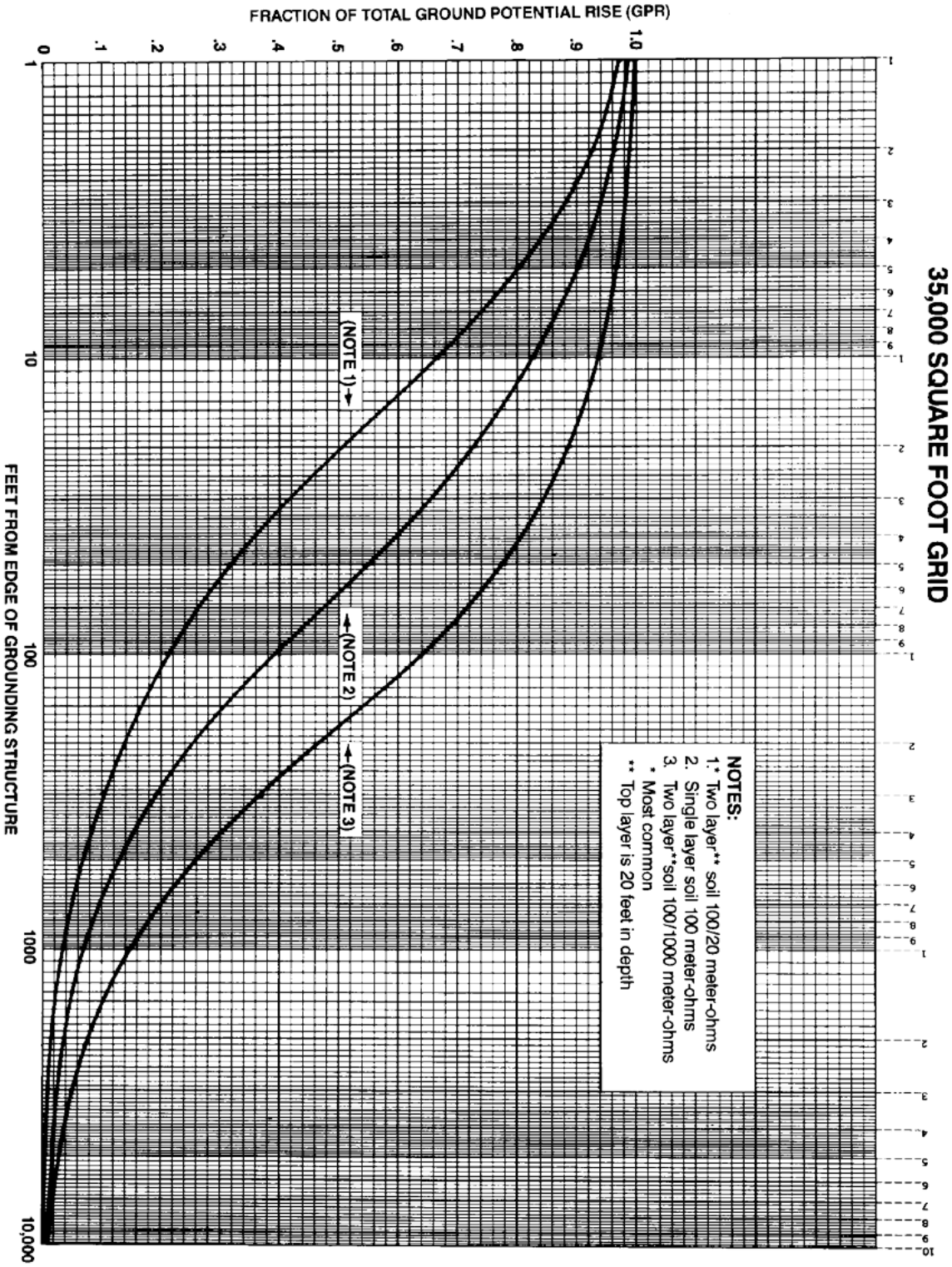


Exhibit 6-3 (GPR) 35,000 Square Foot Grid

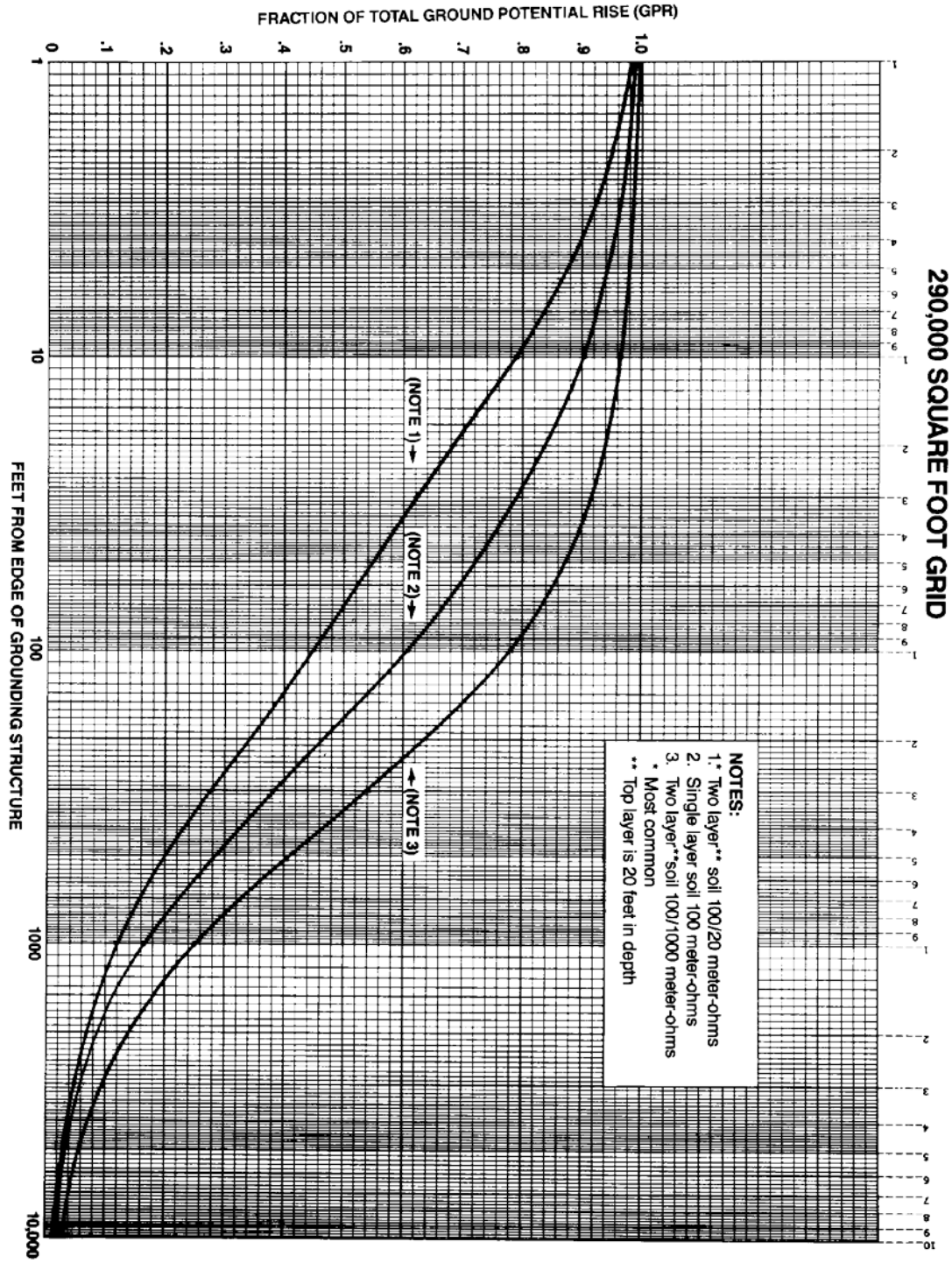


Exhibit 6-4 (GPR) 290,000 Square Foot Grid

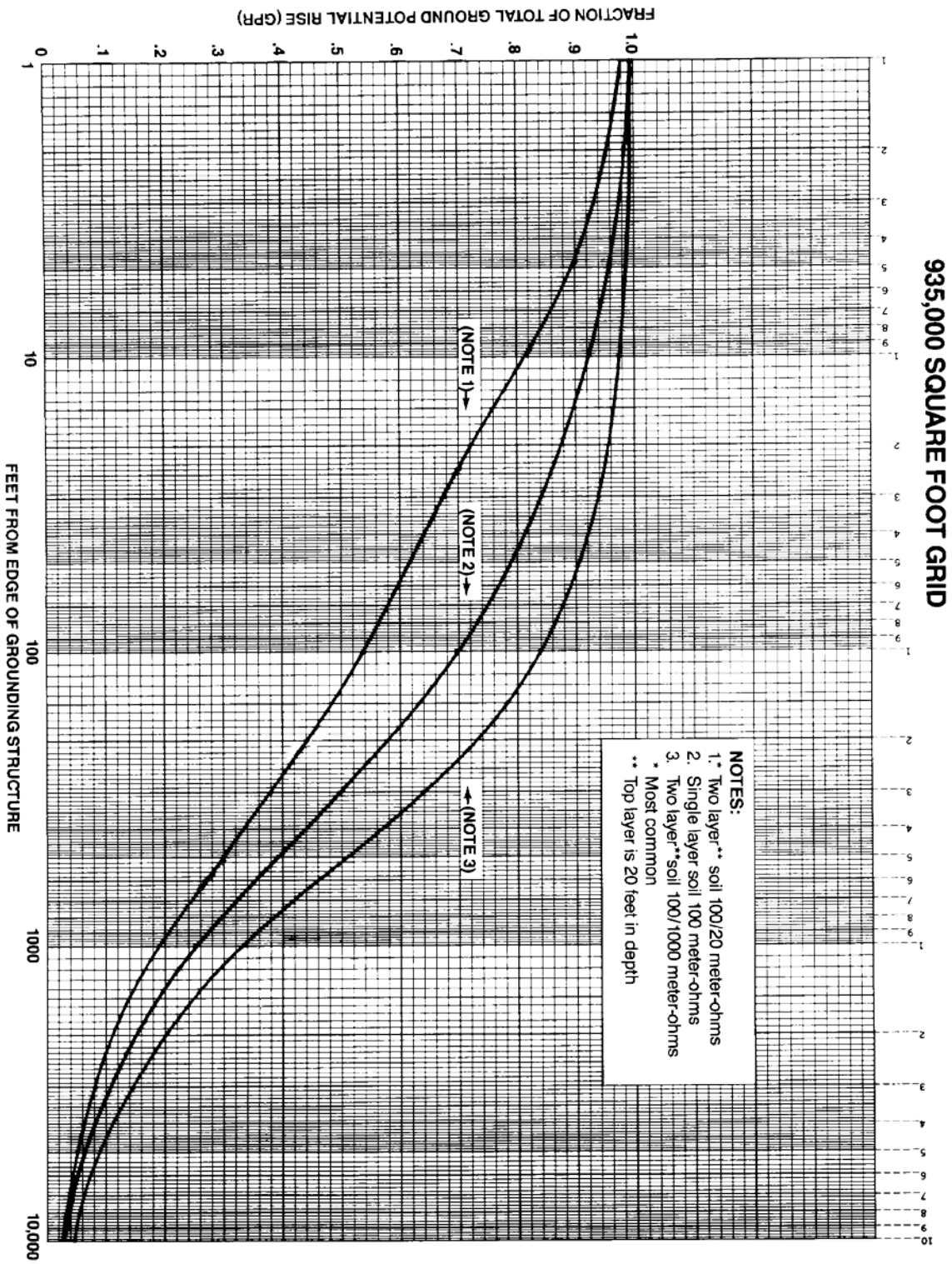


Exhibit 6-5 (GPR) 935,000 Square Foot Grid

7.0 High Dielectric Strength Copper Cable and High Voltage Protection

7.1 CenturyLink Provided High Voltage Protection

When CenturyLink provides high voltage protection, the customer requesting service will be required to provide the following:

