

U S WEST
Communications, Inc.
Technical Publication

Special High
Voltage Protection

PUB 77321
Issue A
June 1988

U S WEST
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Voltage Protection

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This publication describes telecommunication services provided by U S WEST that extend into high voltage environments. Services that enter high voltage environments may require special protection.

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1. General

This document describes telecommunications services provided by U S WEST that extend into high voltage environments. Services that enter high voltage environments may require special protection. This Special High Voltage Protection as designed by U S WEST will provide personnel and equipment safety while insuring the continuity of service. The provision of these services generally follows the recommendations of ANSI/IEEE STD. 487, "IEEE Guide for the Protection of Wire-Line Communication Facilities Serving Electric Power Stations."

2. Purpose

The purpose of this document is to describe services provided on facilities that extend into high voltage environments, i.e., electric power generating, switching and distributing locations. These services 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 U S WEST 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 with the approval of U S WEST.

This offering requires Special High Voltage Protection at the customer's premises and at the U S WEST Central Office whenever the fault-produced GPR/induction equals or exceeds 1000V peak-asymmetrical.

3. Responsibility of U S WEST

U S WEST, working in conjunction with the customer, shall determine the proper methods of protection required to achieve the objectives set forth in Chapter 2. The method of protection for every service in a cable shall be coordinated by U S WEST to be compatible with the protection provided for the most critically important service in that cable.

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

U S WEST reserves the right to treat Special High Voltage Protection on an individual case basis, dependent on the type of facilities available.

U S WEST reserves the right to suspend any service without adequate Special High Voltage Protection until adequate protection is provided.

4. Responsibility of the Customer

The customer shall be responsible for providing to U S WEST a completed Form RG31-0048, "Design Information for Power Industry Channels," (see Exhibits 10-1, pages 1-3 on pages 10-2 through 10-4) which includes the following:

- Exhibit 10-1, page 10-2 is the front of Form RG31-0048 with numbered blocks used for directions on how it is to be completed.
- Exhibit 10-1, page 10-3 is the back of Form RG31-0048 which identifies service types and performance objectives.
- Exhibit 10-1, page 10-4 is the instructions for filling out Form RG31-0048 using Exhibit 10-1, page 10-2.

Changes in the information provided in the first paragraph in this chapter will require written notification, 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.

5. Protection Service Types

Protection services which U S WEST 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.
- Type 2 - Private Line Access Service requiring (ac/dc) Voiceband or (dc) Narrowband transmission, used for pilot wire protective relaying or (dc) tripping respectively.
- Type 3 - Private Line Access Service requiring (ac) Voiceband/Data transmission only, used for telemetering, supervisory control, data, etc.
- Type 4 - Private Line Access Service requiring (ac) Voiceband transmission only, used for audio tone protective relaying.

6. Service Performance Objective Classifications

Interruptions for outages of telecommunications circuits serving electric power substations 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 natural disaster. Circuit failures caused by such events cannot be prevented and U S WEST expressly states that provision of the service provided in this section cannot preclude such service outages as many occur due to the above mentioned circumstances.

Interruptions or outages due to the effects (Ground Potential Rise and/or induction) of faults 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 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. Service Performance Objective Classifications are offered to provide various degrees of service continuity during power system faults.

- 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.

7. Service Offerings

The following customer option matrix identifies intralata service offerings with service performance objective classifications and the associated Universal Service Order Code (USOC).

TYPE/ CLASS SERVICES	SERVICE CODES	USOC (NOTES 1 & 2)										
		HV A	HV B	HV C	HV D	HVE	HVF	HV G	HV H	HVJ	HV K	HVL
1B	LS			X								
1B	BA			X								
1B	SG			X								
1B	CS			X								
2B	PV		X			X						
2B	PW		X			X						
1B	TC	X		X								
1B	TT	X		X								
3B	PA								X	X		
1B	PL			X	X							
1B	RT			X	X							
3A	VM						X	X				
3B	VM								X	X		
1B	OS			X								
1B	IT				X							
1B	TA				X							
1B	TL				X							
3A	FD						X	X				
3B	FD								X	X		
4A	PR										X	X
3A	SS						X	X				
3B	SS								X	X		
1B	LA	X		N	N							
3B	MT								X			
1B	DP	X			N							
1B	DQ	X			N							
1B	DR	X			N							
1B	DW	X			N							
3B	DA									X		
1B	FX			X								
1B	FT			X								
1B	OP			X								
3B	HC									X		
1B	UC			X	X							
1B	UD			X	X							
3B	UE								X			
3A	UG						X	X				
3B	UG								X	X		
3B	UH									N		
1B	US	X		N	N							
1B	UY	X		X								
1B	UZ			X	X							

Figure 7-1 Intralata Service Offerings Matrix (1 of 2)

N-Not available for all applications. 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 7-1 Intralata Service Offerings Matrix (2 of 2)

The following customer option matrix identifies interlata service offerings with service performance objective classifications and the associated Universal Service Order Code (USOC).

TYPE/ CLASS SERVICE	SERVICE DESIGNATO R CODES	USOC (NOTES 1 & 2)										
		HV A	HV B	HV C	HV D	HVE	HVF	HV G	HV H	HVJ	HV K	HVL
1B	VG1			X	X							
1B	VG2	S		X	X							
1B	VG3	S		X	X							
1B	VG4				X							
3A	VG5						X	X				
3B	VG5								X	X		
3A	VG6							X				
3B	VG6									X		
1B	VG7	S		X	X							
1B	VG8	S		S	S							
1B	VG9	S			X							
3A	VG10						X	X				
3B	VG10								X	X		
3A	VG11						X	X				
3B	VG11								X	X		
4A	VG12										X	X
1B	VGW	S		S	S							
3B	VGB								X	X		
1B	LS1			X								
1B	LS2			X								
2B	MT3					X						
1B	TG1	X		X								
1B	TG2			X	X							
1B	FGA	S		S	S							
1B	FGB	S		S	S							
1B	FGC	S		S	S							
1B	FGD	S		S	S							
1B	AP1			X								
1B	AP2			X								
1B	AP3			X								
1B	AP4			X								
1B	DA1	X										
1B	DA2	X										
1B	DA3	X										
1B	DA4	X										
3B	HC1									X		

Figure 7-2 Interlata 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.

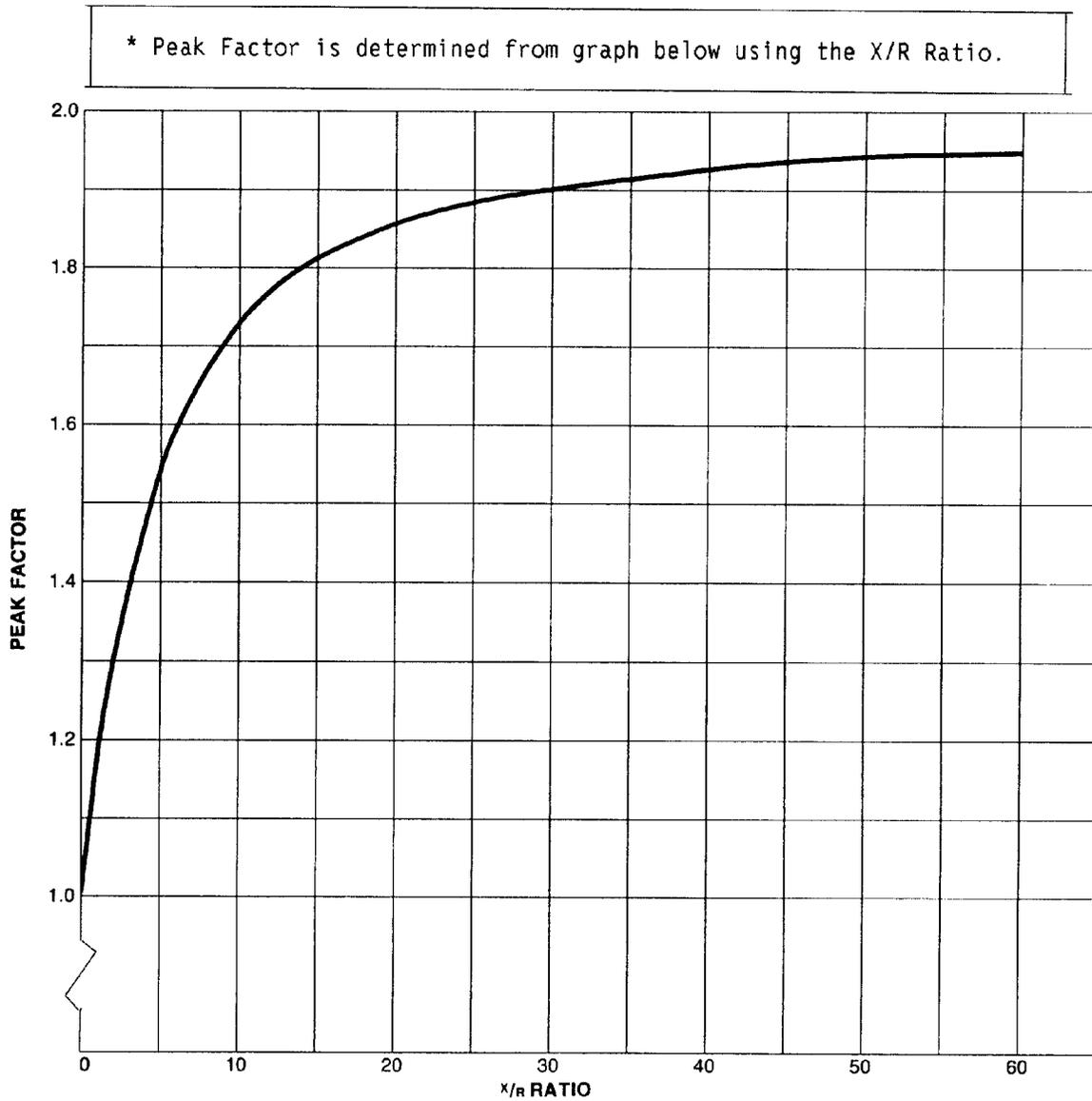
Figure 7-2 Interlata Service Offerings Matrix (2 of 2)

8. Ground Potential Rise (GPR)

The formula used to determine the peak asymmetrical Ground Potential Rise (GPR) is:

$$\text{Earth Return Fault current} \times \text{Grid Impedance} \times \sqrt{2} \times \text{Peak Factor}^*$$

* Peak Factor is determined from graph below using the X/R Ratio.



