Investigation of Potential Revenues from the High Speed Rail Right-of-Way - Co-Location of Utilities

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DELCAN

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Introduction

The Quebec-Windsor corridor is the most heavily travelled in Canada and is the focus of a study to determine the feasibility of introducing a High Speed Rail system to serve the growing travel demand in this corridor. The cost of constructing and operating an HSR line is significant and in view of the cost implications, opportunities for generating new sources of revenue need to be examined and considered. One such opportunity is to allow a portion of the railway ROW to be utilized by utilities on a leased basis. Known as "Co-location", this strategy is being actively pursued by the major North American railways as a new revenue source. However, the market potential, suitability for application in an electrified High Speed Rail corridor and the actual revenue potential are unknown. This study examines existing practices and provides revenue estimates and an indication of the market potential based on a review of existing conditions and experiences. The study's results are limited, however, due to the range of assumptions that must be factored into the analysis and the restricted body of information regarding revenues available from the railways.

Conclusions

The conclusions of this study are:

- Major Canadian and US railways use their ROW's for Co-locate purposes and are aggressively pursuing this market as a source of alternative revenues;
- Clients are the major utility companies - gas, oil and hydro - and, more recently, communications systems companies (telephone) using fibre optics;
- Technically, the installation of the utility services is regulated by established standards associations such as CSA (for gas pipelines), the NTA for oil and hydro and the Canadian Electrical Code Book for specific installation specifications;
- The major market for Co-locate revenues lies with the fibre optic systems although this market growth is likely to be satisfied within the next few years;
- The market potential for Co-locate revenues within the HSR context will be limited due to the timing of the construction and availability of the HSR line (at least 7 years hence) and the likelihood that the needs of the utilities will have been satisfied by that time;
- The potential revenues from Co-location will be affected by a number of factors in addition to the overall market potential. The major factors are: the final alignment selected, the value of land adjacent to the ROW, the relative split between rural and urban land, the length of existing ROW purchased from the railways and the rights to and amount of Co-locate revenue being generated at the time of take-over;

- estimated Co-location revenue, in 1993 dollars, for each of the three HSR ROW options is:

Option	Total Revenue (20 Year Term)	Revenue Per Eligible KM.	Annual Revenue Per Eligible KM.
1	$57,500,000	$80,000	$4,000
2	$69,500,000	$78,000	$3,900
3	$69,500,000	$57,000	$2,900

- Alignment Option 1 is projected to be the most productive due to its more advantageous urban/rural land split.

Summary of Report Findings

The installation of and sharing of space in railway ROW's by the various utility classes (electrical, pipe line, fibre optics) are governed by established Canadian Standards Association guidelines as well as detailed standards utilized by the railways and utilities themselves. Of chief concern with an electrified HSR line is possible interference of the electro-magnetic field of the propulsion distribution system and any of the utility lines, particularly fibre optic systems. The study findings are that this has not presented difficulties given that utility installations specify encasement and insulation standards to guard against such situations.

Co-location uses take two forms, Crossings, where a utility crosses the rail line at an angle, and Parallelism ("longitudinal" in the United States) where the utility runs parallel to the rail ROW. Crossings are the most numerous but least remunerative.

In Europe co-location use of High Speed Rail ROW's is limited primarily due to regulatory constraints. In France, for example, SNCF is designated a public utility and is not able to share its ROW with other utilities. It is, however, in the process of seeking changes to legislation to have this changed.

In North America, all major railways are pursuing co-location opportunities. The major market is in fibre optics (audio and video communications systems) which can provide the railways with both revenues as well as opportunities to combine their signalling and communications needs with the needs of the utilities. Rail ROW's are also beneficial for the utilities since they offer security and limited access through a protected and controlled property.

Agreements with utilities take the form of Easements. The rental or lease rate established by the railway reflects the land value based on the value of the adjacent land, what the market will bear, and the govenmental jurisdiction involved and the sensitivity of the abutting land. Fees charged vary by type of co-location use and type of utility. Due to the still developing nature of this market by the railways, there is no consistent fee scale and wide fluctuations are in evidence.

The identification of total revenues from co-location by present railways is difficult since railways do not aggregate these revenues at present and any such information is highly confidential.

Future Market Potential

Future market potential for co-location uses lies with fibre-optics. However, the demand for ROW space by fibre optic utilities is reaching a limit and by the time an HSR line is opened it is likely that the demand will have been satisfied leaving little or no growth potential. A future growth would then depend on the need by such utilities for more ROW space based on increased demand for fibre optic systems. At the same time, the use of an HSR ROW for fibre optics or any other utility needs will depend upon the suitability of the alignment in meeting the alignment needs of the utility.

Any HSR alignment will likely be an amalgam of new ROW with existing and/or shared ROW's of existing railways. To maximize revenue possibilities, any existing alignment acquired from a railway should include rights to existing co-location leases and revenues.

Based on existing railway co-location rental/lease practices and estimated charges, and based on a number of assumptions including an estimation of the "eligible" kilometrage for revenue generating purposes, adjacent land costs, number of Crossings and length of Parallelisms, the total revenue over a 20 year period could range between $57.5 million and $69.5 million as a maximum and depending upon the HSR alignment finally selected. HSR alignment option number 1 has the potential to produce the most revenue on a Per Kilometre basis since it has the highest urban to rural ROW ratio.

1 Introduction

1.1 Background

The Quebec-Windsor corridor is the most heavily travelled in Canada and, as such, is the focus of a study to determine the feasibility of introducing a High Speed Rail system to serve the needs of the public travelling between the urban centres located in this corridor. To investigate this potential, the Federal government and the Provinces of Ontario and Quebec are co-funding the study, and have engaged a Project Manager to manage it.

Delcan Corporation, in association with SNC-Lavalin, has been retained by the Project Manager to conduct a preliminary routing assessment and costing study associated with the High Speed Rail line. This study considers the alternative High Speed Rail technologies available to provide the service and, in doing so, develops potential alignments, assesses their feasibility and the cost associated with the implementation of a HSR service applicable to each.

The cost of developing, constructing and implementing an HSR line is significant and may take up to seven years to complete from the date approval is given to proceed. In view of the cost implications, it is important that every available method for funding the project or contributing to its subsequent operating costs be examined and considered.

Existing railways are making use of their ROW's to generate other revenues as a way of supplementing traditional operating revenues. One such strategy is to provide space for utilities, known as "Co-location". Since the construction of an HSR line may result in the creation of new rail corridors, there may be opportunities to bring in revenue from these new alignments. By examining the practices and trends of the present railways, it may be possible to provide an assessment and estimate of potential revenues from an HSR ROW.

1.2 Study Purpose

This study reviews the practices of the major railways in Canada and the US with respect to generating Co-location revenue from their ROW's, considers the technical issues and constraints associated with the use of ROW's for other purposes, identifies the market potential and provides an estimate of the revenue potential from the alternative HSR ROW's.

The objectives of this study are:

- to identify technical constraints on the joint use of the ROW for other purposes, ie. communications, pipelines or other utilities;
- to report on foreign experience in regard to this issue and identify what is applicable to Canada;

- to provide an opinion on whether there is a market for such "co-locations" in Ontario and Quebec and in what area, considering the road and rail network already in place.

In this study, the technical issues and constraints associated with the use of fibre-optics, cables, oil, gas and pipeline products and other potential candidates for Co-location are identified and characterized, estimates of current revenue associated with each received by the railways was investigated and a costing process identified for projecting potential revenues from the use of ROW for other purposes.

1.3 Study Approach

The Methodology taken in preparing this Report involved three key steps:

- collection and review of available information from regulatory agencies, the railways and the utilities and applicable databases such as NTIS, TRIS and the TRB;

- an extensive telephone interview process with representatives of the major railways and utilities;

- analysis of the alternative HSR alignments associated with the technology options to determine their suitability for producting alternative revenue and the interpretation of revenue formulae now used by the railways as a basis for estimating revenues.

2 Technical Issues

The section of the report examines the regulations and technical issues that surround the location of linear services along railway corridors. The linear utilities examined in this section include: gas pipelines, oil pipelines, above and below ground electrical lines and telecommunication lines (esp. fibre optics). The process followed and the regulations surrounding each of these services are first individually outlined. There is then a summary of the specific regulations involving railways. Lastly, a brief summary is provided. Excerpts from the various regulatory documents are contained in the Appendix.

2.1 Utilities

Gas Pipelines

In order to determine what regulations pertain to the placement of gas pipelines along railway corridors, the Public Utilities Commission for the City of Kingston, Ontario was first contacted. From that Commission, it was learned that the Canadian Standards Association (CSA), Z184 code book is followed. This document primarily deals with pipelines which cross the railway not running parallel to the railway. The main issues addressed are: the depth of the pipeline under the rail bed, the requirement that a polyethylene pipe must be encased in steel, and control valves/regulator stations must be a specific, minimum distance from the tracks.

Oil Pipelines

Trans Northern Pipeline was contacted while investigating the issues concerning the placement of oil pipelines. In situations where the pipeline exists first, such as with the construction of a new rail right-of-way, the National Energy Board Act governs the conditions under Section 112 of the NEB Act and The Pipeline Crossing Regulations of the NEB (see Appendix C). Where the railway exists first (the vast majority of conditions), the Canadian Transportation Commission has jurisdiction under their General Order E-10.

With specific reference to one major pipeline company, Interprovincial Pipe Line Inc., for construction and design, they follow CSA Z183-M90. Crossings of their ROW are acceptable and the process is to submit drawings to their engineers showing clearances, etc. Their engineers then make recommendations regarding necesary changes as summarized in Appendix C.

Hydro-Electric Lines

The co-location of electrical lines along a railway corridor is regulated by the Canadian Electrical

Code Book and CSA CAN3 C22.3 #1-M87 and applies equally in both Ontario and Quebec. Verification of the application of these standards was made through contact with Ontario Hydro, Quebec Hydro, Canadian National and the Kingston Public Utilities Commission. In each jurisdiction, plans are drawn up, submitted to the railways for approval and then either approved or sent back for revisions by the Chief Engineer for the railway.

Telecommunications

The Building and Industry Consulting Service of Bell Canada was contacted. The placement of any communications lines is regulated under the Canadian Electrical Code Book. The regulations are designed to maximize physical safety and to minimize electrical interference. The major concern for fibre optics is the physical safety. Fibre optic technologies will be increasing in the Quebec-Windsor corridor based on needs assessments and efforts to remain competitive. However, the majority of fibre optic lines run parallel to Highway 401. Due to agreements with the Ministry of Transportation for Ontario and with municipalities in addition to current infrastructure investment, fibre optics will first expand along the highway right-of-way. As far as railways are concerned, most line placement has to do with crossings rather than running parallel to the railways. It is the railway which controls the physical placement of lines and billing of easement fees.