- Mounting structure (plywood back board, H Frame etc.)
- Conduit- 2 to 4- inch schedule 40 PVC placed to the public right of way at least 10 feet beyond the fence surrounding the electrical supply location.
- Local power from DC batteries or local AC utilizing a UPS or inverter system
- Local ground source from the station grounding system

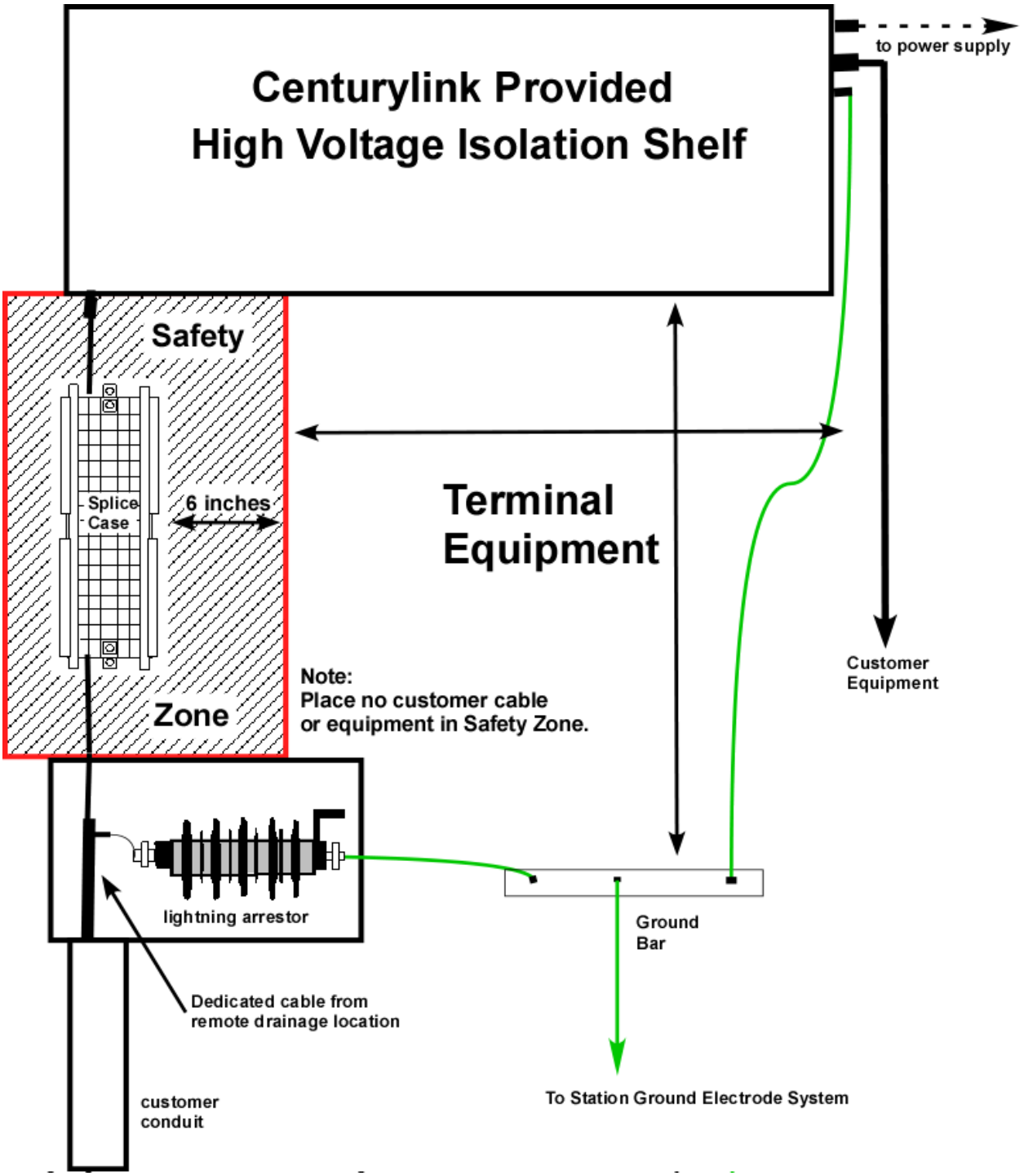


Exhibit 7-1
CenturyLink Provided High Voltage Protection

7.2 Customer Provided High Voltage Protection

When the customer provides high voltage protection, all high voltage protection equipment must be approved by CenturyLink. CenturyLink will interposition the NCTE, NIU as an extended Demarc on the station side of the customer's high voltage protection equipment. The customer requesting service will be required to provide the following:

- Mounting structure -plywood back board
- Conduit- 2 to 4 inch schedule 40 PVC placed to at least 10 feet beyond the fence surrounding the electrical supply location or to the public right of way in some areas.
- CenturyLink or the customer may provide the lightning arrestor and a high voltage isolation jack panel. The jack panel will be considered the primary Demarc for the electrical supply location. Installation of the cable facilities directed to a location beyond the high voltage protection device is *the sole responsibility of the customer requesting service*. In addition, the extended facility shall meet the requirements outlined in IEEE 487-™.
- Local ground source from the station grounding system.
- Local power from DC batteries or local AC utilizing a UPS or inverter system