Maximum Peak Factor vs. Power System X/R Ratio

Figure 8-1 Ground Potential Rise (GPR)

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

9. Ground Potential Distribution From Edge of Power Station 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 10-2, 10-3, 10-4 and 10-5. These graphs will be used by U S WEST to determine the physical distance from the edge of grid to the 300 volt point if actual test results were not provided on Form RG31-0048 (see Exhibit 10-1, page 10-4, Instruction 14).

The vertical axes of these graphs represent a fractional ratio of a selected voltage to the GPR. As a ratio the type of voltages (RMS, peak, peak asymmetrical) selected is of no consequence. U S WEST 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 maybe used to determine distances from the edge of grid areas not given.

10. Detail Service Descriptions

The detail service descriptions show the design configurations with the associated circuit usage (USOC). (See Exhibits 10-6 through 10-20).



RG31-0048
(4-88)

DESIGN INFORMATION FOR POWER INDUSTRY CHANNELS

CUSTOMER INFORMATION

(Use one form for each service order requested. See item Service Classification.)

Pg _____ of _____

CUSTOMER 1			
LOCATION A - STATION NAME 2	ADDRESS 3	TEL. NO. 4	
LOCATION B - STATION NAME	ADDRESS	TEL. NO.	

GROUND POTENTIAL RISE (GPR) FAULT DATA

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

SERVICE CLASSIFICATION (Definitions of type, Class and USOC are on reverse of this sheet. If Class C is requested leave Class item blank.)

LOCATION A	TYPE	CLASS	USOC	
	11	12	13	14
LOCATION B	TYPE	CLASS	USOC	

PROPOSED TERMINAL EQUIPMENT

MAKE	MODEL	FACILITIES INTERFACE CODE
15	15	16

CHANNEL TYPE (Existing Service - New Request - Future Needs)

	EXISTING	NEW	FUTURE
17 <input type="checkbox"/> 2 W. PHONE, 2 W. TRUNK, DC CIRCUITS, ISDN (Type 1 Service)	18	19	20
<input type="checkbox"/> TIE LINE, TRUNK, RADIO REMOTE, ETC. (Type 1 Service)			
<input type="checkbox"/> 2 WIRE <input type="checkbox"/> 4 WIRE			
<input type="checkbox"/> DIGITAL DATA SERVICE (Type 1 Service)			
<input type="checkbox"/> PILOT WIRE RELAY (Type 2 Service)			
<input type="checkbox"/> D.C. TRIPPING (Type 2 Service)			
<input type="checkbox"/> A.C. TONES W/O SIGNALING AND HIGH CAPACITY DIGITAL (DS1)			
<input type="checkbox"/> TELEMETERING, SCADA DATA (Type 3 Service)			
<input type="checkbox"/> HIGH CAPACITY DIGITAL (DS1) (Type 3 Service)			
<input type="checkbox"/> AUDIO TONE PROTECTIVE RELAYING (Type 4 Service)			

ENGINEER OR REPRESENTATIVE (Must have attached sketch of the power station showing present and future power transmission routes.)

21 SIGNATURE	DATE	TEL. NO. ()	ADDRESS
--------------	------	--------------------	---------

TELEPHONE COMPANY INFORMATION

22 SERVICE ORDER NO.	DUE DATE	CIRCUIT NUMBER	SPECIAL BILLING NO.
ACCOUNT REPRESENTATIVE		TEL. NO. ()	SEND TO ELECTRICAL PROTECTION ENGINEER
ELECTRICAL PROTECTION ENGINEER - SIGNATURE		DATE	TEL. NO. ()
		ADDRESS	
PROTECTION REQUIRED	300 V pk POINT DISTANCE (FT)	USOC	TYPE
	LOCATION A		QUANTITY
LOCATION B			
LOOP FACILITY DESIGNER		TELEPHONE NUMBER ()	JOB NUMBER

Exhibit 10-1 Form RG31-0048 Design Information For Power Industry Channels (Page 1 of 3)

DEFINITIONS

CLASS A OR B SERVICE

SERVICE TYPE AND PERFORMANCE OBJECTIVE CLASSIFICATION / USOC*

TYPE ① CLASS ② SERVICE (Phone, Tie Lines, Trunks, Radio Control, DC Alarms, Telegraph and DDS).

↳ All circuits used for talking 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.)

USOC

2 Wire	HVC
#4 Wire	HVA
4 Wire	HVD

TYPE ② CLASS B SERVICE (D.C. 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 only where existing facilities and operating conditions permit).

Services which require both AC and DC transmission and which can tolerate momentary interruptions during a power fault. (Must function before and after a power fault.)

2 Wire	HVE
#4 Wire	HVB

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

↳ Critical non type 4 circuits which require class A performance

Services for AC transmission only which cannot tolerate even momentary interruption. (Must function before, during and after a power fault.)

2 Wire	HVF
4 Wire	HVG

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

↳ All tone signals 300 HZ to 5 MHZ and High Capacity Digital (DS1 Rate)

Services for AC transmission only which can tolerate momentary interruptions during a power fault. (Must function before and after a power fault.)

2 Wire	HVH
4 Wire	HVJ

TYPE ④ CLASS A SERVICE (Audio Tone Protective Relaying)

↳ Protective Relaying or Transfer Trip only. (Voice Grade 12 when interlata)

Services for AC transmission only which cannot tolerate even momentary interruption. (Must function before, during and after a power fault.)

2 Wire	HVK
4 Wire	HVL

#Services limited to a maximum ground potential rise (GPR) of 4.0 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-asymmetric, no protection is required and Class C service may be requested. This shall be determined by Electrical Protection Engineer.

*TYPE of service refers to circuit usage.

CLASS of service refers to reliability of HVP during a power fault.

**Exhibit 10-1 Form RG31-0048 Design
Information For Power Industry Channels
(Page 2 of 3)**

INSTRUCTIONS FOR FORM 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 multipoint circuit locations.
6. X/R (inductive reactance to resistance) ratio for the worst case fault current.
7. Worst case return fault current passing through the grid resulting in a Ground Potential Rise (GPR).
8. Grid impedance in relation to remote earth.
9. Area covered by station ground grid in square feet.
10. Ground Potential Rise (GPR) in rms volts.
11. Type of service requested. See note on back of form.
12. Class of service performance objective requested. See note on back of form.
13. USOC is determined by Type/Class of service and whether 2 or 4 wire. See back of form.
14. (Optional) The distance from the edge of the grid to the 300 volt point calculated from field tests.
15. Enter information on connecting terminal equipment.
16. Facilities Interface Code. (When required by the service order.)
17. Check appropriate boxes for requested service.
18. Existing number of services of each type now at the location.
19. Number of services of each type marked being requested.
20. Projected future services of each type expected at this location. This and items 18 and 19 are needed when a new entrance facility or High Voltage Protection upgrade is required.
21. A signature and date is required from the engineer providing the information or a representative of the company requesting the service. Include telephone number and address of that person.
22. Make no entries in this area.

Exhibit 10-1 Instructions For Form RG31-0048
Design Information For Power Industry Channels
(Page 3 of 3)