General Conditions

In any of the foregoing situations where the utility/pipe lines are in place before a new rail line, such as may be the case with an HSR line and we are not aware of any precedents in this regard, it should be assumed, as in other jurisdictions, that an easement for the rail line may need to be negotiated with the land owner and utility.

Regulations and engineering standards for the construction and placement of the utility/pipe lines are the same in both Ontario and Quebec although there would need to be differing legal agreements between the two provinces because of the use of Civil Law in Quebec and Common Law in Ontario.

2.2 Regulations

Table 1 summarizes the available information which is specific to utilities located in railway corridors. Other regulations may be found in the Appendix.

Table 1 Utilities Co-location Regulations With Railways

Depth of cover for Pipelines in railway right of ways		75cm
Depth of cover for Pipelines within 7m of the centre of railway track		200cm if un-cased 120cm if cased
Least nominal wall thickness for steel casing pipe in cased crossing and carrier pipe in un-cased crossings	Pipe Outside Diameter	
	88.9mm	3.2mm
	101.6mm	3.2mm
	114.3mm	3.2mm
	141.3mm	4.0mm
	168.3mm	4.8mm
	219.1mm	4.8mm
	273.1mm	4.8mm
	323.9mm	4.8mm

Least nominal wall thickness for steel casing pipe in cased crossing and carrier pipe in un-cased crossings

Pipe Outside Diameter	Thickness
355.6mm	5.6mm
406.4mm	5.6mm
457.0mm	6.4mm
508.0mm	7.1mm
559.0mm	7.9mm
610.0mm	8.7mm
660.0mm	9.5mm
711.0mm	10.3mm
762.0mm	10.3mm
813.0mm	11.1mm
854.0mm	11.9mm
914.0mm	11.9mm
965.0mm	12.7mm
1016.0mm	12.7mm
1067.0mm	12.7mm
1118.0mm	14.3mm
1168.0mm	15.9mm
1219.0mm	15.9mm
1270.0mm	15.9mm
1321.0mm	19.1mm
1372.0mm	19.1mm
1423.0mm	19.1mm
1524.0mm	20.6mm

Electrical Overhead Vertical Clearance above top of rail at railway crossing, AC

Nature of Wire	Clearance
guys, messengers communication, lighting	7.3m
trolley lines	6.7m
open supply conductors	
0.00-750.0 V	7.3m
0.75- 22.0 KV	7.6m
22.0- 50.0 KV	8.1m
50.0- 90.0 KV	8.4m
90.0-120.0 KV	8.7m
120.0-150.0 KV	9.0m
150.0-250.0 KV	9.0m + 0.01m for each KV over 150
250.0-300.0 KV	10m + 0.01m for each KV over 250
over 300.0 KV	10.5m + 0.01m for each KV over 300

Electrical Overhead Vertical Clearance above top of rail at railway crossing, DC	Nature of Wire	Clearance
	open supply conductors	
	0.75- 100 KV	8.8m
	100 - 150 KV	9.1m
	150 - 200 KV	9.3m
	200 - 250 KV	9.5m
	250 - 300 KV	9.8m
	300 - 350 KV	10.0m
	350 - 400 KV	10.2m
	400 - 450 KV	10.4m

Electrical Overhead Horizontal Clearance above top of rail at railway crossing, AC	Nature of Wire	Clearance of Wire closest to track	
		Main	Siding
	guys, messengers communication, lighting	2.5m	1.9m
	open supply conductors		
	0.00-750.0 V	2.5m	1.9m
	0.75- 22.0 KV	2.7m	2.1m
	22.0- 50.0 KV	3.2m	2.6m
	50.0- 90.0 KV	3.5m	2.9m
	90.0-120.0 KV	3.8m	3.2m
	120.0-150.0 KV	4.1m	3.5m
	150.0 + KV	4.1 + 0.01m for each KV over 150	3.5m + 0.01m for each KV over 150

Electrical Overhead Horizontal Clearance above top of rail at railway crossing, DC	Nature of Wire	Clearance	
	open supply conductors	Main	Siding
	0.75- 100 KV	2.8m	2.2m
	100 - 150 KV	3.0m	2.5m
	150 - 200 KV	3.3m	2.7m
	200 - 250 KV	3.5m	2.9m
	250 - 300 KV	3.7m	3.1m
	300 - 350 KV	4.0m	3.4m
	350 - 400 KV	4.2m	3.6m
	400 - 450 KV	4.4m	3.8m

Electrical Overhead Horizontal Separations from supporting structure to railway tracks		Main 2.5m Siding 1.9m
Electrical Underground depth of cover below base of rails		1.1m
Duct Material under railways	Material	Encased in 75mm of concrete for at least 2m beyond each outside rail but preferable for the full width of the right of way
	Depth	Top of duct at least 450mm below the surface of the earth or the bottom of ditches
	Horizontal	Accesses must be at least 2.5m away from main tracks and 1.9m away from sidings

2.3 Summary

This section of the report has examined the regulations and technical issues that affect the location of linear services along railway corridors. The linear utilities examined included: gas pipelines, oil pipelines, above and below ground electrical lines and telecommunications lines, especially fibre optics. Many of the issues dealt with in this section are regulated by standards set out by the Canadian Standards Association (CSA), 178 Rexdale Blvd., Rexdale, Ontario, M9W 1R3, telephone number (416) 747-4000.

3 Current Practice

3.1 Foreign Experience

Our investigation included contact with European rail authorities in Germany and France to determine what their practices and experiences were with regard to the use of HSR ROW's for co-location revenue purposes. Contact with European railways was deemed to be advantageous due to the presence of extensive HSR operations and their experience could provide an indication of any constraints or problems that needed to be considered in pursuing co-location opportunities in Canada as well as an indication of what were the sources for such revenues. Information was received from the French National Railways (SNCF) who operate an extensive and growing High Speed Rail network. Requests for information from the German State Railways went unanswered.

From the reply from SNCF and our general knowledge of European HSR operations, we are aware that use has been made of HSR alignments to a limited degree for co-location purposes, specifically with respect to communications systems such as fibre-optics. Technical issues appear to be similar to those existing in North America in that adequate containment and insulation is required to minimize interference with the Electro-magnetic Field generated by the power transmission lines of HSR propulsion and also to avoid interference with HSR communications systems. However, we were unable to obtain specific information in this regard.

SNCF commented that granting access to the High Speed line to a third party for maintenance purposes is "unthinkable" but, in any event, the "Declaration of Public Utility (DPU)" does not provide for co-location of the high speed line with other installations in the ROW. Recently, however, recommendations have been made to have joint DPU's for a new rail line and a new highway following the same alignment. Between the two but still outside the high speed ROW, a telecommunications cable has been installed but is not the responsibility of SNCF.

SNCF has rented out excess capacity in its signalling/telecommunications fibre optic cable lines to such users as the Post Office, the police and customs services (in areas close to the border). They are also undertaking a new initiative to install and sell television cable space in their ROW's and re-organized their Telecommunications Department into a Telecommunications Agency effective January 1, 1993 with the mandate of selling this type of service. The contractual framework for this service has not yet been clearly defined and the level of charges has not been fixed.

Revenues from co-location applications in Europe can not be estimated because of the limited information available but, in any event, would not likely be applicable in the Canadian situation in view of the much higher population densities prevalent in Europe and the differing values associated with large costs, ownership and acquisition.

3.2 Canadian Experience

In addressing the matter of Canadian experience, contact was made with the two major railways, Canadian National and Canadian Pacific, VIA Rail Canada, and information obtained pertaining to the experience of Ontario Northland. Contact was also made with the major utilities who occupy rail ROW's.

Current Practice

In general, Canadian railways have only been actively pursuing the use of their ROW's for alternative revenue purposes for the past 10 years and are still in the process of developing this market. Price determination, in particular, lacks consistency or set formulae and is subject to individual situations, negotiation and an element of "what the market will bear".

With the increasing financial constraints facing railways, interest in the use of ROW's for other revenue purposes has accelerated in the past few years. De-regulation of the telecommunications industry and the development of fibre-optic systems have presented market and revenue opportunities.

The use of ROW's for other purposes includes the following utilities and/or services:

- gas pipeline
- oil pipeline
- hydro transmission lines
- telephone cables including fibre-optic lines
- cable TV
- road allowances
- advertising displays/signboards

Use of ROW's by utilities takes two forms: Crossings, where utilities such as pipelines and hydro transmission lines cross at right-angles to the ROW; and, Parallelism ("longitudinals" in the U.S.) where the services parallel the ROW. Historically, Crossings have been the predominant example of co-location uses of railway ROW's.

Today, fibre-optics represent the major new market and new revenue source for railways. Many of these applications involve shared use of fibre-optic installations along railway ROW's wherein the railways negotiate to use some of the fibre-optic system capacity for their own signalling/communications purposes. This arrangement benefits the railway by allowing it to acquire the use of modern telecommunications technology to serve its needs without having to develop it in-house. Conversely, if railways convert to fibre optics for their own signalling and communications needs by their own initiative, excess capacity built in to the network can be leased out to private communications firms thereby both covering the cost of the up-graded system and providing added revenue. A report prepared by Mssrs. G. T. Fisher and J. G. Johnson of CPCS Ltd. in Montreal in May 1991, discusses the benefits of fibre optic systems for railways. According to the authors there are over 3,000 km of fibre optic cables installed on railway ROW's in Canada, 2,000 km of which are installed in Ontario and Quebec. CN

install, operate and maintain fibre optic cable systems for their own use and for the use of telecommunications companies. CP Rail provide licensing for the use of their ROW only leaving it to the utility to install and maintain its system.

Charges take the form of Occupancy licences or, now more commonly, Easements, with set fees for crossings and contracts for parallelisms based on a combination of factors:

- land value based on the adjacent land values,
- negotiation with the client,
- length and type of installation, and
- market competition.

Market competition includes not only other railway ROW's but, chiefly, highways and hydro ROW's. Notably, legislation governing the use of highway/road allowances is more favourable for this purpose than the comparable provisions under the railway acts. In addition, highway ROW's are wider and thus provide more lattitude for the installation and servicing of the co-located services. However, railway ROW's offer greater privacy and limited access through a protected and controlled property and are thus preferred by utilities.