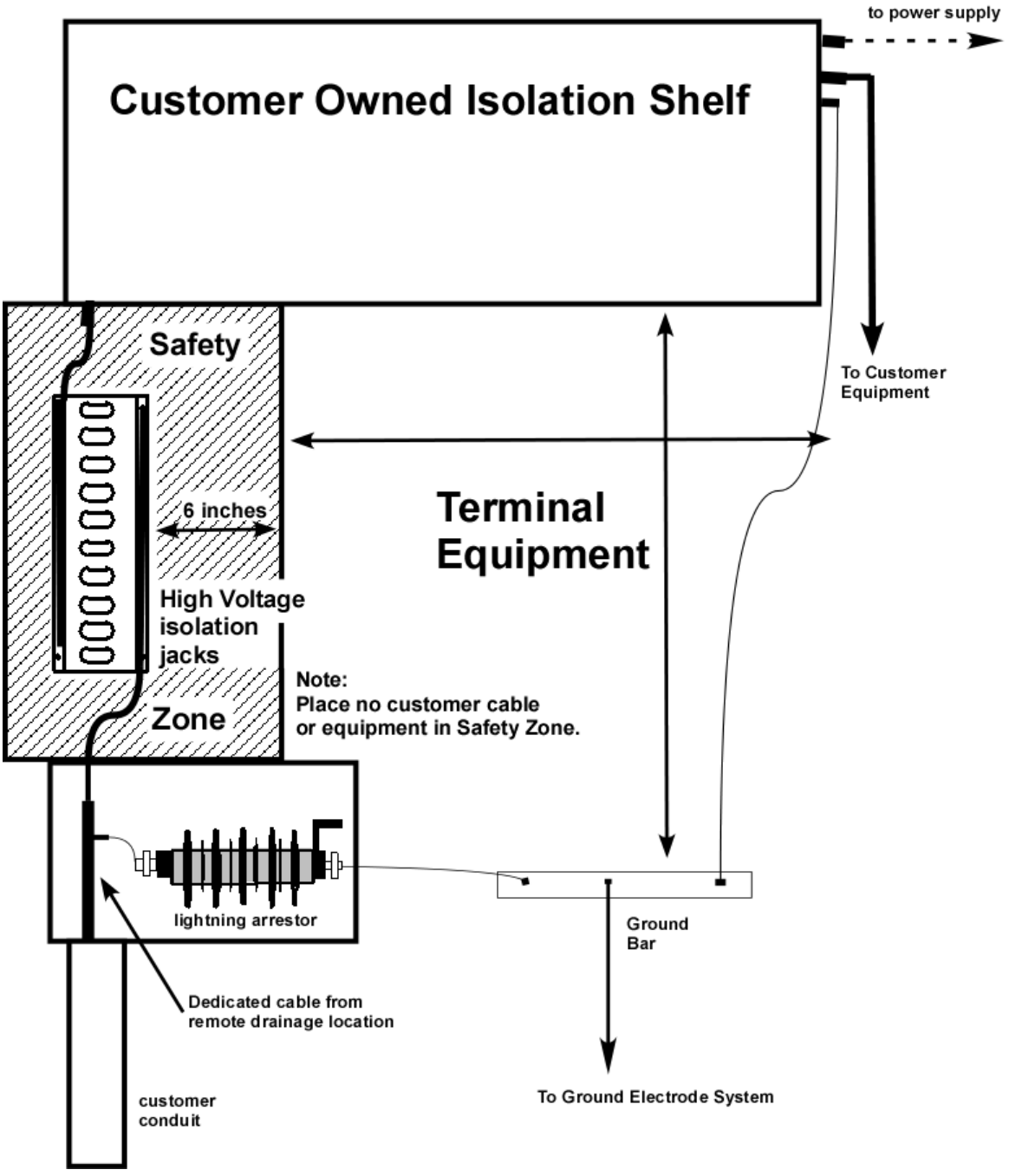


Exhibit 7-2
Customer Provided High Voltage Protection

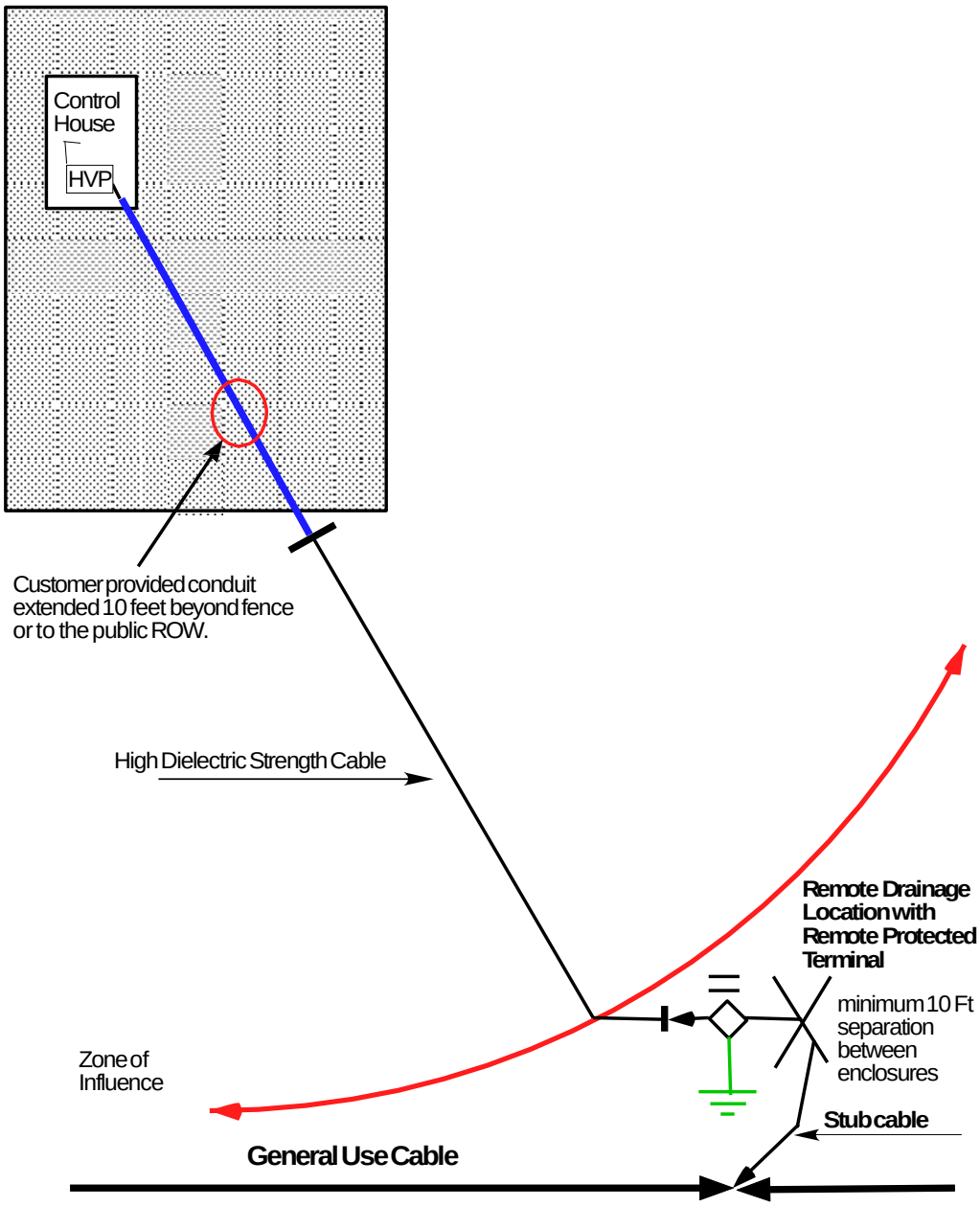


Exhibit 7-3
Service into Electrical Supply Location

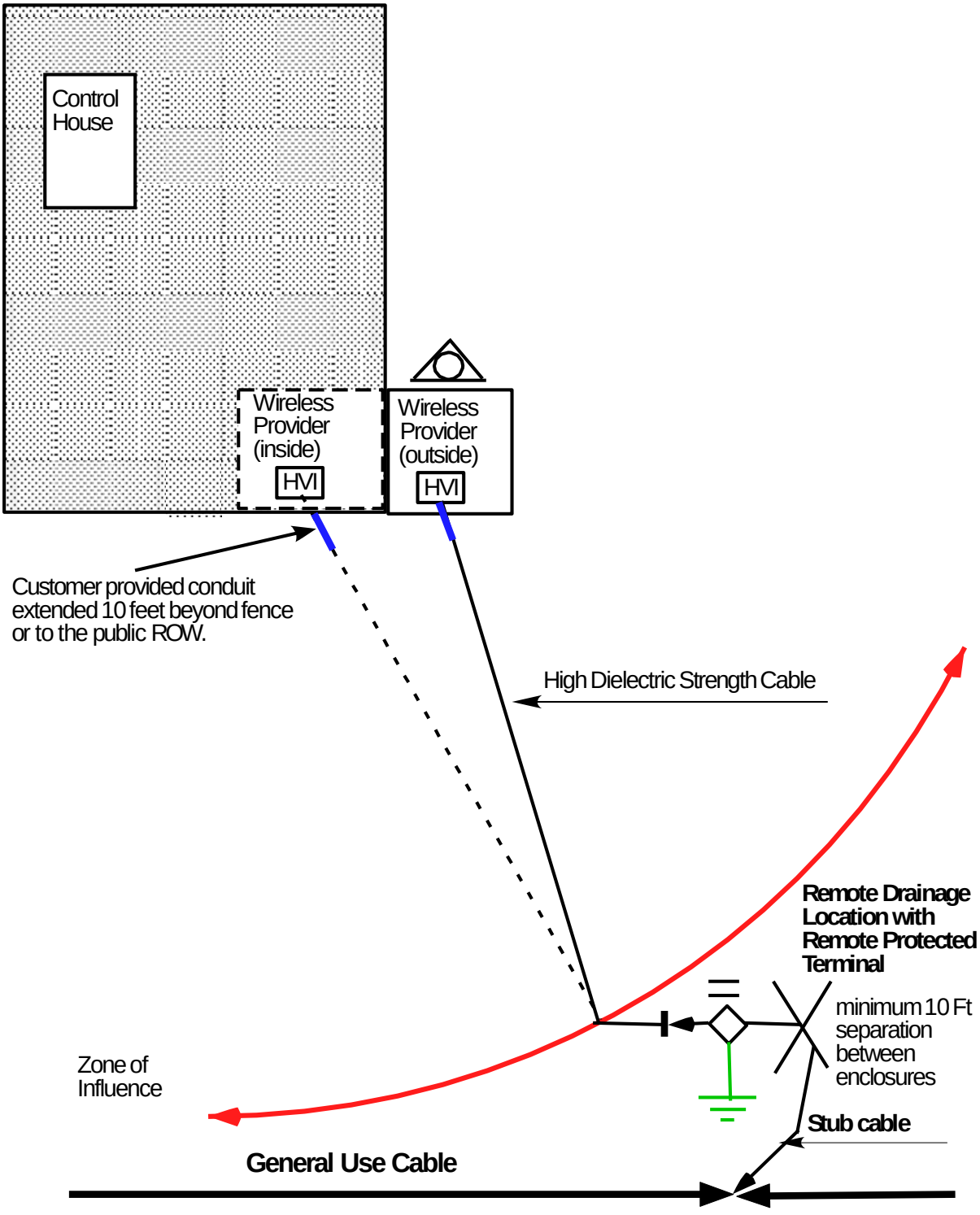


Exhibit 7-4
Service into Wireless Providers Co-Located at Electrical Supply Locations

8.0 Optical Fiber Facilities (see IEEE 487.2™ and IEEE 487.3™)

Optical fiber solutions are used to eliminate the use of dedicated metallic facilities within the ZOI and provide electrical isolation, or when the requested data rate exceeds the ability of copper facilities. A fiber solution is REQUIRED at locations with a calculated peak- asymmetrical GPR value of 17,000 volts (17 kV) or greater or as directed by the CenturyLink Electrical Protection Engineer. There are two types of optical fiber cable solutions available for use in serving electrical supply locations.

- Central office or remote electronic based systems
- Copper-to-fiber hybrid systems.
  Regardless of the optical fiber solution used, the optical fiber cable and associated support structures shall be all dielectric (non-metallic).
- All dielectric (no metallic strength members or shield) dedicated optical fiber cable shall be installed within non-metallic conduit/inner duct.
- Electronic Marker Systems (EMS) locating devices shall be placed every 25 feet along the path of the dedicated all-dielectric optical fiber cable serving the electrical supply location.
- Non-metallic cable route markers are to be located a maximum of 500 feet or line of sight the length of the dedicate cable route.
- No "pest" duct (rodent proof with metallic components) or metallic locate wires may be used as they create a serious safety hazard during a GPR event.