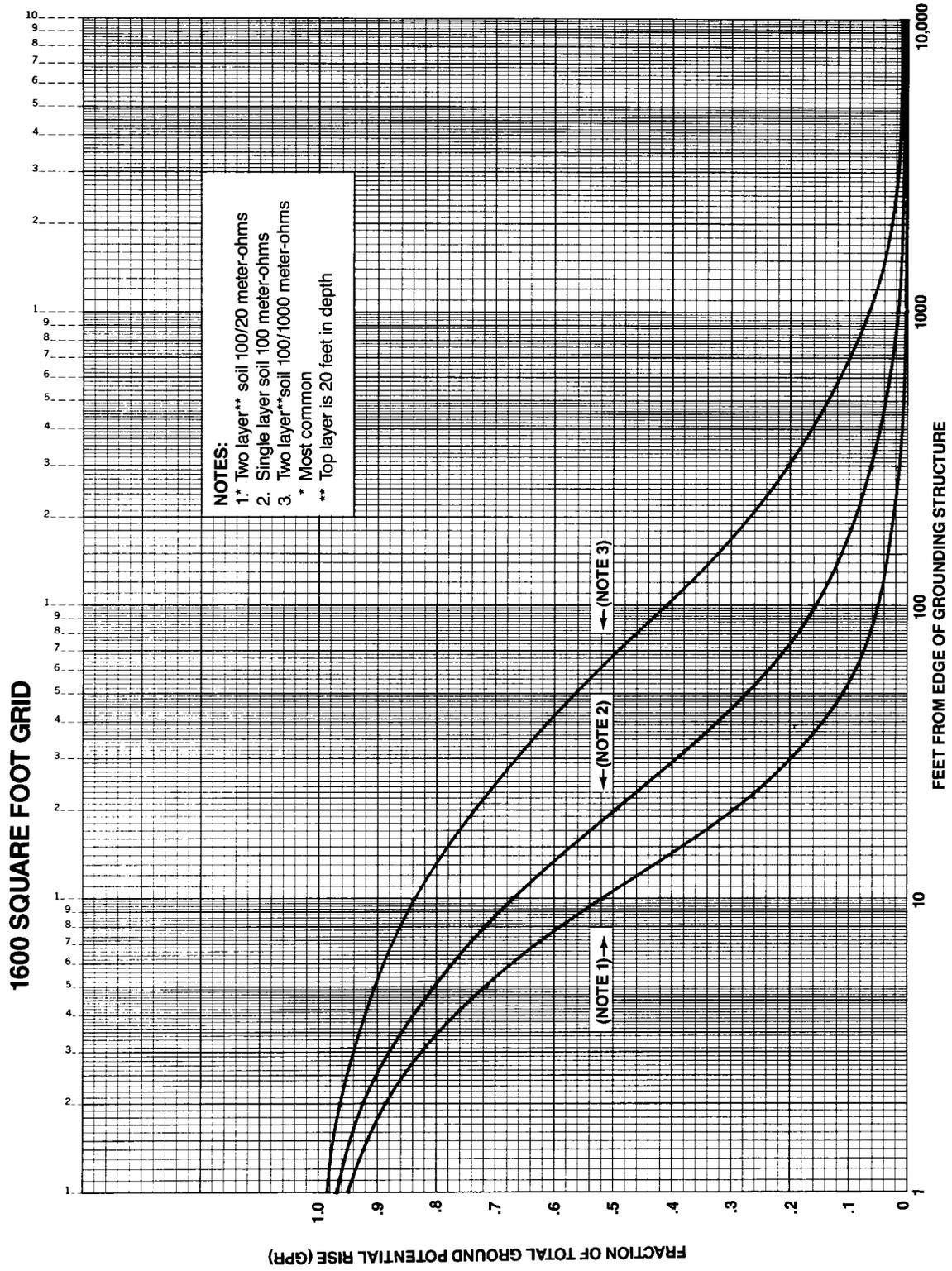


Exhibit 10-2 (GPR) 1600 Square Foot Grid

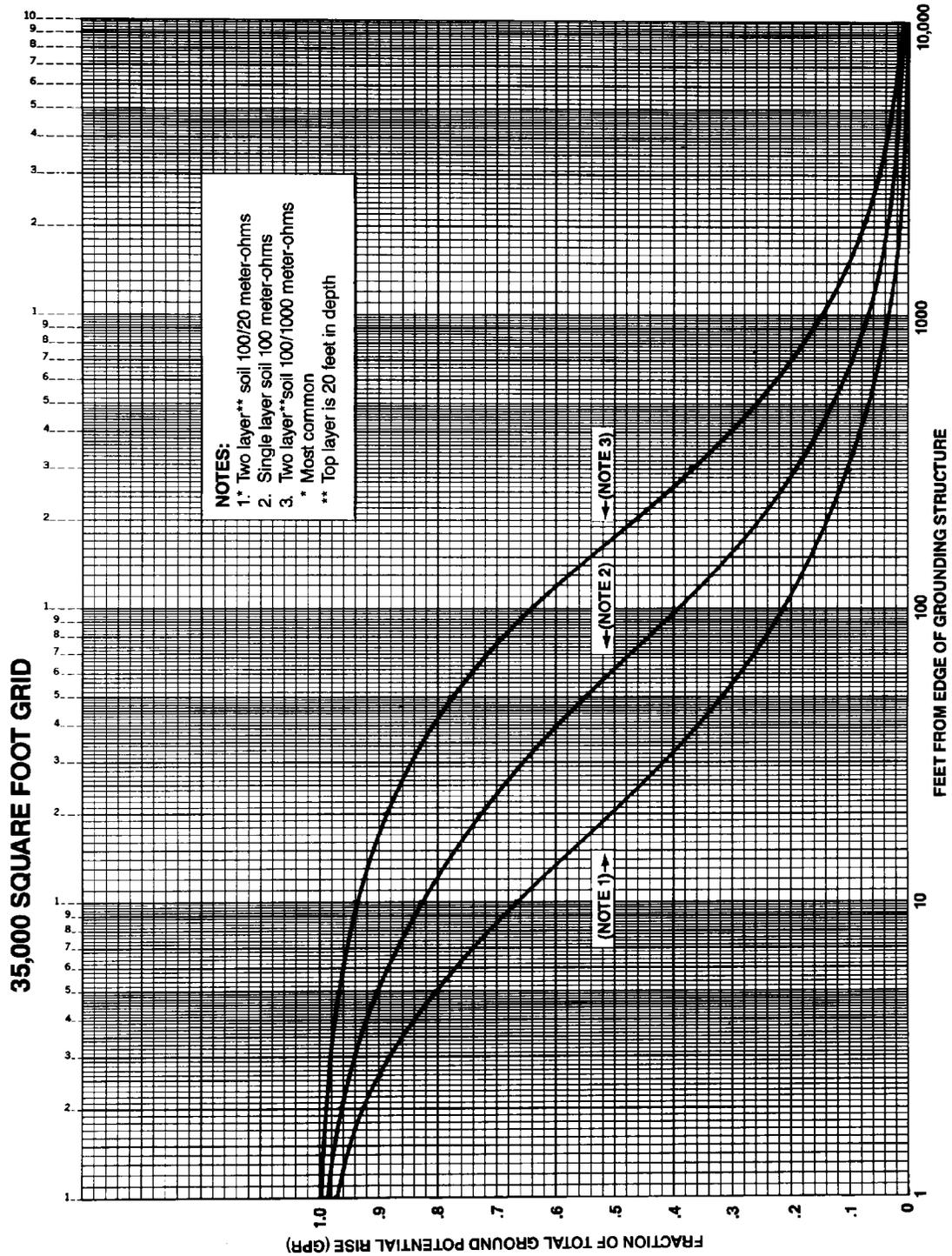


Exhibit 10-3 (GPR) 35,000 Square Foot Grid