Each utility or potential customer for a ROW co-location has its own set of design and installation parameters affecting access, construction and setbacks as discussed in the Task 1 Report Memorandum. Similarly, railways have conditions which stipulate the nature of the application, how it is to be constructed, its on-going servicing/maintenance procedures and accessibility constraints. These are set out within the context of railway operations and have requirements such as prior notification to and approval from the railway to enter and service except in emergency situations, for which examples are proscribed in the agreements. An example of the topics covered by a typical agreement is summarized on the attached Exhibit 1, "Table of Contents".

From a safety and servicing standpoint, fibre optic systems present the most compatible conditions for a rail ROW compared to either pipeline or electrical installations since they generally require less maintenance and, in the event of malfunction, would be unlikely to disturb rail operations or the physical ROW. From a maintenance standpoint, the repair of any utility could involve the use of maintenance vehicles and the requirement for reduced train speeds, flagmen, etc., all directly proportional to the size and complexity of the utility. With fibre optics, these intrusions are minimized.

The establishment of a rate for a parallel use of a ROW is a complex, yet imprecise process which, as noted previously, must acccount for what the market will bear, the value of adjacent land along the installation, the number of jurisdictions involved, the strategic importance of obtaining or permitting the installation as well as the itinerant social obligations.

The co-locate use of an ROW should therefore ideally have minimal effect on the railway operations, the abutting land use and area residents. Below ground installations which require limited space and include mitigative measures are preferred. For these reasons, fibre-optics are an attractive product for co-locate purposes and coincide with the Railways' objectives of augmenting their revenue sources and the de-regulation of the communications (ie. long distance telephone) industry.

EXHIBIT 1

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Revenues

Fees charged by Canadian railways vary not only by type of application (crossing versus parallelism, and utility) but also between railways. Because of renewed interest and opportunities in the revenue potential of ROW co-location use, fees are under review and will likely increase significantly.

Exhibit 2 summarizes sample fees currently in use by 3 railways in Canada compared to 4 railways in the United States. Railway #7 operates in the densely populated Boston-Washington corridor which accounts for its high fees per co-location. As such, these rates would not likely be applicable to any Canadian condition. Nevertheless, in comparing the rates among the three Canadian and the other 3 USA railways, there would appear to be room for an increase in the average Canadian fee per application. The ultimate fee able to be charged, of course, will depend upon market conditions, competition, and adjacent land values as noted previously.

The total amount of revenue attributable to the use of ROW's for alternate revenue purposes has been difficult to identify because of the sensitive and competitive nature of this matter and the accounting methods used by the railways. In this regard, the railways do not aggregate and identify this revenue separately but have it split between utility type and region.

Revenues, however, can only be generated in situations where the railway owns the ROW and where, in the case of Utility Crossings, the railway ROW was present first. In instances, such as could apply with a new ROW for a High Speed Rail line, where the utility was in place first, the railway could not expect to gain revenue from a utility crossing and instead would have to seek an agreement, or easement, to cross the utility.

Summary

Canadian railways have and continue to market their Rights-of-Way for alternate revenue purposes and are aggressively pursuing this market as a result of their need to develop other revenue sources and the opportunities afforded by de-regulation of the communications industry.

Key candidates for co-location uses and revenues are utilities such as gas and oil pipelines, and fibre-optic systems.

Co-location uses take the form of either Crossings or Parallelisms, with Crossings being the most numerous examples.

Charges for such occupancies are now taking the form of Easements and vary by type of application and utility. Fees also vary widely and are highly dependent on the value of the adjacent land. Due to the developing nature of this market by the railways, there is no consistent fee scale and there are wide fluctuations in evidence. However, it is likely that fees will increase on average to equate certain Canadian and U.S. railway examples.

EXHIBIT 2
SUMMARY OF REVENUE CHARGES
RAILWAY RIGHT-OF-WAY ALTERNATIVE REVENUE SOURCES

Railway	CROSSINGS[1]					PARALLEL[2]	
	UNDERGROUND				OVERHEAD		
	Telephone Wire	Electrical	Power Cable	Pipe	Wire	Overhead Electrical[3]	Underground Cable[4]
1. (Canadian)	$450	$450	$450	$450	$450	$42,150	$6,000
2. (Canadian)	280	280	280	280	465	4,800	2,000
3. (Canadian)	1,575	1,575	1,575	1,575	1,680	15,975	8,025
4. (United States)	1,100	1,600	1,600	1,600	1,100	60,100	6,100
5. (United States)	2,300	2,300	2,300	2,300	2,300	2,300	2,300
6. (United States)	1,375	4,300	4,300	2,900 - 4,300	3,875	22,400	22,400
7. (United States)	11,200	12,900	14,600	12,900 - 16,200	15,400	37,000	4,600

[1] Based on 20 year terms and per crossing

[2] Cost per mile and 20 year term

[3] Land value - $30,000

[4] Land value - $3,000

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4 Market Assessment

In order to assess the potential for revenues from co-location in the High Speed Rail Right-of-Ways, information has been obtained from selected Canadian and United States railways and the major utilities who do now occupy railway ROW's. As well, the assessment is based on the three major alternative technologies and associated ROW's being considered for the HSR line.

This assessment of revenue potential, because of a large number of variables and factors which can influence the projections, is based on a series of assumptions ranging from land cost to the number of utilities and their likelihood of using the HSR ROW. These are detailed within this section. Any change in these assumptions will affect the revenue projections.

Current Practice

As noted in the Section 3, the major Canadian and United States railways lease out space within their ROW's for revenue purposes. The major electrical, communications and pipeline utilities are the primary occupants and the space leased to them takes the form of Crossing or Parallel Easements. The lease amount for a Crossing is based on an annual fee plus an administration charge. A multi-year agreement, typically 20 years, is involved and the rate varies according to the number of Crossings, or encroachments, involved.

For Parallelisms, the rate is based on the length of ROW accupied and the value of the ROW being leased. Determination of the ROW value involves an assessment of the value of the adjacent land plus an allowance for administration, or some other appropriate allowance. This process is influenced to a large degree by what the market will bear from both a strict valuation standpoint as well as the nature of the area being leased and for what purpose. For example, in a remote rural environment there will be few residents, businesses or the municipal/township government to contend with if the ROW is to be leased for an oil or gas pipeline. If an environmentally sensitive marsh or bird sanctuary is nearby, there could be great interest in the intended ROW lease along with possible objections. This situation could likely have a downward influence on the cost of the lease.

Attempts to quantify the revenue received by the railways from the leasing of ROW space have been unsuccessful primarily because this is a sensitive and competitive area. It is also a relatively new area of attention with the railways and one which, it appears, from an organizational standpoint is only now receiving specific emphasis. As a result, revenues from the ROW space leasing have not been aggregated by the railways in their accounting systems. This, therefore, makes it difficult for them to estimate their total revenues from this source.

For the purpose of this study then, the sources for the revenue and the methods used to establish the fees and rates used has been examined and form the basis for this market assessment and revenue estimate based on a number of assumptions.

Assumptions

For this analysis and estimation of the revenue potential from the use of HSR ROW, the following assumptions have been made:

- potential new co-locate market is for fibre-optic/communications systems
- above ground electrical (Hydro) wires would be permitted within the HSR ROW in a parallel application
- revenue calculations are based on full utilization of the "eligible" ROW kilometrage
- "eligible" kilometrage is either New or Acquired Existing ROW
- the frequency of Crossings is one per 10 kilometres and are either pipelines or electrical cables or hydro wires
- the land costs are based on analysis conducted by Delcan staff contained in Interim Report No. 3 - Cost Estimates and averaged at: $500,000 for urban land; $5,000 for rural land per hectare. Kilometrage for "urban" areas has been estimated from the kilometrage summary found in Interim Report No. 2 - Detailed Routing Analysis
- no revenue would accrue where a new railway ROW crosses an existing utility ROW
- all revenues are estimates only and NET of costs since maintenance costs would be borne by the utility
- all revenue estimates and fee charges are in 1993 dollars

Market Potential

As discussed in the Section 3, the primary market for the leasing of ROW space is with fibre-optic/communications systems. There is some potential for pipelines (oil or gas) but this is highly dependent on the future needs of this industry which are uncertain at this time. It does appear that the basic pipeline network is complete and sufficient to meet the future needs of that market. Independent of this factor, the attractiveness of any HSR ROW is highly dependent on the final alignment of the HSR line and its make-up (continuity of ownership).

Advertising billboards are another potential source but this requires high visibility to either parallel roadways or to a large public audience such as would be found in urban areas. This revenue source has not been pursued within this study due to limited existing examples.

In considering the market potential for the use of ROW space for alternative revenue purposes, two considerations are critical. First is the completion and operating date for the HSR line. We have assumed that the line would not be operational before the turn of the century, or approximately 7 years from the date of this report.

Second is the alignment selected or the technology to be used. Within this context, the

alignment and technology are inter-dependent since the technology selected essentially determines the alignment.

With respect to the completion date for the HSR line, seven years is a significant time span since it appears that the opportunities to attract utilities, and specifically fibre-optic systems, to a new railway ROW are limited. The expectation now is that the needs of these companies will be satisfied by the existing railway, and other, ROW's since they provide the most desireable and needed links between the major urban areas. An HSR alignment which generally parallels existing railway ROW's may not be attractive since it would not offer a new route for the utilities. The only exception may be, for example, a more direct, shorter, route between Toronto and Ottawa which might offer the utilities some cost savings. In such instances, however, the cost to re-locate to the new alignment would have to be offset by either a lower lease cost, or some other consideration. Therefore, it may be that by the time the HSR line is operational, or at least the HSR Operating company has ownership of its ROW and can then lease out space, the opportunities to use its ROW for alternative revenue purposes will be minimal.

Related to this issue, and of equal importance to the question of revenue potential, is the matter of the final HSR alignment.

In reviewing the three main alignments being considered, they are an amalgam of new ROW, purchase of existing ROW and shared use of existing ROW. Exhibit 3 summarizes the relative relationship of these combinations. Alignment/technology option 3 (over 300 kph in New Corridor) has the largest length of new ROW. Option 1 (200-250 kph in Existing Rail Corridors) has the least new ROW but the greatest acquired ROW.

From a revenue standpoint, and considering the assumption that the existing railways are anticipated to have satisfied the market for the use of railway ROW's by the utilities and fibre-optic companies by the turn of the century, the acquisition of existing ROW's for HSR purposes may offer an immediate revenue potential, provided this right comes with the acquisition of the ROW.

As noted above, a new alignment may have limited revenue potential because it would largely parallel existing ROW's. Also, any new alignment, as dictated by the train technology selected, would traverse rural areas, or, at best, the periphery of urban areas. Since the fees charged for the use of the ROW for Parallelisms are based on land costs, and specifically, the cost of the abutting land, rural lands and lands on the urban fringe are typically lower value and hence command low lease rates.