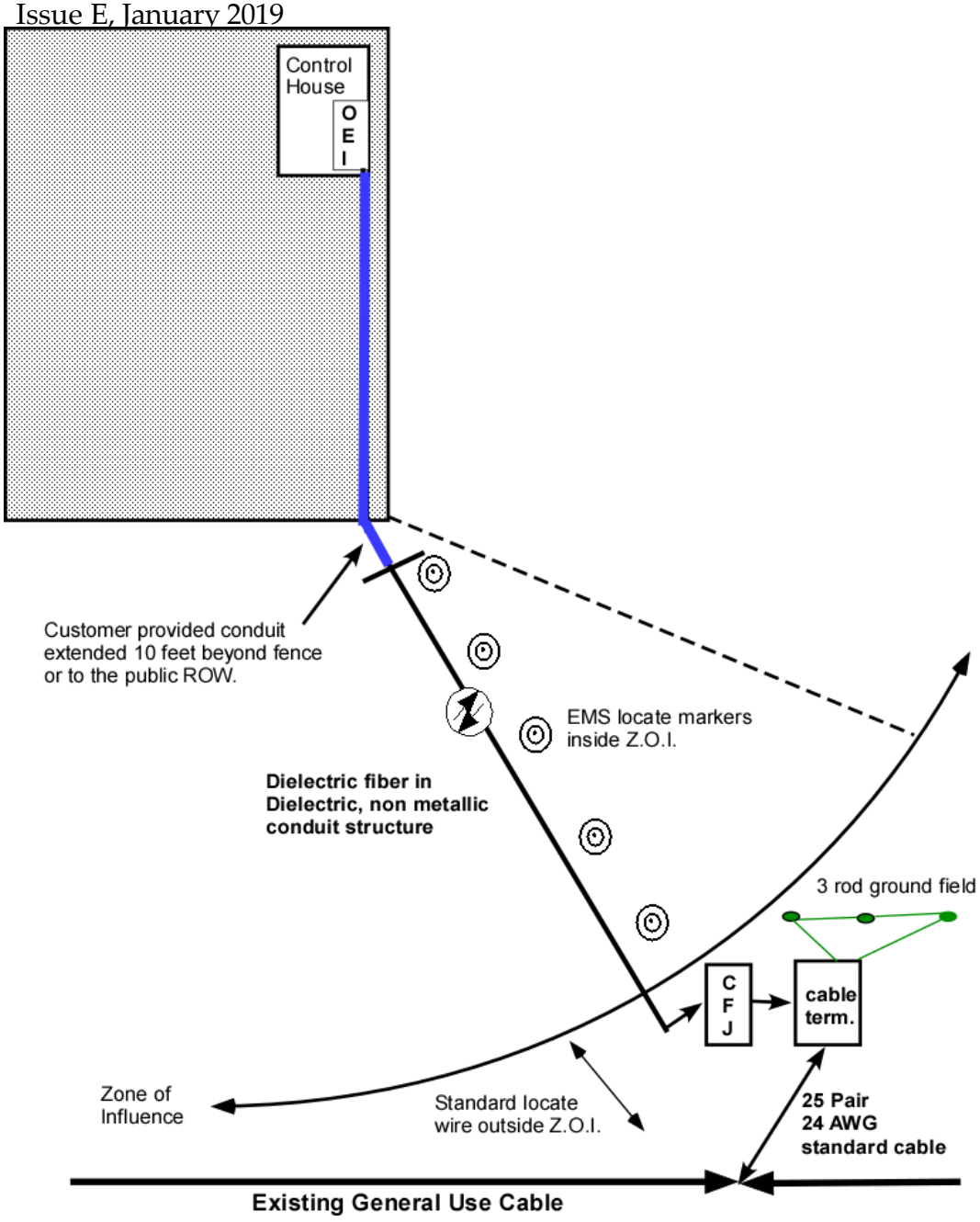


Exhibit 8-1

Customer Provided Hybrid Optical Fiber System

8.1 CenturyLink Provided Optical Fiber System

When CenturyLink provides the optical fiber systems, the Demarc will be located at the remote terminal equipment serving the customers location.

8.1.1 Central Office or Remote Electronic Cabinet Based System

Central office based termination equipment, located at/in the electrical supply location, shall have all metallic components bonded together and bonded to the station grounding system. This will ensure the safety of technicians working on the equipment and help prevent damage to the equipment during a GPR event.

8.1.1.1 Equipment Powering

Central office or remote electronic based optical fiber termination equipment, located at/in the electrical supply location, must be locally powered from the electrical supply location batteries or from a customer provided AC power source utilizing a UPS or inverter.

8.1.2 Copper to Fiber Hybrid

Hybrid optical fiber systems are specialized electronics that convert electrical signals from the existing copper facilities to optical signals, providing service to the customer location. The electronic components of a hybrid system are:

- Intermediate Electronics – This unit is located at the copper- to-fiber junction (CFJ)
- Optical Equipment Interface (OEI) – This unit is located at the customer location to convert the optical signal back to an electrical signal

An all dielectric nonmetallic dedicated optical fiber cable is to be installed between the intermediate electronics (CFJ) and the OEI. No locate wires shall be used in placing optical fiber facilities. EMS marker devices should be placed along the trench at regular intervals.

The copper to fiber hybrid OEI, located at/in the electrical supply location, shall be locally powered from the electrical supply location batteries or from a customer provided AC power source utilizing a UPS or inverter system.

8.2 Customer Provided Optical Fiber System

Any Optical fiber system provided by the customer requesting service must follow IEEE 487.2™ *IEEE Standard for the Electrical Protection of Communication Facilities Serving Electric Supply Locations Through the Use of Optical Fiber Systems*© or IEEE 487.3™ *IEEE Standard for the Electrical Protection of Communication Facilities Serving Electric Supply Locations Through the Use of Hybrid Facilities*© and be approved by CenturyLink. On any customer provided optical fiber systems, the fiber distribution panel or the copper to fiber junction shall be considered the Demarc.