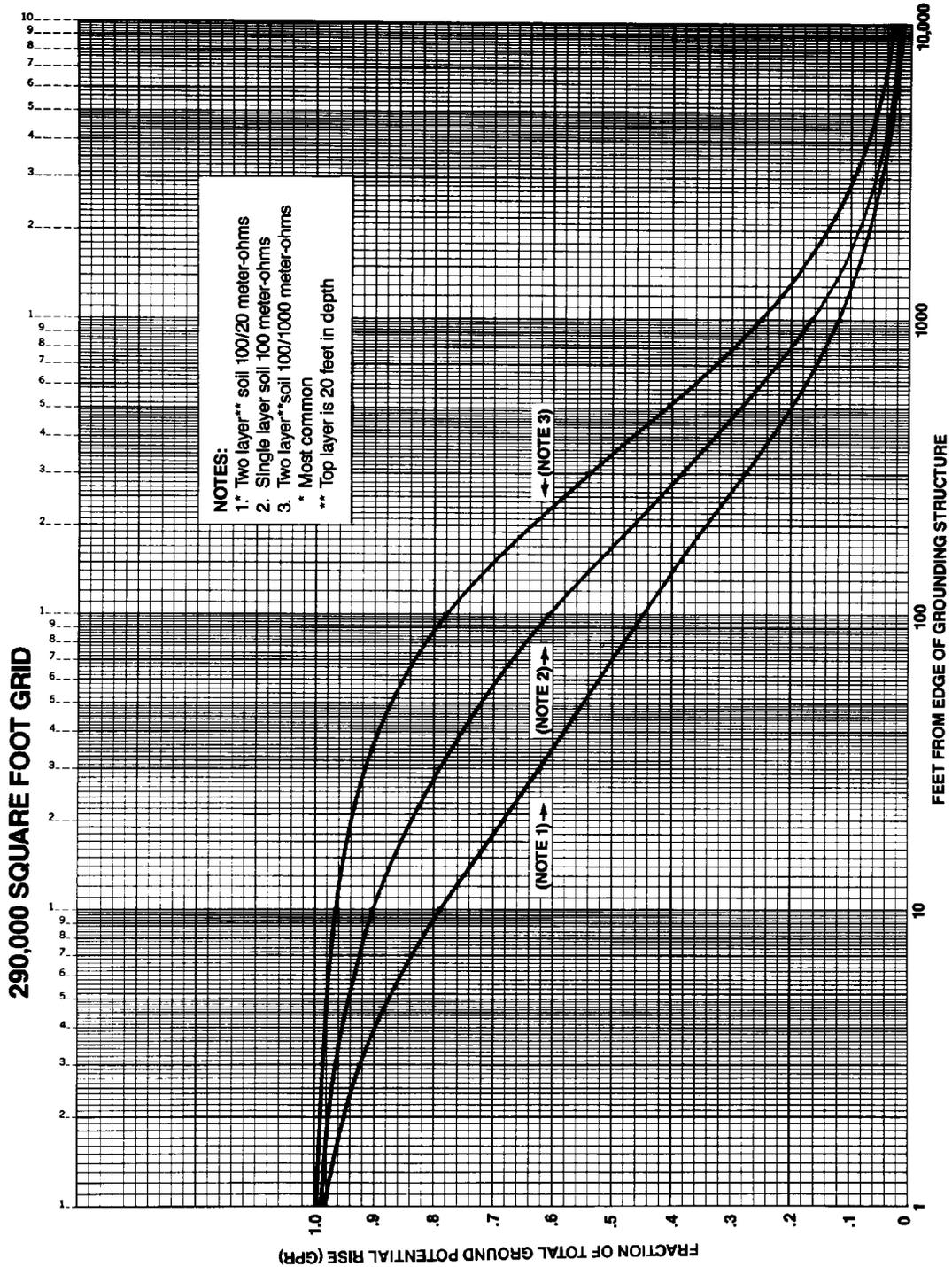


Exhibit 10-4 (GPR) 290,000 Square Foot Grid

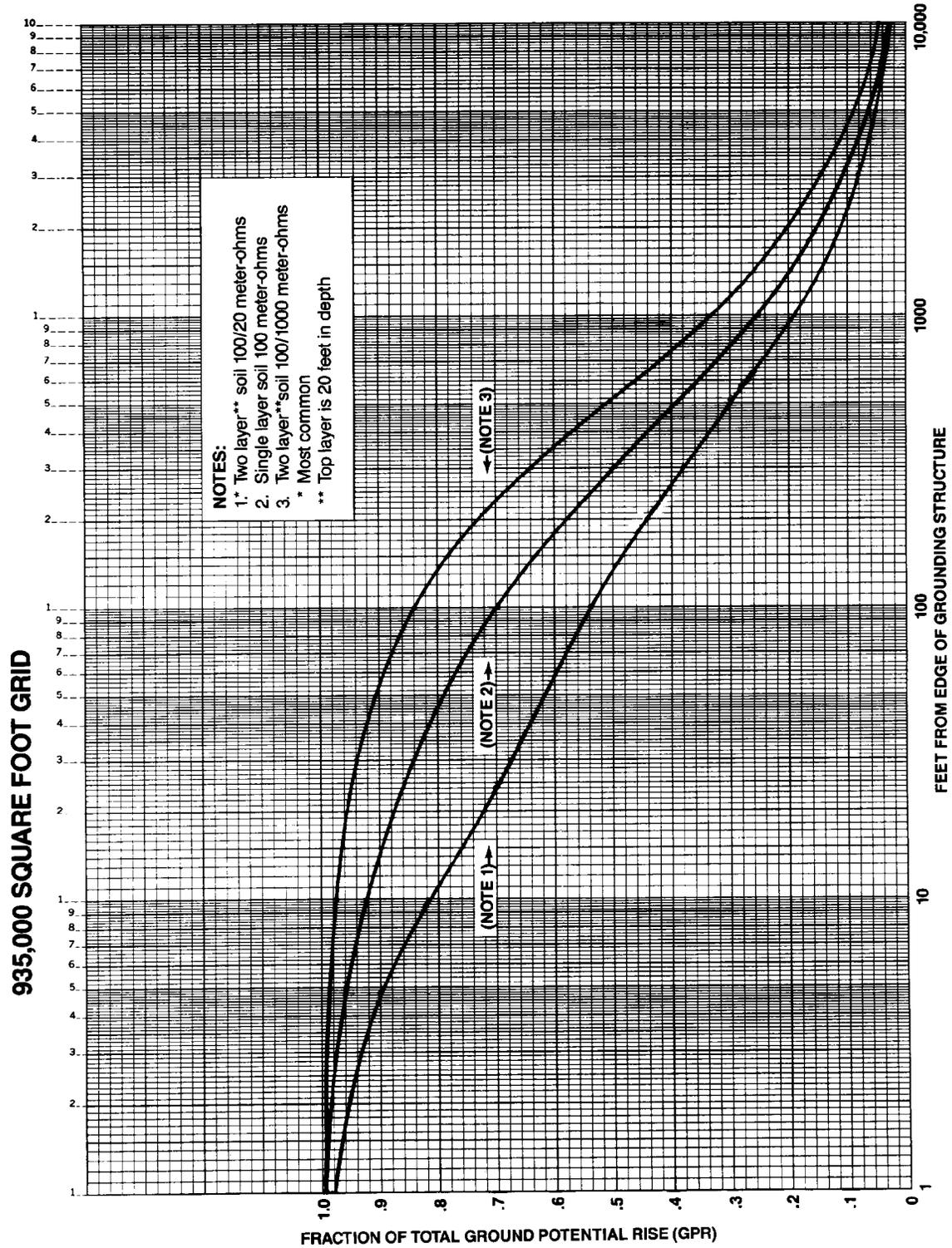
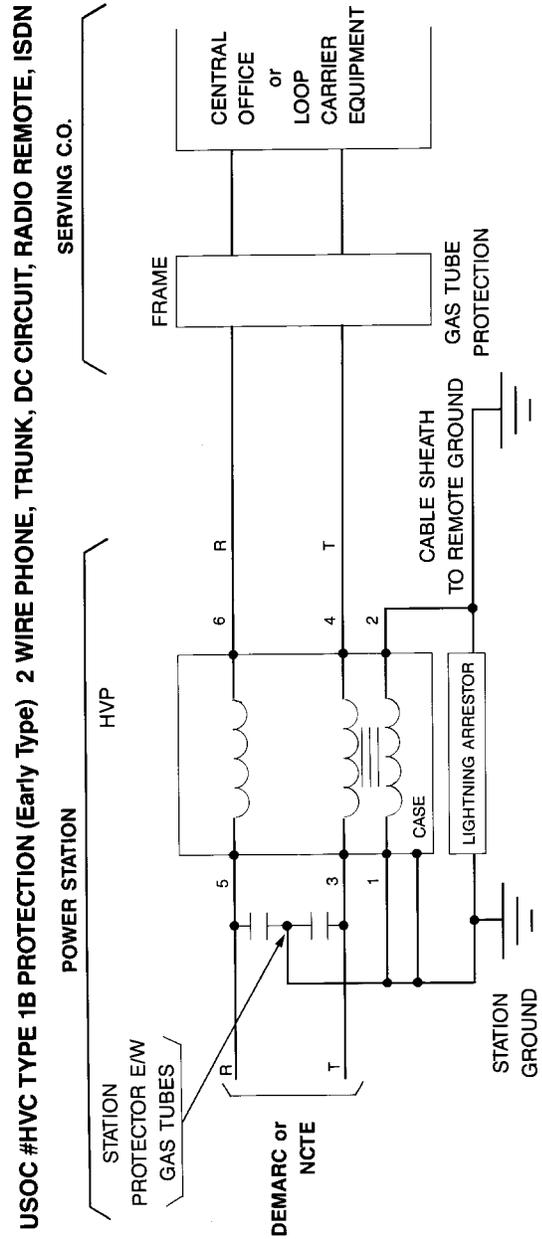
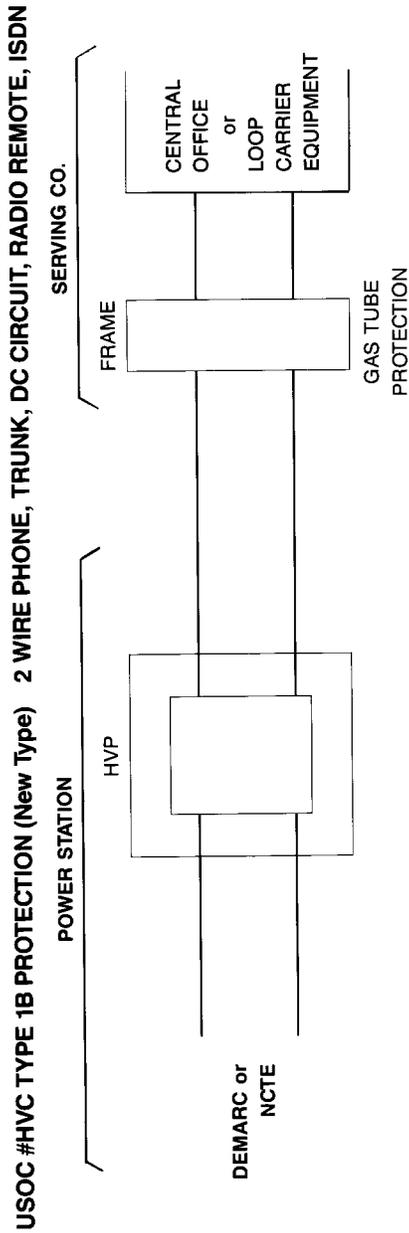