Exhibit 4 summarizes typical land costs for the urban areas followed by each of the alignment options together with an estimate of the average rural land cost, in dollars per hectare (one hectare equals approx. 2.5 acres). These values are drawn from the land cost analysis undertaken as part of the HSR Alignment study. The average cost per hectare in the mid-sized cities (Windsor, London, etc.) is estimated at $400,000 (1993 dollars) rising to $600,000 per hectare in Toronto and Montreal. The average cost per rural hectare is $5,000. Thus the mix of urban and rural land within the selected alignment/technology has a significant bearing on

EXHIBIT 3
HIGH SPEED RAIL RIGHT-OF-WAY
CHARACTERISTICS

	High Speed Rail Alignment Option		
	1	2	3
New ROW	268 km	556 km	1,049 km
New in Existing ROW	254	110	15
Existing ROW Shared	281	223	135
Existing ROW Acquired	446	332	57
TOTAL ROW LENGTH	1,249 km	1,221 km	1,256 km
Urban Areas	324 km	267 km	182 km
Rural Areas	925 km	954 km	1,074 km

Source: Draft Final Report - Preliminary Routing Assessment and Costing Study, June/93.

EXHIBIT 4
HIGH SPEED RAIL
LAND VALUE - ALIGNMENT LOCATION

Area	Option			Estimated Land Value $/Hectare
Urban:	1	2	3	
Windsor	14 km	14 km	0 km	$400,000
London	48	48	0	400,000
Hamilton-Oshawa	145	126	93	600,000
Belleville	10	0	0	250,000
Kingston	10	0	0	250,000
Ottawa	31	31	31	500,000
Montreal	58	40	40	600,000
Quebec City	8	8	8	400,000
TOTAL URBAN KM	324 km	267 km	172 km	500,000*
TOTAL RURAL ROW KM	925 km	954 km	1,074 km	500,000*
TOTAL ROW LENGTH	1,249 km	1,221 km	1,246 km	

* Average

Source: Interim Report No. 2, Detailed Routing Analysis, May/93.

the revenue potential.

Exhibit 5 illustrates the relative distribution of urban and rural land between each of the alignment options. It further distributes this according to whether the ROW is New, New in Existing, Shared or Acquired Existing.

For revenue estimation purposes, as discussed previously only New ROW and Acquired Existing ROW's offer the opportunity for revenue generation since it is these ROW's that would be within the control of the HSR corporation. The kilometrages falling within these classifications then can be considered "Eligible for Co-Location Revenue" and are listed, both for the rural and urban situations, in Exhibit 5. Alignment Option 1 includes the most urban kilometrage (324 Km.) while Option 3 has the least urban kilometrage but the most rural kilometrage which is consistent with the technology associated with it.

Revenue Estimation For Co-Location Use of HSR ROW

Exhibit 6 presents an estimate of revenues for each HSR alignment/technology alternative calculated for Urban and Rural land designations and for each of the two kinds of co-location uses, Crossings or Parallelisms.

The total potential revenues, based on the assumptions used to develop the estimates, are $57.5 million over 20 years for Option 1, $69.5 million for Options 2 and 3. Annual revenues would therefore be approximately $2.9 million and $3.5 million respectively.

In reviewing the market potential for co-location revenues with an HSR line noted earlier, one of the prime determinants in being able to lease the use of the ROW to a prospective user, will be the suitability of the HSR alignment for the buyer's purposes. Unless the alignment provides new access between destination points not already served or available in a competing ROW or, offers advantages such as a shorter distance between destination points then the potential to generate revenue from the leasing of the ROW will be limited. From this standpoint, it appears that Option 3, with its dominant rural kilometrage but which largely duplicates existing ROW's, offers the least potential.

On a Revenue Per Kilometre basis, Alignment Option 1 offers the best return at $80,000 over twenty years based on its more favourable rural/urban kilometre mix. Alignment Option 3 is the poorest at $57,000.

In terms of estimating future revenues in the short, medium and longer term, based on the information available to date and the market trend, the revenue potential would likely be maximized within a short time, 2 to 3 years, after the inauguration of the HSR service and takeover of the ROW. Any further revenue growth potential would depend heavily upon the development of new technologies requiring the use of a dedicated ROW space or a growth in the need for more installations of existing utilities due to increased demand. These conditions can not be predicted at this time.

EXHIBIT 5

SUMMARY OF RIGHT-OF-WAY

OWNERSHIP AND LAND VALUES

	High Speed Rail Alignment Option					
	1		2		3	
	Urban	Rural	Urban	Rural	Urban	Rural
New ROW	19 km	249 km	75 km	481 km	77 km	972 km
New ROW in Existing ROW	34	220	0	110	0	15
Existing ROW Shared	206	75	166	57	101	34
Existing ROW Acquired	65	381	26	306	17	40
TOTAL	324 km	925 km	267 km	954 km	195 km	1,061 km
Total km Eligible for Co-Location Revenue	84 km	630 km	101 km	787 km	94 km	1,112 km
Average Land Values (per Hectare)	$500,000	$5,000	$500,000	$5,000	$500,000	$5,000

Source: Interim Report No. 3 - Cost Estimates

EXHIBIT 6
ESTIMATED CO-LOCATION REVENUE
FOR HSR ROW ALTERNATIVES

ITEMS	HSR Alignment Options					
	1		2		3	
	Rural	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**
Eligible ROW (km)	630	84	787	101	1,112	94
Parallelism:						
Electrical (Overhead) Rev./km	$6,320	$294,000	$6,320	$294,000	$6,320	$294,000
Cable (underground) Rev./km	6,320	294,000	6,320	294,000	6,320	294,000
TOTAL Revenue (000's)	7,963.2	49,392.0	9,947.7	59,388.0	14,055.7	55,272.0
Crossings:						
Number (@ 1/10 km)	63	8	79	10	111	9
Revenue/km/Crossing	1,575	1,575	1,575	1,575	1,575	1,575
TOTAL Revenue (000's)	99.2	12.6	124.4	15.8	174.8	14.2
TOTAL REVENUES*	8,062.4	49,404.6	10,072.1	59,403.8	14,230.5	55,286.2
GRAND TOTAL ALL REVENUES (000'S)*	$57,500.0		$69,500.0		$69,500.0	
REVENUE PER KILOMETRE*	$80,000		$78,000		$57,000	
ANNUAL REVENUE (000'S)	$2,900.0		$3,500.0		$3,500.0	
ANNUAL REVENUE PER KM	$4,000		$3,900		$2,900	

*TERM - 20 years

Summary

Canadian and U.S. railways lease ROW space for co-location revenue purposes to electrical, communications and pipeline companies. The leasing of space is in the form of Crossings or Parallelisms.

The major market potential for co-location revenue lies with fibre-optic companies although by the time the HSR line is operational the opportunities to lease space to these companies may be limited because existing railway ROW's may have met the demand.

The potential for co-location revenue from an HSR ROW depends on several factors:

- the attractiveness or suitability of the alignment to a utility company;
- ownership and continuity of the HSR ROW since it may be an amalgam of new and existing ROW;
- existing ROW acquired by the HSR corporation should include rights to existing co-location leases and revenues;
- New ROW may only be attractive if it provides some advantage over existing ROW's being used (such as a shorter distance);
- Revenue potential is determined by adjacent land values, negotiations with the client and is inversely proportional to the length of rural kilometrage;
- Identification of total revenues from co-location by present railways is difficult since the railways do not aggregate these revenues at present. The information is also confidential.

Considering these factors and other assumptions noted within this report, our estimation of co-location revenues, in 1993 dollars, for each HSR ROW alignment option is as follows:

Option	Total Revenue (20 Year Term)	Revenue Per Eligible KM.	Annual Revenue Per Eligible KM.
1	$57,500,000	$80,000	$4,000
2	$69,500,000	$78,000	$3,900
3	$69,500,000	$57,000	$2,900

On a Total Revenue basis, Alignment Option 3 would produce the most revenue, marginally higher than Option 2. However, on a Per Kilometre basis, Alignment Option 1 would be the most productive.

These estimates are based, as noted previously, on full utilization of the eligible kilometres which includes the acquisition of existing ROW's. We have been unable to identify the

revenues that the railways now receive for the ROW that would be acquired by the HSR corporation so that the above estimates may differ from actual current revenues.

The HSR Project Manager should determine what appropriate percentage of the HSR line should be considered for co-location revenue purposes and use the above per kilometre rates.

5 Conclusions

This report summarizes the practices of the major railways in Canada and the US with respect to the use of Right-of-Ways for alternative revenue purposes, the technical issues associated with such uses and the potential for generating such revenues from a High Speed Rail ROW.

The major conclusions as a result of this investigation are:

- Major Canadian and US railways use their ROW's for Co-locate purposes and are aggressively pursuing this market as a source of alternative revenues;

- The clients for this use are the major utility companies - gas, oil and hydro - and, more recently, communications systems companies (telephone) using fibre optics;

- The major market for Co-locate revenues lie with the fibre optic systems although this market growth is likely to be satisfied within the next few years;

- Technically, the installation of the utility services is regulated by established standards associations such as CSA (for gas pipelines), the NTA for oil and hydro and the Canadian Electrical Code Book for specific installation specifications;

- The market potential for Co-locate revenues within the HSR context will be limited due to the timing of the construction and availability of the HSR line (7 years) and the likelihood that the needs of the utilities will have been satisfied;

- The potential revenues from Co-location will be affected by a number of factors in addition to the overall market potential. The major factors are: the final alignment selected, the value of land adjacent to the ROW, the relative split between rural and urban land, the length of existing ROW purchased from the railways and the rights to and amount of Co-locate revenue being generated at the time of take-over;

- estimated Co-location revenue, in 1993 dollars, for each of the three HSR ROW options is:

Option	Total Revenue (20 Year Term)	Revenue Per Eligible KM.	Annual Revenue Per Eligible KM.
1	$57,500,000	$80,000	$4,000
2	$69,500,000	$78,000	$3,900
3	$69,500,000	$57,000	$2,900

- Alignment Option 1 is projected to be the most productive due to its more advantageous urban/rural land split.

APPENDIX

A Regulations affecting the Location of Utilities

B Guidelines to Cross Facilities of Interprovincial Pipe Line Inc.