8.2.1 Point to Point or Optical Fiber Handoff

When the customer provides their own optical fiber termination equipment (MUX), CenturyLink will hand off service in an approved fiber distribution panel (FDP). The location of this panel may be negotiated with the customer requesting service. Options for placing the FDP include but are not limited to:

- Wall mounted inside the customers building/ cabinet
- Rack mounted inside the customers building/ cabinet
- In a CenturyLink approved outdoor rated enclosure in the public right of way.

8.2.2 Customer Provided Hybrid Optical Fiber Solution

- For hybrid optical fiber based facilities, CenturyLink will meet the customer at or beyond the calculated 300 volt point of the zone of influence when the GPR exceeds 17 kV Peak Asymmetrical. For sites below 17 kV Peak Asymmetrical, the CFJ can be located at or beyond the ZOI or outside the substation fence as long as the entire hybrid system is located on the substation ground grid.
- Fiber equipment located at the CFJ may be line powered, when available, from the CenturyLink circuits or externally powered by an AC source OTHER than from the electrical supply location being served. This is to ensure the safety of CenturyLink technicians working on the equipment and the reliability (survivability) of the protection system.

- For any optical fiber solution used to provide service to a wireless provider at or near substations or on high voltage transmission poles/towers, the CenturyLink Electrical Protection Engineer will require electrical data which shall be requested from the customer/power provider using form RG31- 0048 and the GPR/ZOI shall be calculated by a CenturyLink Electrical Protection Engineer PRIOR to the system being designed

NOTE: Examples of typical Hybrid Optical Fiber Systems and CFJ Layouts are found in the following diagrams:

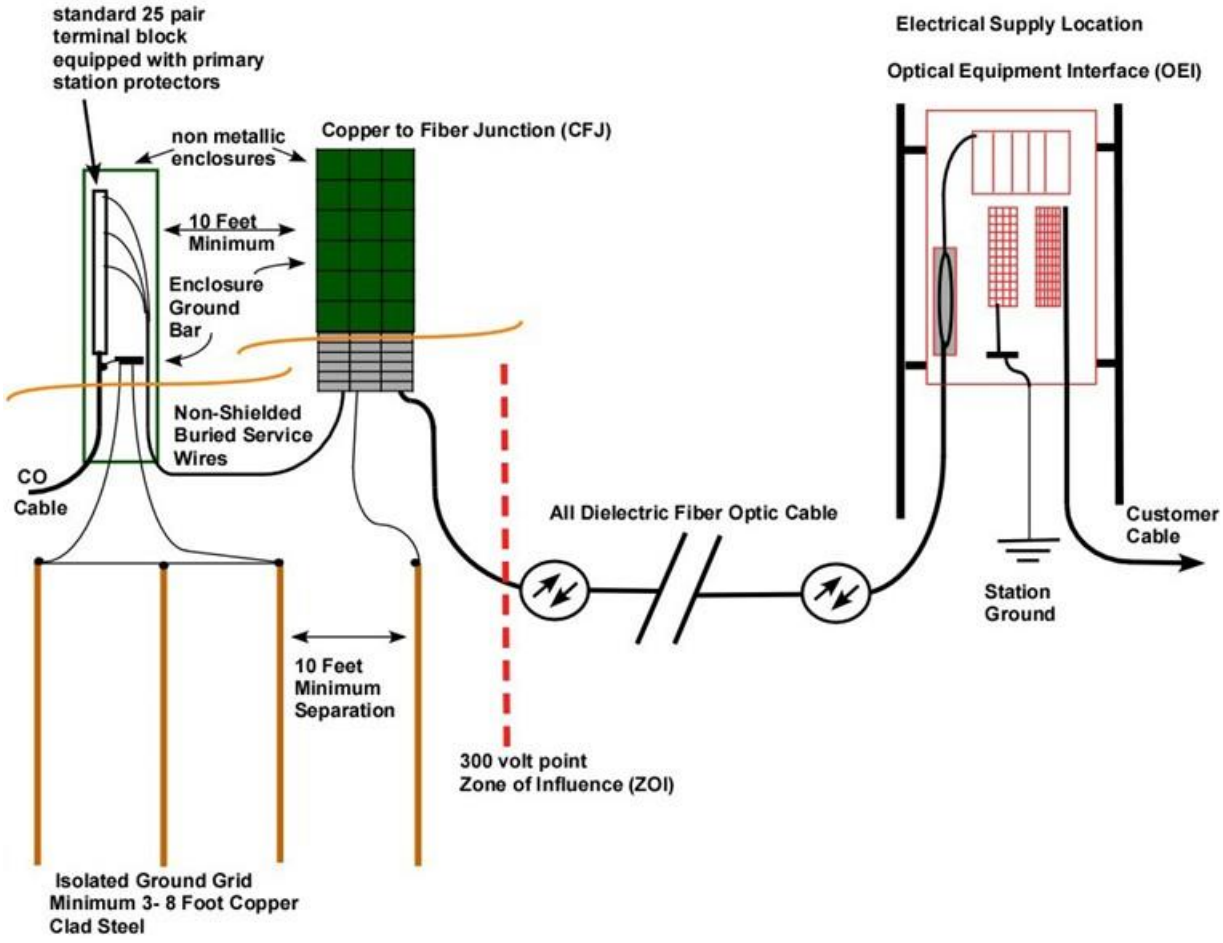


Exhibit 8-2
Basic Customer Provided Hybrid Optical Fiber System Layout

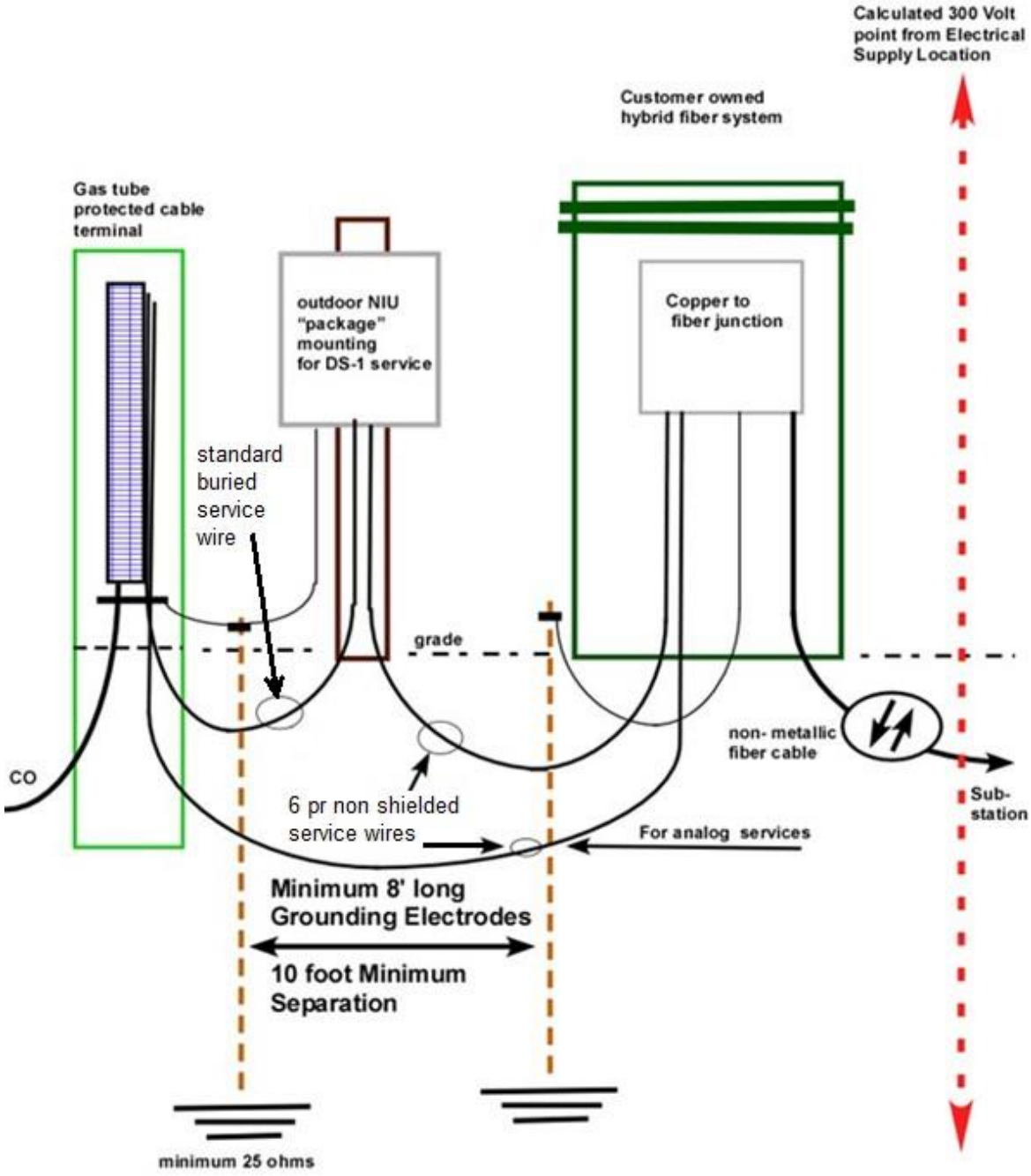


Exhibit 8-3
Example of a Customer Owned Hybrid Optical Fiber System CFJ

9.0 Acronyms

- GPR Ground Potential Rise
- ZOI Zoe of Influence
- AC Alternating Current
- DC Direct Current
- IEEE Institute of Electrical and Electronic Engineers
- USOC Universal Service Order Code
- Inter-LATA Inter-Local Access and Transport Area
- Intra-LATA Intra-Local Access and Transport Area
- ISDN Integrated Services Digital Network
- CFJ Copper to Fiber Junction
- OEI Optical Equipment Interface
- FDP Fiber Distribution Panel
- UPS Uninterruptable Power Supply

10.0 References

10.1 IEEE

Dot series of documents including:

- IEEE 487™ IEEE "Standard for the Electrical Protection of Communications Facilities Serving Electric Supply Locations—General Considerations"©
- IEEE 487.1™ IEEE "Standard for the Electrical Protection of Communication Facilities Serving Electric Supply Locations Through the Use of On-Grid Isolation Equipment"©
- IEEE 487.2™ IEEE "Standard for the Electrical Protection of Communication Facilities Serving Electric Supply Locations through the Use of Optical Fiber Systems"©
- IEEE 487.3™ IEEE "Standard for the Electrical Protection of Communication Facilities Serving Electric Supply Locations Through the Use of Hybrid Facilities"©
- IEEE 487.4™ IEEE "Standard for the Electrical Protection of Communication Facilities Serving Electric Supply Locations Through the Use of Neutralizing Transformers"©
- IEEE 487.5™ IEEE "Standard for the Electrical Protection of Communication Facilities Serving Electric Supply Locations Through the Use of Isolation Transformers"©

- IEEE 789™ "IEEE Standard Performance Requirements for Communications and Control Cables for Application in High Voltage Environments"©

- IEEE 367™ "IEEE Recommended Practice for Determining the Electrical Power Station Ground Potential Rise and Induced Voltage from a Power Fault"©

10.2 Exhibits

4-1 Design Information for Power Industry Channels

4-2 Intralata Service Offerings Matrix

4-3 Inter-lata Service Offerings Matrix

4-4 through 4-19 Detailed Service Descriptions

5-1 RG31-0048 form and instructions

6-1 Ground Potential Rise (GPR) X/R Chart

6-2 Chart used to help determine the ZOI (1600 square foot grid)

6-3 Chart used to help determine the ZOI (35000 square foot grid)

6-4 Chart used to help determine the ZOI (290,000 square foot grid)

6-5 Chart used to help determine the ZOI (935,000 square foot grid)

7-1 CenturyLink Provided High Voltage Protection

7-2 Customer Provided High Voltage Protection

7-3 Service into Electrical Supply Location

7-4 Service into Wireless Providers Co-Located at Electrical Supply Locations

8-1 Customer Provided Hybrid Optical Fiber System

8-2 Basic Customer Provided Hybrid Optical Fiber System Layout

8-3 Example of a Customer Owned Hybrid Optical Fiber System CFJ