Exhibit 10-5 (GPR) 935,000 Square Foot Grid



Exhibits 10-6 and 10-7

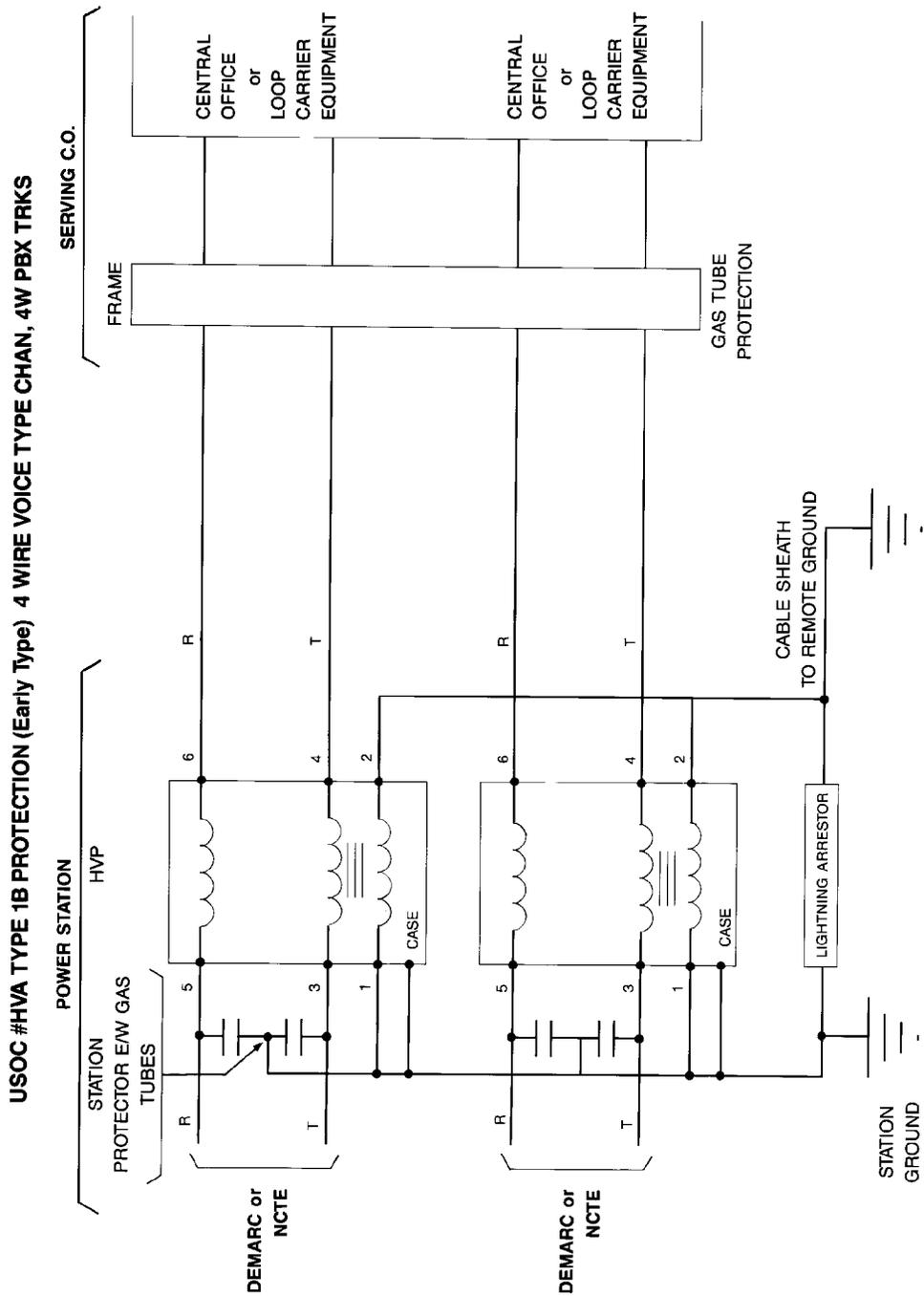


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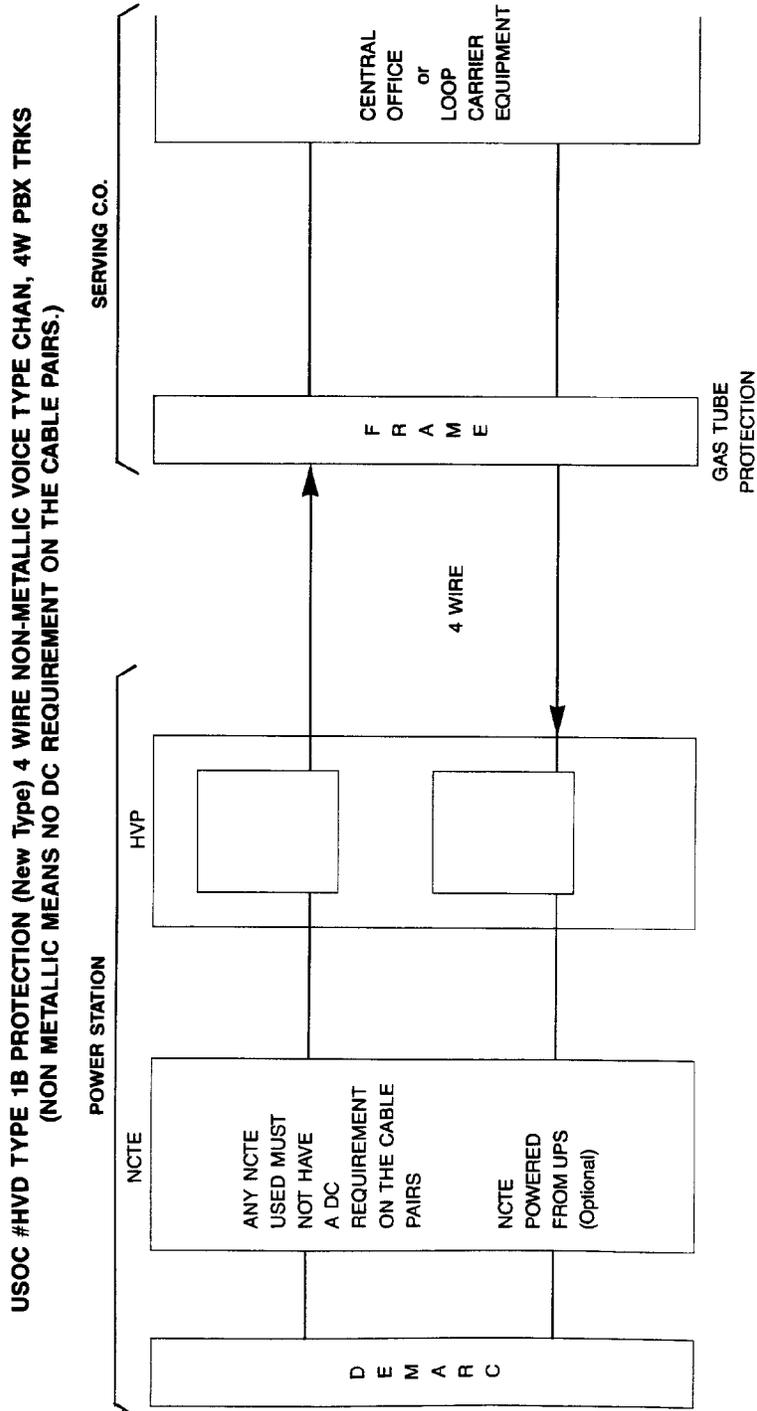


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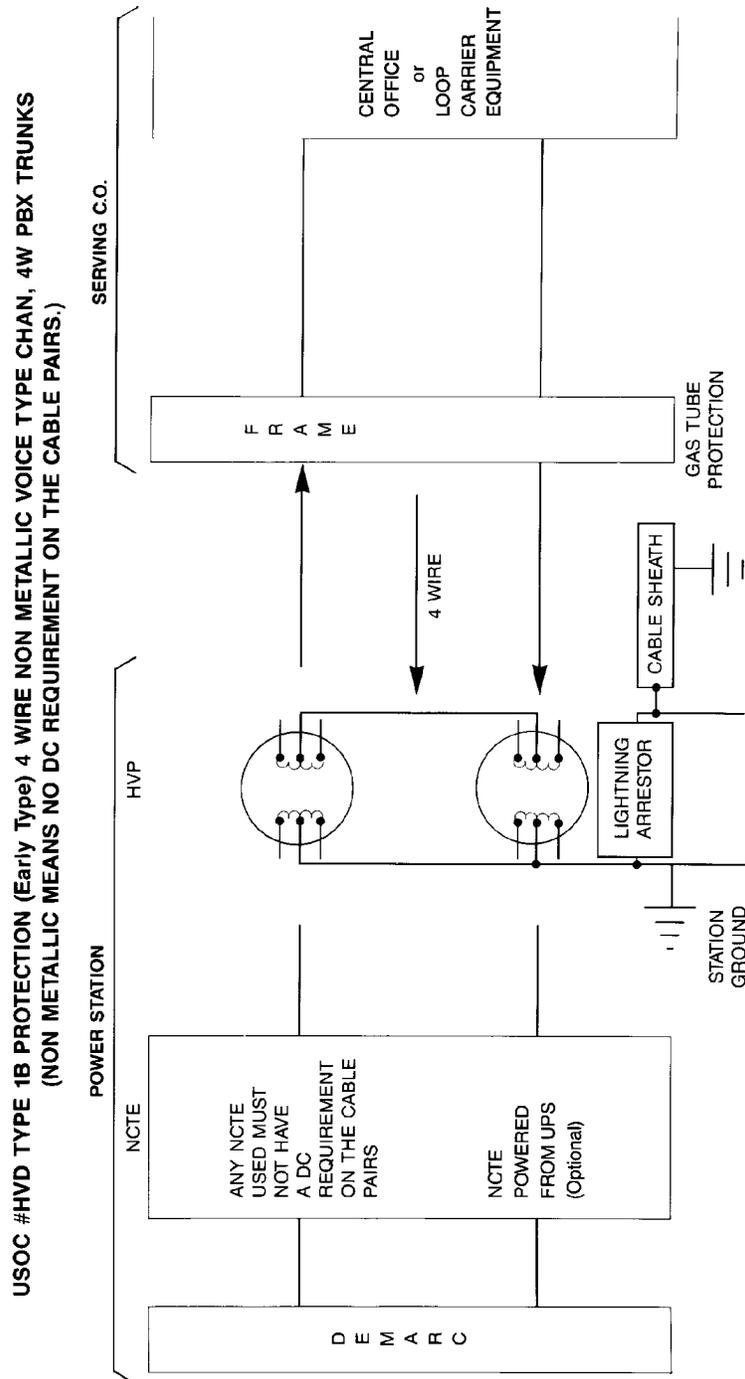