C Amtrak Requirements and Specifications for Pipeline Occupancy

D Specifications for Wire, Conduit and Cable Occupations of Amtrak Property

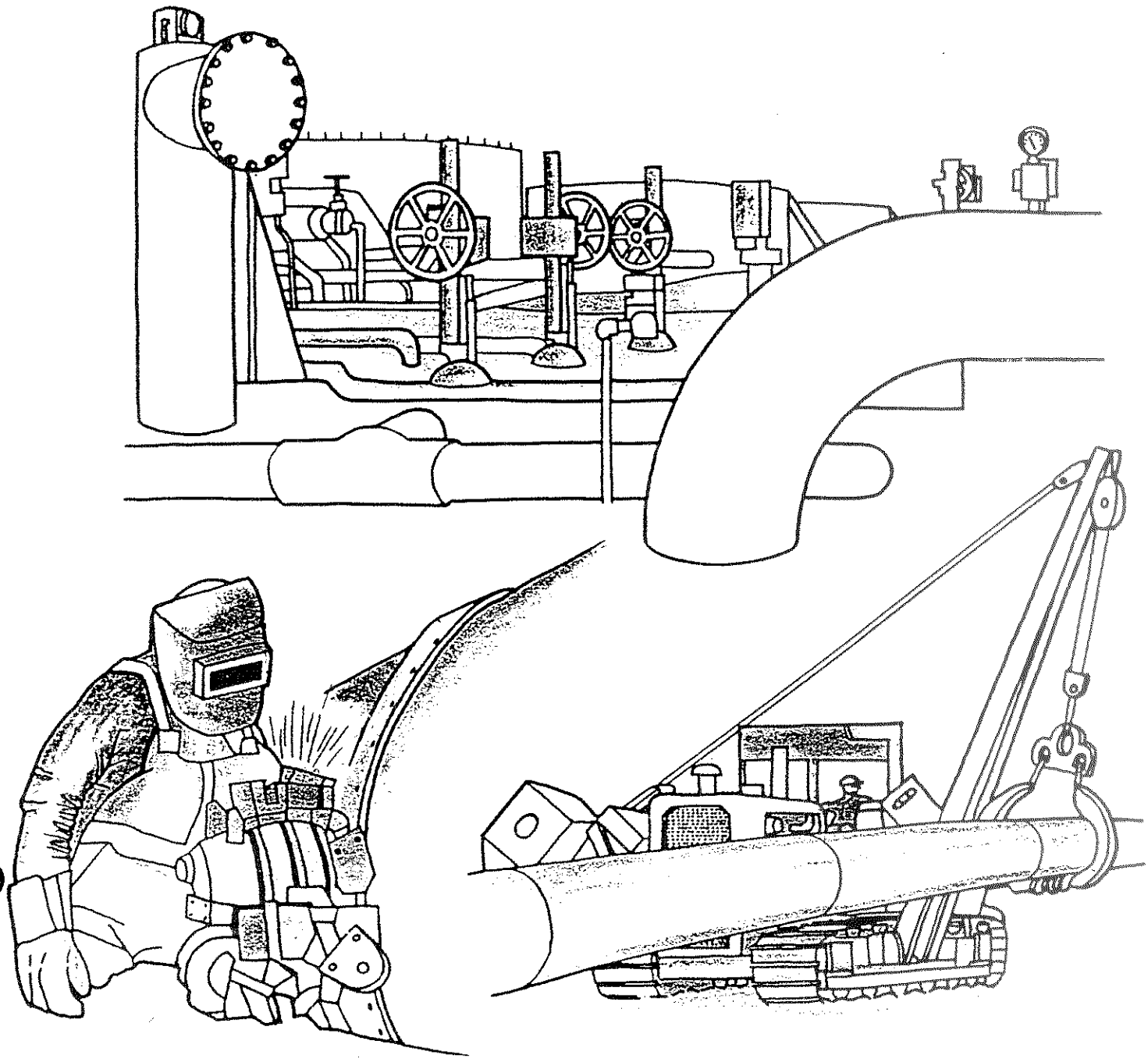
APPENDIX A

Regulations Affecting the Location of Utilites

- CSA Z184 M92 Gas Pipeline Systems
- CSA C22.3 No. 1-M87 Overhead Systems
- CSA C22.3 No. 1-M1979 Overhead Systems and Underground Systems

CAN/CSA-Z184-M92
Gas Pipeline Systems

A National Standard of Canada



(c) limits on the height of the inside and outside weld flash of electric welded pipe; and
(d) an upper limit on yield strength.

5.5.2.4
The pipeline system designers shall consider the torsional, tensile, and compressive strengths of the mechanical interference fit joint; the effect of torsional and bending loads on the joint.

5.5.2.5
Pipeline systems with mechanical interference fit joints shall not be subjected to service conditions that would adversely affect the performance of the joint.

5.5.2.6
Mechanical interference fit joints shall not be used to join dissimilar pipe materials.

5.5.3 Threaded Connections

5.5.3.1
The use of threaded pipe-to-pipe and pipe-to-component connections on permanently buried installations shall not be permitted, except for service connections to cast-iron distribution lines and auxiliary connections (such as drains, valve body bleeds, or instrumentation taps) directly into components.

5.5.3.2
Except as allowed by Clause 5.5.3.1, threaded connections shall not be used on pipe sizes larger than
(a) 114.3 mm OD; or
(b) 60.3 mm OD with a maximum operating pressure greater than 3500 kPa.

5.6 Cover and Underground Clearance for Steel Pipe

5.6.1 Cover Requirements

5.6.1.1 General
The cover requirements for pipelines and casings shall be as follows:
(a) buried gathering lines, transmission lines, distribution lines, and casings shall be installed with a minimum cover of 60 cm, unless otherwise required or permitted herein;
(b) it shall be permissible to install buried gathering lines, transmission lines, and distribution lines operating at hoop stresses less than 30% of the specified minimum yield strength of the pipe and located within private rights-of-way, private thoroughfares, sidewalks, or parkways with less than the minimum cover of 60 cm if it is considered that external damage to the pipe will not be likely to occur;
(c) where underground structures or adverse sub-surface conditions prevent the installation of gathering lines, transmission lines, or distribution lines with the minimum cover, it shall be permissible to install such pipelines with less cover if they are provided with additional protection to withstand anticipated external loads; and
(d) service lines shall be installed in accordance with the requirements of Clause 7.5.1.

5.6.1.2 Pipelines Within Railway, Highway, Road, and Street Rights-of-way

5.6.1.2.1

Pipelines that are intended to operate at hoop stresses of less than 30% of the specified minimum yield strength of the pipe and cross or are located within the rights-of-way of highways, roads, or streets shall meet the applicable cover requirements of Clauses 5.6.1.1 and 7.5.1. Pipelines that are intended to operate at hoop stresses of less than 30% of the specified minimum yield strength of the pipe and cross or are located within the rights-of-way of railways shall meet the cover requirements specified for pipelines operating at higher hoop stresses in Clause 5.6.1.2.2(b).

5.6.1.2.2

Pipelines that are intended to operate at hoop stresses of 30% or more of the specified minimum yield strength shall meet the following cover requirements:

(a) Where practicable, the depth of cover within the rights-of-way of highways, roads, or streets shall not be less than 75 cm, measured from the top of the carrier and any casing pipe. Where practicable, pipelines located within 7 m of the edges of the travelled surface of highways, roads, or streets, measured at right angles to the centreline of the travelled surface, shall be so constructed that the difference in elevation from the travelled surface to the top of the carrier and any casing pipe is not less than 120 cm. However, where it is not practicable to provide such depths of cover, special design and construction procedures shall be used to protect the highways, roads, streets, and pipelines from physical damage.

(b) Where practicable, the depth of cover within railway rights-of-way shall not be less than 75 cm, measured from the top of the carrier or casing pipe. Where practicable, pipelines located within 7 m of the centreline of the outermost track, measured at right angles to the centreline of the track, shall be so constructed that for uncased installations the difference in elevation from the top of the carrier pipe to the base of the rail is not less than 200 cm, and for cased installations the difference in elevation from the top of the casing to the base of the rail is not less than 120 cm. Where it is not practicable to provide such depths of cover, special design and construction procedures shall be used to protect the railways and pipelines from physical damage.

5.6.2 Underground Clearance

The following underground clearance requirements shall apply:

(a) Where practicable, there shall be at least 30 cm of clearance between any pipeline and any other known underground structure that it parallels, but in no case shall the clearance be less than 5 cm.

(b) Where practicable, there shall be at least 5 cm of clearance between any pipeline and any other known underground structure that it crosses; where a clearance of at least 5 cm is not practicable, the pipeline shall be protected from damage that might result from the proximity of the other structure.

(c) Precautions shall be taken to prevent electrical contact with, or the imposition of external stresses from or on, any other underground structure.

shall be at least 50 mm greater than the outside diameter of the carrier pipe. For carrier pipe 168.3 mm OD or larger, the inside diameter of the casing pipe shall be at least 75 mm greater than the outside diameter of the carrier pipe.

(c) Carrier pipe shall be held clear of the casing pipe by properly designed supports, insulators, or centering devices, so installed as to preclude the transmission of excessive external loads to the carrier pipe.

(d) The ends of casings shall be suitably sealed to the outside of the carrier pipe. Venting of sealed casings is not mandatory; however, where vents are installed, they shall be protected from the weather to prevent water from entering the casing. Where casing seals of a type that will retain more than 35 kPa pressure between the casing and the carrier pipe are installed, and vents are not used, provision shall be made to relieve any internal pressure before carrying out maintenance work.

(e) Casing pipe under highways, roads, and streets shall be of sufficient length to absorb all of the external loading from the road bed at the point of crossing.

(f) Casing pipe under railways shall extend a distance, measured at right angles to the centreline of the track, of at least 7 m beyond the centreline of the outermost track, 0.6 m beyond the toe of slope, or 1.0 m beyond the ditch line or area that may be affected by normal ditch cleaning operations, whichever is the greatest.

(g) The least nominal wall thickness for steel casing pipe used in railway, highway, road, and street crossings shall be in accordance with the requirements of Table 5.5.

Table 5.5
Least Nominal Wall Thickness for Steel Casing Pipe in Cased Crossings and Carrier Pipe in Uncased Crossings

	Least nominal wall thickness, mm	
Pipe outside diameter, mm	**Highways, roads, and streets**	**Railways**
88.9	3.2	3.2
101.6	3.2	3.2
114.3	3.2	3.2
141.3	4.0	4.0
168.3	4.8	4.8
219.1	4.8	4.8
273.1	4.8	4.8
323.9	4.8	4.8
355.6	4.8	5.6
406.4	4.8	5.6
457	4.8	6.4
508	4.8	7.1
559	5.6	7.9
610	6.4	8.7
660	6.4	9.5
711	6.4	10.3
762	6.4	10.3
813	6.4	11.1

(Continued)

10.10.5
Where existing pipelines are to be crossed by unimproved public roads, hard surfaced roads, highways, public streets, or railways, the pipelines in such locations shall be either upgraded to meet the requirements of Clauses 5.3 and 5.4 or subjected to
(a) an engineering assessment in accordance with the requirements of Clauses 10.10.1(a) and (b); and
(b) a detailed engineering analysis of all loads expected to be imposed on the pipeline during construction and operation of the crossing, and the resulting combined stresses in the pipeline.

10.10.6
Where the engineering assessment described in Clause 10.10.5(a) reveals that the pipeline is in satisfactory condition, it shall be permissible to use any crossing design (such as casing, change in pipe specification, suitable depth of cover, or load distributing structure) that results in combined pipe stresses in accordance with the requirements of Clause 5.19, as determined from the detailed engineering analysis described in Clause 10.10.5(b).

10.11 Evaluation and Repair Procedures for Steel Pipeline Systems Operating at Hoop Stresses of 30% or More of the Specified Minimum Yield Strength of the Pipe

10.11.1 General

10.11.1.1
Where imperfections are found in steel piping, evaluations shall be made in order to determine its suitability for continued service.

10.11.1.2
Where the pipe is determined to be subjected to significant secondary stresses, such stresses shall be considered when the suitability of damaged pipelines for continued service is being assessed.

10.11.1.3
Excavation of piping suspected of containing imperfections and its subsequent permanent or temporary repair, if required, shall be performed after the piping is depressurized or at an operating pressure that is considered to be safe for the proposed work.

10.11.1.4
Evaluations shall include inspection by methods capable of detecting cracks associated with imperfections.

10.11.1.5
External coatings that conform to the requirements of Clause 9.2.8 shall be applied following cleaning, evaluation, and repair operations.

10.11.1.6
Where piping is not qualified for continued service at the established maximum operating pressure due to the presence of defects, either the maximum operating

30°C; however, it shall be permissible for service risers to operate between 30°C and 50°C for short periods of time as a result of ambient conditions.

11.2.2.3
Wall thicknesses of polyethylene pipe shall be not less than the applicable minimums specified in CSA Standard CAN/CSA-B137.4. Pipe on which saddle fusions will be performed shall have minimum wall thicknesses of 4.2 mm or greater.

11.2.3 Design Pressures of Fittings
Design pressures of fittings shall be not less than the design pressures of the pipe with which they are used.

11.2.4 Valves
Valve installations shall be designed to protect the pipe material against excessive torsional or shearing loads when the valve or shut-off is operated, and from any other secondary stresses that might be exerted through the valve or its enclosure. Valves made of plastic shall comply with the requirements of ANSI Standard B16.40.

11.2.5 Protection from Hazards
Piping shall be designed in accordance with the applicable requirements of Clause 5.9.

11.2.6 Cover and Crossing Requirements

11.2.6.1 Cover Requirements for Distribution Lines
The cover for distribution lines shall be in accordance with the requirements given for steel pipe in Clause 5.6.1.

11.2.6.2 Cover Requirements for Service Lines
The cover for service lines shall be in accordance with the requirements of Clause 7.5.1.

11.2.6.3 Cover Requirements Within Highway, Road, and Street Rights-of-Way
Cover requirements for pipelines with standard dimension ratios up to and including SDR 11 shall be in accordance with the applicable requirements given for steel pipelines in Clause 5.6.1.2. For pipelines with standard dimension ratios greater than SDR 11, cover requirements shall be determined by calculations.

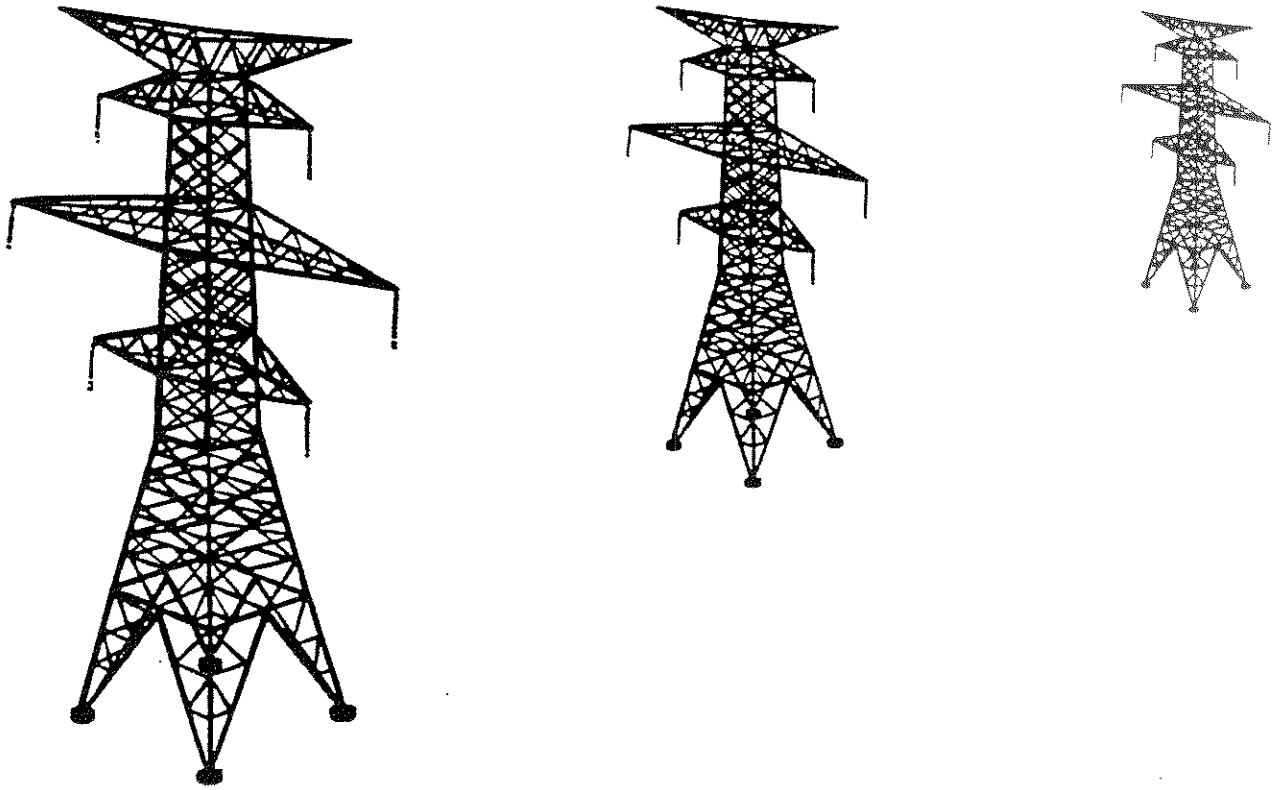
11.2.6.4 Cover Requirements Within Railway Rights-of-Way
Pipelines within railway rights-of-way shall have cover in accordance with the applicable requirements given for steel pipelines in Clause 5.6.1.2, except where the pipelines cross under the tracks. Uncased pipeline crossings shall be so constructed that the base of the rails is not less than 152 cm above the top of the carrier pipes. Where casings are used, the cover shall be in accordance with the requirements of Clause 5.6.1.2.2(b).

11.2.6.5 Casing Design
Where pipelines are cased, casings shall be designed in accordance with the requirements given for steel pipelines in Clause 5.7.4.

Canadian Standards Association

CAN/CSA-C22.3 No. 1-M87
Overhead Systems

A National Standard of Canada



Electrical Installation Codes

elevation of this mark shall be tied (levelled) into bench marks or similar types of permanent markers established in bedrock or in the concrete foundation of towers, or as established by the surveyor. The bench marks must be recorded along with the time and date. Where possible, the bench marks and other permanent markers established should in turn be tied into Geodetic Survey of Canada bench marks or horizontal control markers, or into those of the Canadian Hydrographic Service.

4.3.3.2 Basic Clearances

The minimum vertical clearances of wires and conductors above navigable water shall be as specified in Table 3 except that:

(a) for areas where vessel heights are known to exceed the reference vessel height at the time of design, the required clearance in Table 3 shall be increased by the difference between the taller vessel and the reference vessel height shown in Table 3.

(b) for elevation above 1000 m and where voltages exceed 50 kV, the clearances specified in Table 3 shall be increased by 1% for each 100 m or any part in excess of 1000 m above mean sea level.

4.3.4 Maximum Height of Wires and Equipment Above Ground in the Vicinity of Airports

The maximum height of wires and equipment in the vicinity of airport runways is limited. The heights of wires, supporting structures, and equipment on land adjacent to, surrounding, or near an airport in Canada are subject to the regulations of Transport Canada and are not covered by this Standard.

4.4 Horizontal Design Clearances of Wires and Conductors from Railway Tracks

4.4.1

Where wires and conductors are along a railway track or tangent to a curved track and where, under maximum sag conditions, the wires and conductors provide less than the minimum vertical clearance above rails required by Clause 4.3.1, minimum horizontal clearances shall be provided in accordance with Clauses 4.4.2 and 4.4.3. This minimum horizontal clearance shall be the distance between the vertical projection of the inside edge of the top of the nearest rail and the nearest position of the wire under the conditions of swing specified in Clause 4.2.7.

4.4.2

Where there is no curvature of the railway tracks, the horizontal clearances shall be as specified in Table 6.

4.4.3

At a point of curvature of the railway track, the horizontal clearances shall be as specified in Table 6 plus an increment of 25 mm for each degree of curvature and, in addition, where the wire is closer to the low side of tracks that are at different elevations a further increment of 2.5 mm for each millimetre of super-elevation. (The total of these two increments will not exceed 0.75 m, and 0.75 m may be used in place of calculations, if desired.)

4.5 Horizontal Separations of Supporting Structure from Railway Tracks

Note: *Side separations, as specified in Clauses 4.5.1 to 4.5.5, are not customary construction separations but are minimum separations for circumstances where greater separations cannot be obtained. To allow working space for normal maintenance operations, the Railway does not ordinarily permit poles, guys, etc, to be placed on the railway right of way less than 9 m from the track centreline where space permits. On narrower rights of way, structures and guys must be placed as far as possible from the centreline of the nearest track.*

4.5.1

Any part of a supporting structure not complying with the vertical clearance requirements of Clause 4.3.1 shall be provided with minimum horizontal separations from railway tracks in accordance with Clauses 4.5.2 to 4.5.5. The minimum horizontal separations shall be the distance between the vertical projection of the inside edge of the top of the nearest rail and the nearest position of the structure.

4.5.2

Where there is no curvature of the railway tracks, the minimum horizontal separations shall be as specified in Table 7 increased, where applicable, to meet the requirements of Clauses 4.5.4 and 4.5.5.