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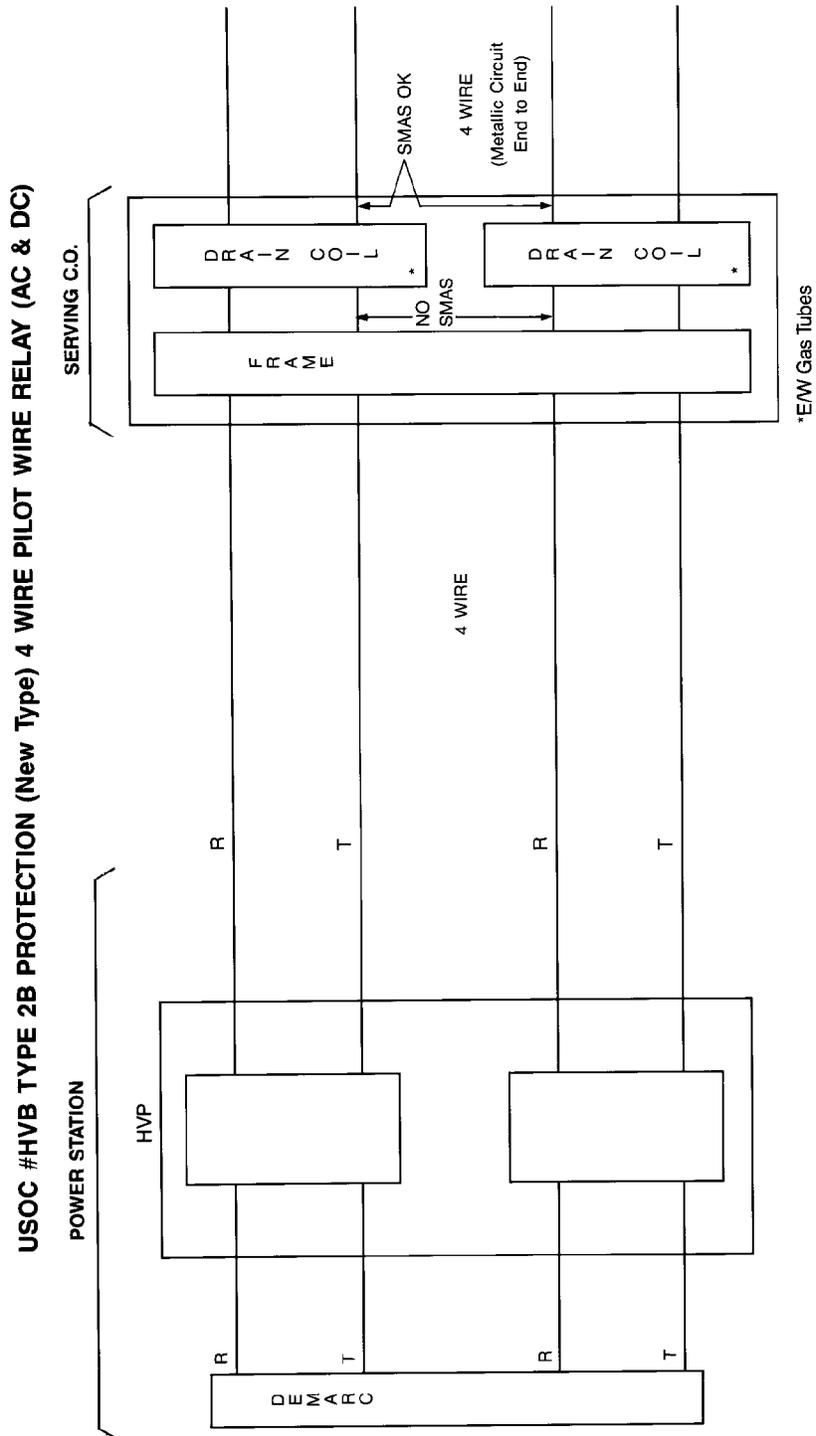


Exhibit 10-11

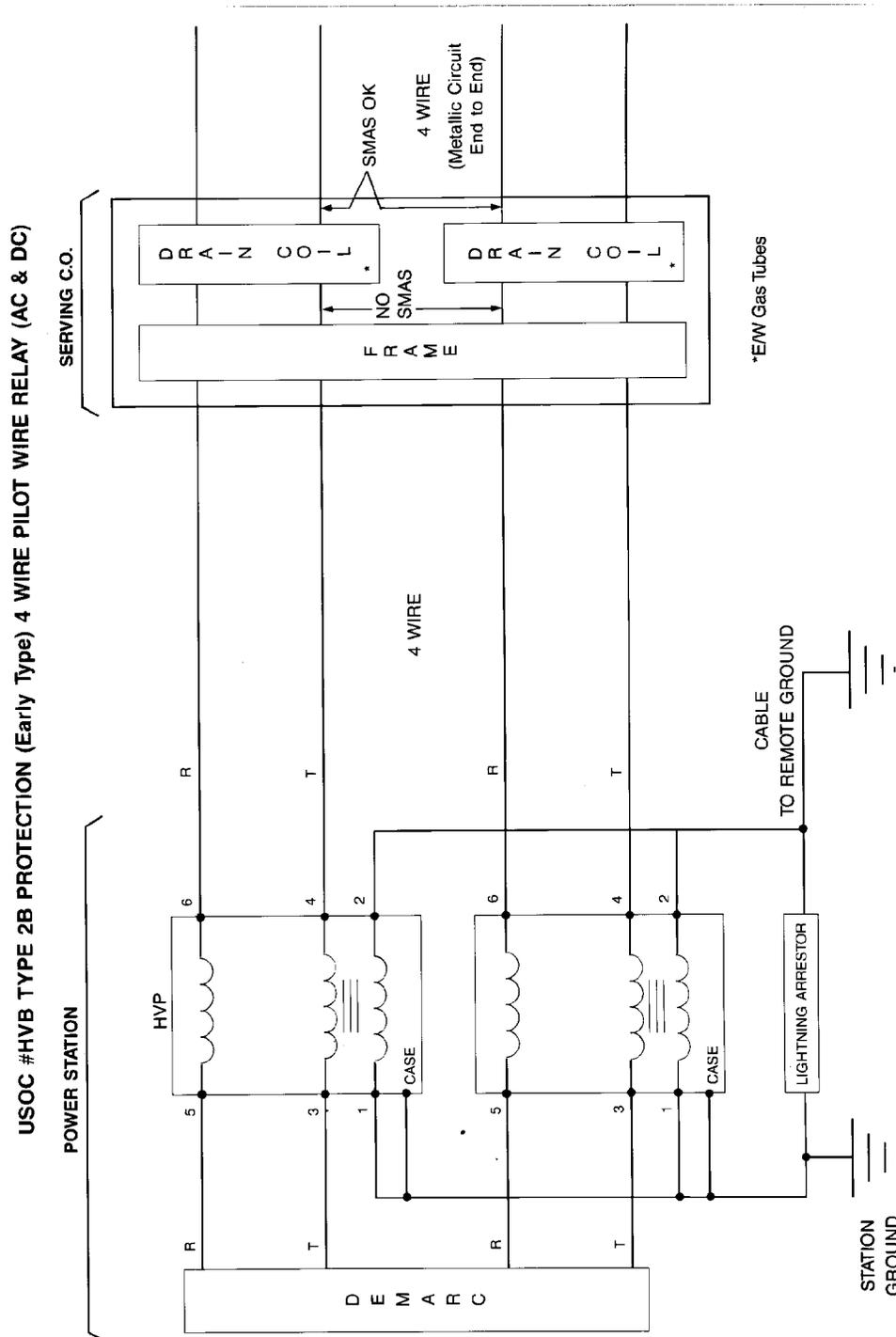
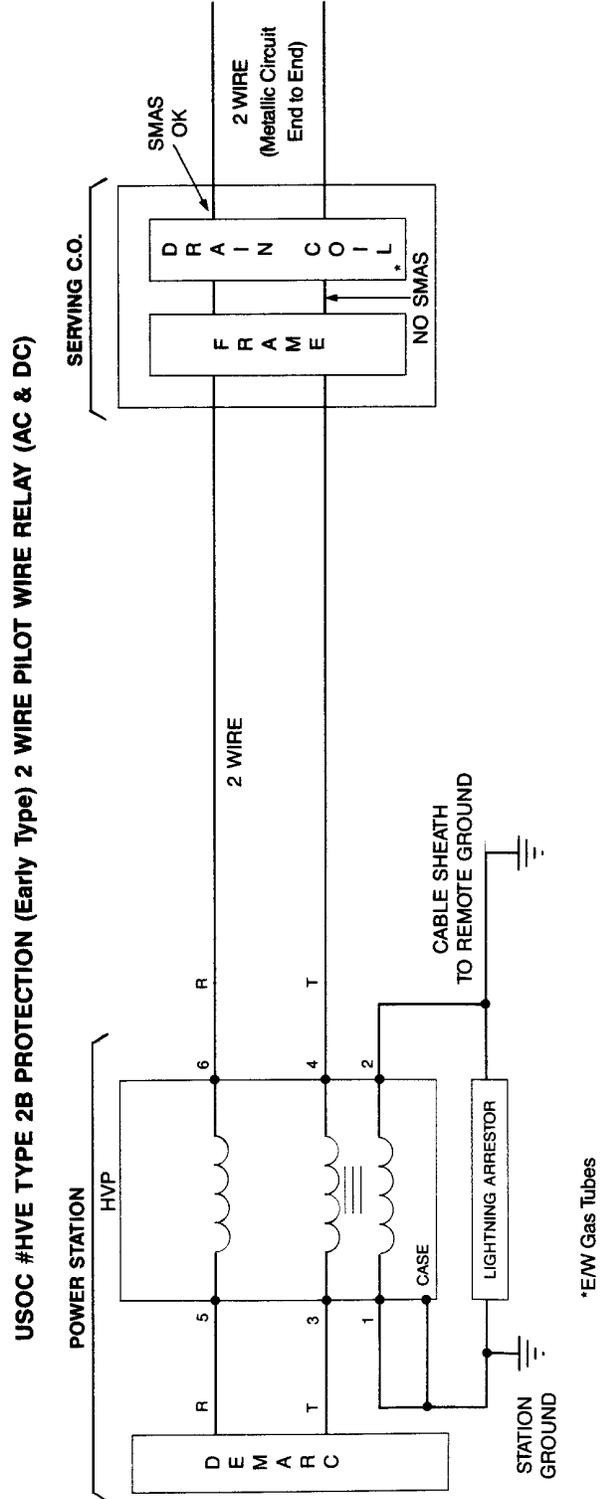
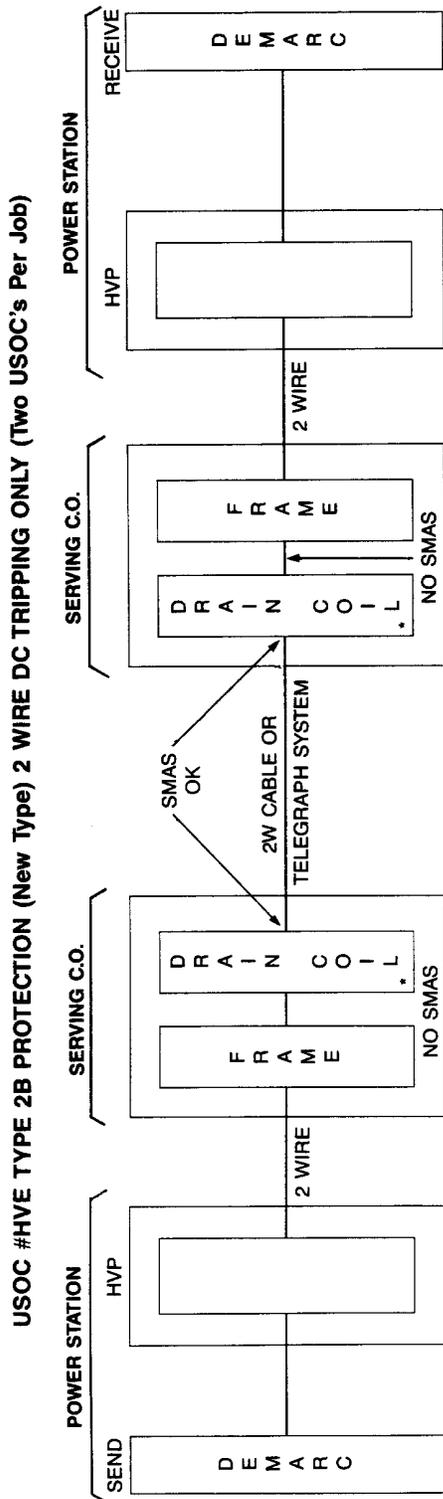