4.5.3

At a point of curvature of the railway tracks, the minimum horizontal separation shall be as specified in Table 7, plus the increment required by Clause 4.4.3, and increased where applicable to meet the requirements of Clauses 4.5.4 and 4.5.5.

4.5.4

At loading sidings, sufficient space shall be left for a driveway in accordance with the stated needs of the Railway.

4.5.5

Horizontal separations shall, in all cases, be great enough to permit the unobstructed view of signals, signs, and similar equipment.

4.6 Horizontal Separations of Supporting Structures from Fire Hydrants, Street Corners, and Curbs

4.6.1 Horizontal Separation from Fire Hydrants

Supporting structures (including guys or attachments) that are less than 2 m above the top of the hydrant shall have a minimum horizontal separation from the hydrant of 1 m.

4.6.2 Horizontal Separation from Street Corners

Supporting structures, including guys, shall be set as far as practicable from the beginning of curvature.

4.6.3 Horizontal Separation from Curbs

4.6.3.1

Structures shall be set at least 150 mm from the edge of the curb, measured away from the travelled portion of the roadway.

4.6.3.2

Where crossarms and other attachments such as guys provide less than the minimum vertical separation above roads required for guys in Clause 4.3.1, such attachments shall have the minimum horizontal separation specified in Clause 4.6.3.1.

4.7 Clearances of Wires, Conductors, and Equipment from Buildings, Signs, Bridges, Swimming Pools, and Similar Plant

4.7.1 General

Wires and cables shall not interfere with the normal use of balconies, doors, fire escapes, windows, permanent ladders, catwalks, etc.

4.7.2 Clearances of Supply Conductors from Buildings When Attached

Where the permanent attachment of supply conductors to buildings is necessary (as for an entrance), the minimum clearance of the conductors from the surface of buildings shall be as listed in Table 8 and apply under the following conditions:

(a) vertical clearances apply under conditions of maximum sag of the conductor;

(b) horizontal clearances apply when the conductor is in the position of swing as calculated according to Clause 4.2.7.

4.7.3 Clearances of Wires and Conductors Passing By or Over Buildings, Signs, Billboards, Lamp and Traffic Signs, Standards, and Antennas (Not Attached)

4.7.3.1 Ladder Space

Where buildings exceed three storeys (or 15 m) in height, and where it is necessary to raise ladders for fire fighting (ie, the local fire department practice does not exclude the use of ladders), overhead lines shall be arranged where practical so that a clear space or zone at least 2 m wide is left either adjacent to the building or beginning not more than 2.5 m from the building.

4.7.3.2 Basic Clearances

The minimum horizontal and vertical clearances from wires and conductors to buildings, signs, and similar plant shall be as specified in Table 9 and apply under the following conditions:

(a) clearances apply to any part of a building, including balconies, fire escapes, antennas and their supporting structures, and other permanent fixtures;

(b) vertical clearances apply under conditions of maximum sag of the wire or conductor;

(c) horizontal clearances apply when the wire or conductor is in the position of swing as calculated according to Clause 4.2.7;

(d) guy wires, communication cables, and drop wires shall not be allowed to rub buildings or other plant.

4.7.3.3 Application of Clearances

In the following explanation the word "building" is intended to refer to any of the plant covered by Clause 4.7.3.2.

Table 2 (Concluded)

Location of wires or conductors	Guys; messengers; communication, span, and lightning protection wires; communication cables	Trolley contact conductors and associated span wires; trolley feeders 0—750 V when paralleled by trolley contact conductors	Open supply conductors and service conductors, alternating current*, minimum clearances in metres								
			0 to 750 V	Over 0.75 to 22 kV	Over 22 to 50 kV	Over 50 to 90 kV	Over 90 to 120 kV	Over 120 to 150 kV	Over 150 to 250 kV	Over 250 to 300 kV	Over 300 kV
	Col. I	Col. II	Col. III	Col. IV	Col. V	Col. VI	Col. VII	Col. VIII	Col. IX	Col. X	Col. XI
Alongside land likely to be travelled by road vehicles‡						5.5	5.8	6.1	6.1 plus 0.01 m for each kilovolt over 150 kV	7.1 plus 0.07 m for each kilovolt over 250 kV	10.6 plus 0.025 m for each kilovolt over 300 kV
Over driveways to residences and residence garages for vehicles not exceeding 2.4 m in height	3.7	3.7	3.7	4.75	5.2	5.5	5.8	6.1	6.1 plus 0.01 m for each kilovolt over 150 kV	7.1 plus 0.07 m for each kilovolt over 250 kV	10.6 plus 0.025 m for each kilovolt over 300 kV
Alongside roads and highways in areas unlikely to be travelled by road vehicles (with no overhang) and within 1.5 m of the limit of the right of way**	3.0	NA	3.4	4.15	4.6	4.9	5.2	5.5	5.5 plus 0.01 m for each kilovolt over 150 kV	6.5 plus 0.07 m for each kilovolt over 250 kV	10.1 plus 0.025 m for each kilovolt over 300 kV
Over walkways or ground normally accessible to pedestrians only††	2.5	NA	3.1	3.4	3.7	4.0	4.3	4.6	4.6 plus 0.01 m for each kilovolt over 150 kV	5.6 plus 0.01 m for each kilovolt over 250 kV	6.1 plus 0.01 m for each kilovolt over 300 kV
Above top of rail at railway crossings	7.3	6.7	7.3	7.6	8.1	8.4	8.7	9.0	9.0 plus 0.01 m for each kilovolt over 150 kV	10 plus 0.01 m for each kilovolt over 250 kV	10.5 plus 0.01 m for each kilovolt over 300 kV

Note: Above 250 kV (line-to-ground) the specified clearances are minimum and are based on horizontal configuration of conductors where induced electrostatic steady-state currents are low. Other types of construction with double-circuit vertical construction may require larger clearances to keep steady-state currents to the same safe minimum values.

*For dc voltages below 750 V, use Columns II and III of Table 2.

†Where communication wires or communication cables run along alleys, this clearance may be reduced to 4 m.

Table 4
Minimum Vertical Design Clearances Above Ground or Rails, Direct Current

(See Clauses 4.3.1 and 4.7.4.1.)

Open supply line conductors (direct current)—minimum clearances in metres									
Location of conductors	0.75 to 100 kV*	Over 100 to 150 kV	Over 150 to 200 kV	Over 200 to 250kV	Over 250 to 300 kV	Over 300 to 350 kV	Over 350 to 400 kV	Over 400 to 450 kV	Over 450 kV
	Col. I	Col. II	Col. III	Col. IV	Col. V	Col. VI	Col. VII	Col. VIII	Col. IX
Over land likely to be travelled by road vehicles, including highways, streets, lanes, alleys, and driveways (other than to residences or residence garages)	5.8	6.0	6.3	6.5	6.7	6.9	7.2	7.4	To clearance in Col. VIII add 0.005 m for each kilovolt over 450 kV
Over the right of way of underground pipelines	5.8	6.0	6.3	6.5	6.7	6.9	7.2	7.4	
Alongside and within the limits (with no overhang) of streets and highways in densely populated areas	5.8	6.0	6.3	6.5	6.7	6.9	7.2	7.4	
Over or alongside farmland likely to be travelled by vehicles	5.8	6.0	6.3	6.5	6.7	6.9	7.2	7.4	
Alongside land likely to be travelled by road vehicles	5.8	6.0	6.3	6.5	6.7	6.9	7.2	7.4	
Over driveways to residences or residence garages	5.6	5.9	6.1	6.3	6.6	6.8	7.0	7.2	
Alongside roads and highways in areas unlikely to be travelled by road vehicles (with no overhang) and within 1.5 m of the limit of the right of way†	5.5	5.7	6.0	6.2	6.4	6.6	6.9	7.1	
Over walkways or ground normally accessible to pedestrians only‡	4.6	4.8	5.0	5.3	5.5	5.7	6.0	6.2	
Above top of rail on railway crossing	8.8	9.1	9.3	9.5	9.8	10.0	10.2	10.4	

For dc voltages below 750 V, use Columns II and III of Table 2.

†*This is ground generally adjacent to fences and accessible to small vehicles but not likely to be travelled by high road vehicles or big farm machinery.*

‡*Seasonal conditions may dictate additional clearances.*

Table 6
Minimum Horizontal Design Clearances Between Wires and Railway Tracks
(See Clause 4.4.)

	Wire closest to tracks		Minimum clearances in metres	
			Main tracks	Sidings
	Guys; messengers; communication, span, and lightning protection wires; communication cables		2.5	1.9
	Open supply line conductors and service conductors of 0—750 V and effectively grounded continuous metallic sheathed cables of all voltages		2.5	1.9
Alternating current	Open supply line conductors and cables other than those having an effectively grounded continuous metallic sheath	Over 0.75— 22 kV	2.7	2.1
		Over 22— 50 kV	3.2	2.6
		Over 50— 90 kV	3.5	2.9
		Over 90—120 kV	3.8	3.2
		Over 120—150 kV	4.1	3.5
	Supply conductors over 150 kV		4.1 plus 0.010 m for each kilovolt over 150 kV	3.5 plus 0.010 m for each kilovolt over 150 kV
Direct current	Open supply conductors	0—750 V	2.5	1.9
		Over 0.75—100 kV	2.8	2.2
		Over 100—150 kV	3.0	2.5
		Over 150—200 kV	3.3	2.7
		Over 200—250 kV	3.5	2.9
		Over 250—300 kV	3.7	3.1
		Over 300—350 kV	4.0	3.4
		Over 350—400 kV	4.2	3.6
		Over 400—450 kV	4.4	3.8
		Over 450 kV	4.4 plus 0.005 m for each kilovolt over 450 kV	3.8 plus 0.005 m for each kilovolt over 450 kV

Table 7
Minimum Horizontal Separations from Supporting Structure to Railway Tracks
(See Clause 4.5.)

Tracks	Minimum horizontal separation in metres
Main tracks (straight, level runs)	2.5
Sidings (straight, level runs)	1.9

Table 8
Minimum Design Clearances of Supply Conductors Attached to Buildings
(See Clause 4.7.2.)