Exhibit 10-12



Exhibits 10-13 and 10-14

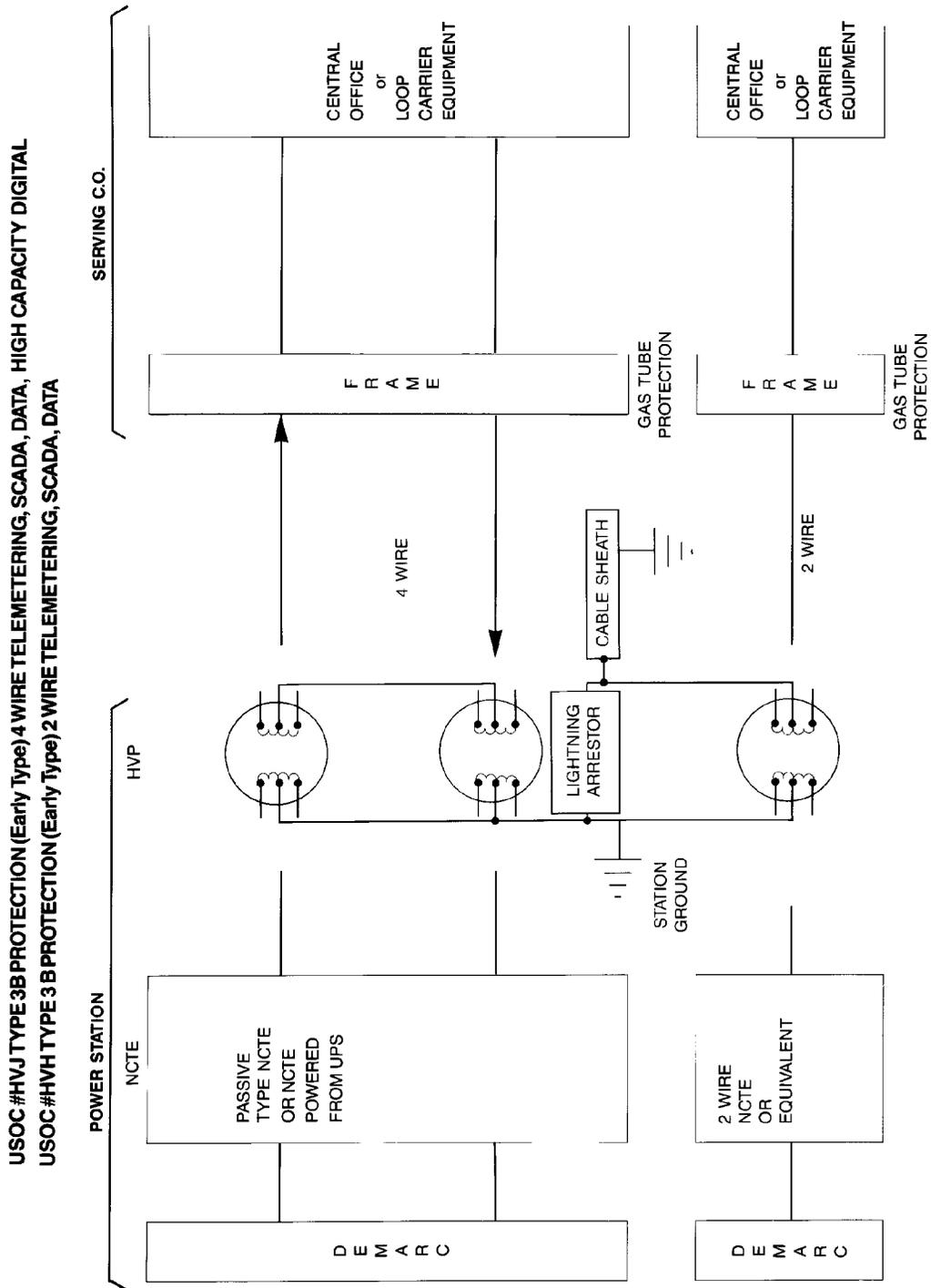
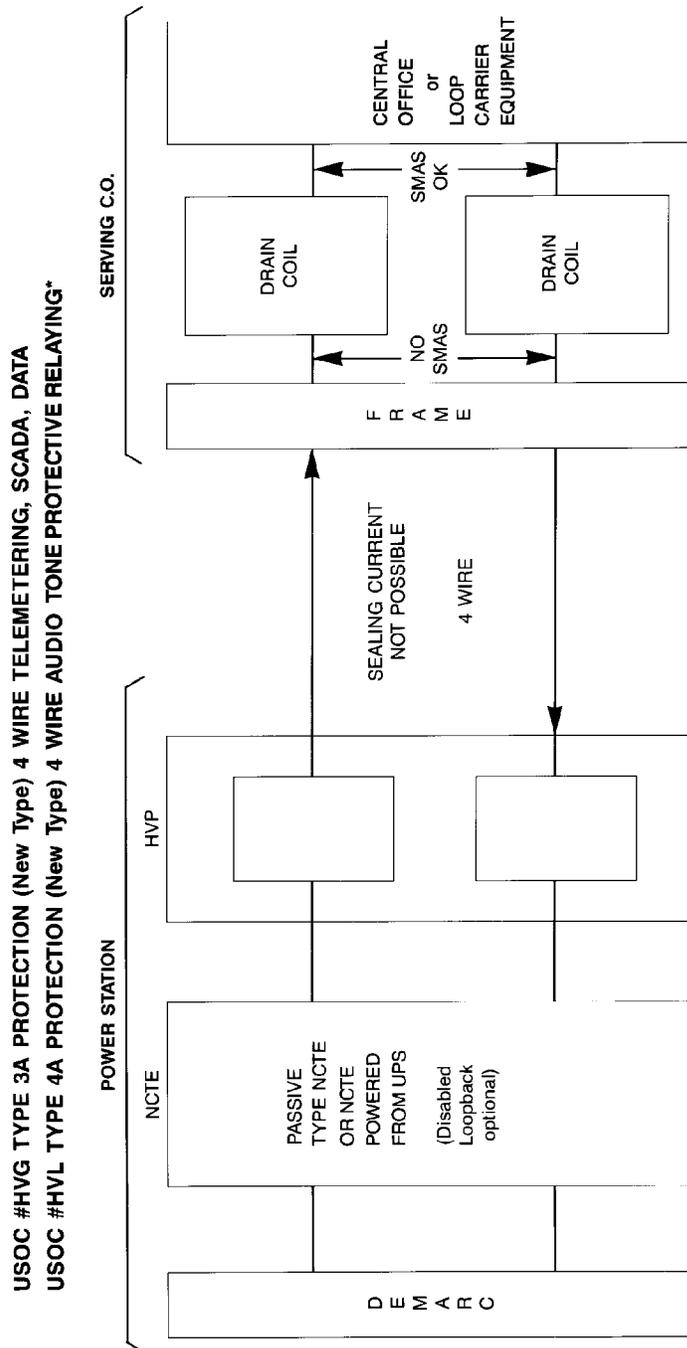
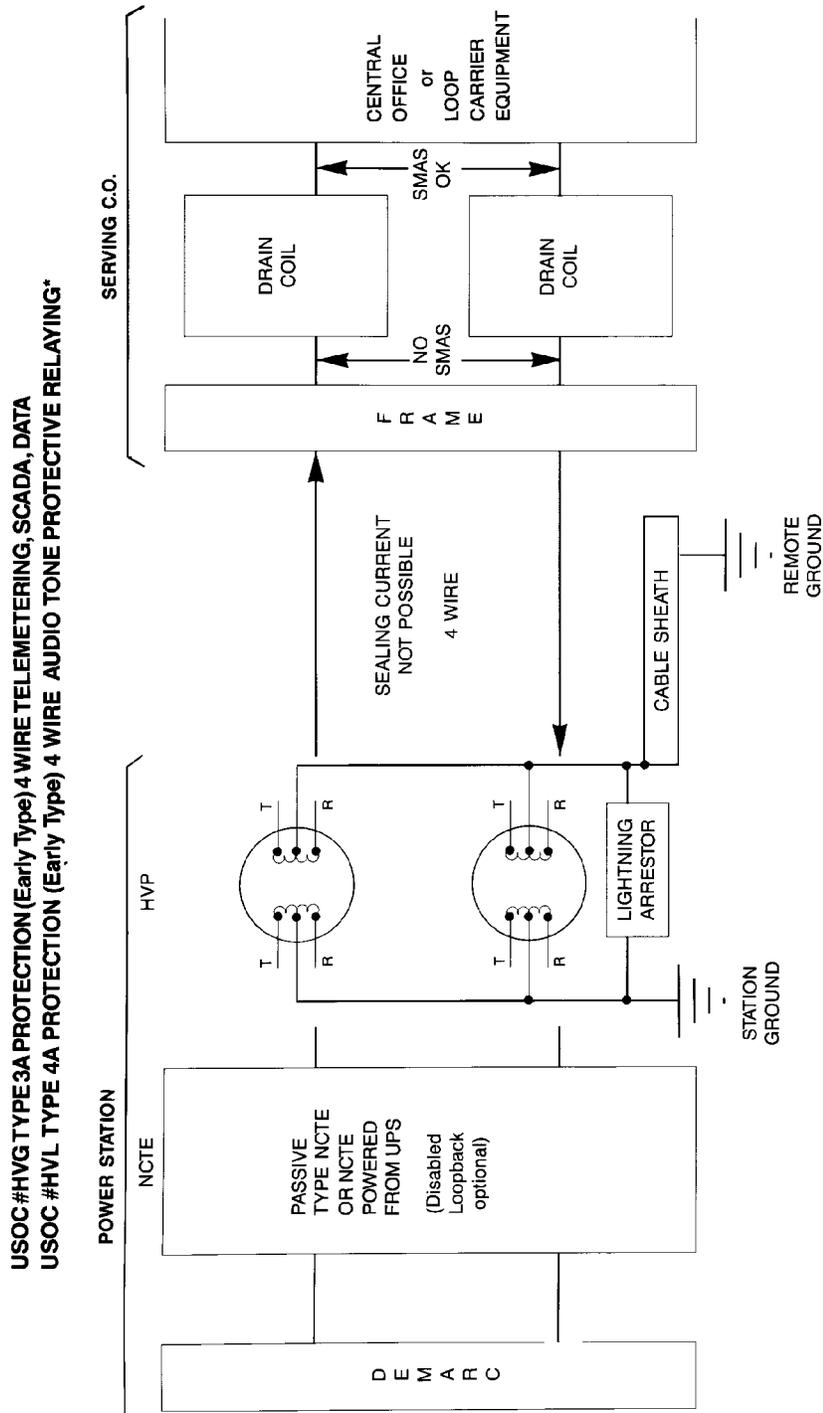


Exhibit 10-16



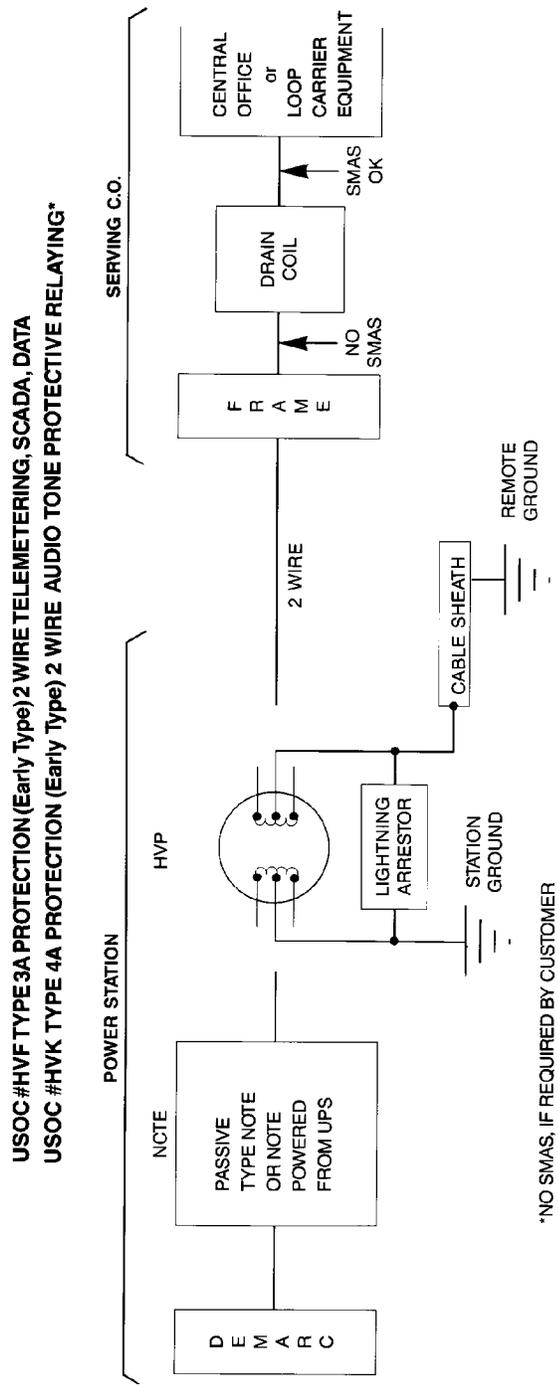
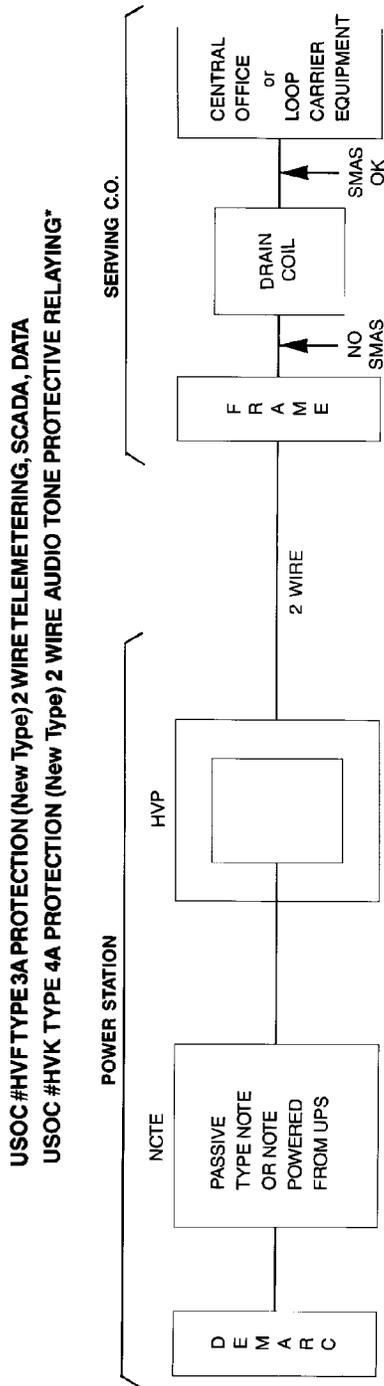
*NO SMAS IF REQUIRED BY CUSTOMER

Exhibit 10-17



*NO SMAS IF REQUIRED BY CUSTOMER

Exhibit 10-18



Exhibits 10-19 and 10-20

11. Definitions

11.1 Acronyms

GPR	Ground Potential Rise
AC	Alternating Current
DC	Direct Current
IEEE	Institute of Electrical and Electronic Engineers
USOC	Universal Service Order Code
InterLATA	InterLocal Access and Transport Area
IntraLATA	IntraLocal Access and Transport Area
ISDN	Integrated Services Digital Network