Conductor attached to building*		Minimum clearance in metres			
		Horizontal to normally inaccessible surface	Horizontal to readily accessible surface	Vertical to normally inaccessible surface	Vertical to readily accessible surface
0 to 750 V	Insulated or grounded	0	1.0	1.0	2.5
	Enclosed in effectively grounded metallic sheath	0	0	0	0
0 to 750 V	Neither insulated nor grounded, nor enclosed in effectively grounded metallic sheath	0.08	1.0	1.0	2.5
Over 0.75 to 5 kV	Not enclosed in effectively grounded metallic sheath	0.15	1.2	1.2	2.7
	Enclosed in effectively grounded metallic sheath	0	0	0	0
Over 5 to 22 kV	Not enclosed in effectively grounded metallic sheath	0.3	1.5	1.5†	3.0†
	Enclosed in effectively grounded metallic sheath	0	0	0	0

(Continued)

Table 25
Minimum Grades of Construction for Crossings
(See Clauses 5.3.2, 6.8.1.1, 6.8.2, 6.8.3, and 6.9.1.)

Item at lower level	Grade of construction		
	Minimum grade where the conductors, messengers, or cables at the upper level are:		
	Communication	0—750 V	Over 750 V
Railway control facilities and tracks	1	1	1
Limited and controlled access highways	2	2	2
Roads and highways—general	3	3	3
Pipelines and waterways	3	3	3
Aerial tramways	1	1	1
Other private or public property	3	3	3
Communication			
Cable	3	3	1*
Open wire in general	3	3	1*
Drop wire	3	3	3
Supply			
0—750 V	2†	3	2‡
Over 750 V	1†	2	2

**The grade of construction may be Grade 2 where one of the following conditions is complied with:*

(a) the supply and communication have coordinated protection;

(b) where coordinated protection is not practicable, the supply conductors have a breaking strength of at least 13 kN; *or*

(c) the supply conductors are enclosed in effectively grounded continuous metallic sheathed cable.

†The communication line may be Grade 3 where the supply conductors are in cable with effectively grounded continuous metallic sheath.

‡Where the supply conductors at the upper level are in effectively grounded continuous metallic sheathed cable, Grade 3 construction may be used.

Table 26
Minimum Grades of Construction for Proximities
(See Clauses 5.3.3, 6.8.1.1, 6.8.2, 6.8.3, and 6.9.1.)

In proximity to	Minimum grade of construction		
	Communication	Conductors 0—750 V or effectively grounded continuous metallic sheathed supply cables of all voltages	Conductors over 750 V
Railway control facilities and tracks	1	1	1
Limited or controlled access highways	2	2	2
Roads and highways—general	3	3	3
Pipelines and waterways	3	3	3
Aerial tramways	1	1	1
Other private or public property	3	3	3
Communications			
Cable	3	2	1*
Open wire in general	3	2	1*
Drop wire	3	3	3
Supply			
0—750 V	2	3	2†
Over 750 V	1	2	2

**The line may be Grade 2 if the supply and communications have coordinated protection.*
†Where the supply conductors at the upper level or the supply conductors creating the proximity are in effectively grounded continuous metallic sheathed cable, Grade 3 construction may be used.

Canadian Standards Association

OVERHEAD SYSTEMS and UNDERGROUND SYSTEMS

Forming Part of Canadian Electrical Code Part III

7.18.2 **Selection of Insulators**
In selecting insulators to be used for any line, consideration in determining the test voltage rating shall be given to the conditions under which the line will operate, as follows:

(a) Whether a system operates in areas of intermittent rains, moderate lightning, and very little or no contamination; or

(b) Whether operating conditions are more severe than those set forth in Item (a) above, due to the extent of the system, the prevalence of exceptionally severe lightning, bad atmosphere due to chemical fumes, dust, salt, fog, or other foreign matter, or to a long dry season with heavy dust accumulation followed by moisture.

7.18.3 **Protection Against Arcing**
When installing the insulators and conductors, such precautions as are sanctioned by good practice shall be taken to prevent, as far as possible, any arc from forming or to prevent any arc that might be formed from weakening or burning any parts of the structures, insulators, or conductors.

8. Underground — General

8.1 **General**
Clause 8 of this Standard deals with requirements that are applicable to both direct buried and duct and manhole systems. Clauses 9 and 10 deal specifically with direct buried and duct and manhole systems, respectively. In cases where the underground system is a combination of each of these two systems (e.g., the case of a direct buried cable crossing under a highway, railway, etc., in duct), the appropriate Clauses of 9 and 10 shall apply.

8.2 **Definitions and Limitations**

8.2.1 In the underground Clauses of this Standard the definition in Clause 8.2.2 and the voltage limitations of Clause 8.2.3 shall apply.

8.2.2 *Swimming pool* means any one of the following types of pools, whether it is constructed above or below grade:

(a) A pool constructed in such a manner that it cannot be readily disassembled for storage;

(b) A pool constructed in such a manner that it may be disassembled for storage and reassembled to its original integrity;

(c) A therapeutic pool;

(d) A wading pool;

(e) A decorative pool that could be used as a wading pool, is larger than 1.5 m in any dimension, and is readily accessible to the public.

8.2.3 Voltage limitations are as follows:

(a) Communication cables are deemed to be cables used for the transmission of information by means of electric current. If such cables contain circuits that operate at voltages exceeding 150 V line-to-ground or 300 V between any two points of the circuit, and the transmitted power exceeds 150 W under normal operating conditions or fault conditions, the requirements of Clause 3.8 shall apply;

Note: Telephone, telegraph, railway-signal, messenger-call, fire-alarm, police alarm, community television, and other systems conforming with the above are included.

(b) Supply cables are those used for transmitting electric energy, and operating at a voltage (ac or dc) of 120 V or higher, but not exceeding 150 kV.

8.3 **Location**

8.3.1 **General Location**
Underground supply and communication systems shall be located so as to cause, or be subject to, the least disturbance practicable. Railway tracks and underground structures, including catch basins, pipelines, etc., shall be avoided where practicable.

8.3.2 **Location of Above-Ground Facilities**
Above-ground facilities associated with the underground system, such as service pedestals, equipment housings, cable riser poles, etc., shall be located so as to be subject to the least exposure practicable to vehicular or other foreign damage. The live parts of such equipment shall not be exposed to the public. Above-ground facilities shall provide safe access and operating space.

8.3.3 **Standard Location**
Pipelines, supply, and communication facilities should occupy a standard allocated position on the street allowance and on private property. For a typical arrangement, see Appendix B.

8.3.4 **Ducts**
The ducts between adjacent manholes, or other outlets, shall be laid as straight and direct as conditions will permit.

8.3.5 **Manholes**

8.3.5.1 Manhole openings shall be located so as to provide safe and convenient access. Where this is not possible, special safety precautions shall be taken.

8.3.5.2 The location shall be so chosen as to avoid the possibility of other underground structures passing through the manhole.

8.3.6 **Steam Pipelines**
Steam pipelines close to cables can cause a damaging overheating of the cable, and this effect shall be taken into account in addition to the separations stipulated elsewhere in this Standard.

8.3.7 **Induced Voltages and Currents**
When there is a parallel between supply cables and communication circuits or metallic pipelines (especially those with insulating coverings) adequate precautions shall be taken to minimize any hazard due to induced voltages and currents.

8.3.8 **Crossings**
Where it is necessary for one underground system to cross over or under another underground system, the crossing shall be made at right angles, or as nearly so as circumstances will permit.

8.4 Identification of Underground Plant

8.4.1 Marking of Plant Locations
When located along or across railways (and other important rights-of-way), underground plant shall be marked above ground as permanently as possible, using visual means such as a post, pedestal, or labels on above-ground equipment. In other locations accessible to the public and where conditions permit, the presence of main underground plant should be similarly indicated.

Note: It is recommended that maps or records of sufficient accuracy be maintained to locate and identify main underground plant. The location, depth of burial, and type of plant should be recorded.

8.4.2 Cables of One Utility
Where there are buried cables of different circuits, close to one another, identification shall be provided on all cables at each location where the cables emerge from the earth.

***Exception:** Identification need not be provided on each individual cable where several cables, all operating at a nominal voltage below 750 V (phase-to-phase), emerge from the earth at the same location.*

8.4.3 Identification of Cables in Manholes
Cables shall be permanently identified by tags or other means at each manhole or other permanent opening of the underground system. Where the duct formation entering and leaving the manhole is the same, the cables should be installed in corresponding ducts.

***Exception:** This requirement does not apply where all cables in the system are communication cables and owned by the same communication utility.*

8.4.4 Identification of Apparatus Connected in Multiple
Where transformers, regulators, or other similar apparatus not located in the same manhole operate in such a way that low-voltage feedback can result in excitation of the high-voltage side of the equipment, special tags, diagrams, or other suitable means shall be used to indicate that fact.

8.5 Associated Equipment

8.5.1 Communication Equipment
Above-ground communication equipment shall be so designed and located that there is ready access to it by communication utility personnel.

8.5.2 Supply Equipment
Supply equipment, if it is exposed to the public, shall be tamperproof and any access doors shall be provided with some form of locking device.

8.5.3 Joint-Use Equipment
Equipment that is used jointly by the supply and communication utilities shall have the supply section separate from the communication section. There shall be no access to the supply section through the communication section or vice versa.

8.6 Construction of Underground Systems

8.6.1 General
The reliability of an underground system is dependent upon its design, how it is installed, and how it is operated. It shall have adequate load capacity for normal and emergency conditions without risk of damage to nearby underground facilities. The facilities provided for switching, grounding, etc. shall be adequate for and consistent with the requirements for the safe operation of the system. It is important that sound engineering practices be employed in the installation of the systems.

8.6.2 Excavating

8.6.2.1 Excavating shall be done in such a manner and with such safeguards as to minimize the risk to the public, to the workmen involved, and to existing underground structures. Every effort shall be made to shore the trench against cave-ins and to protect the workmen in the trench against injury from falling earth or stones. Regulations calling for specific precautions to be taken shall be followed, where they exist.

8.6.2.2 All work on railway, highway, or other rights-of-way shall be done in co-operation with the appropriate authority and at such time and in such manner as to cause the least interference with the proper and safe use or operation of the property, tracks, roadway, or other facility involved.

8.6.2.3 When crossing under railways, no bracing shall extend above the base of rail or be attached in any way to the rail or ties. Excavated material from railway roadbeds shall be so placed as not to interfere with traffic in any way. Ballast material shall be kept separate and free from earth if the ballast material is to be reused.

8.6.3 Backfilling

8.6.3.1 In general cases, the trench shall be backfilled to the grade line in layers of backfill not exceeding 300 mm, and each layer shall be thoroughly compacted until no further settlement is apparent.

8.6.3.2 On roadways, highways, airports, or similar rights-of-way, the trench shall be backfilled to the top of the subgrade in layers of backfill not exceeding 150 mm, and each layer shall be thoroughly compacted with mechanical tampers until no further settlement is apparent. Surfacing, paving, and all other surfaces shall be replaced as required.

8.6.3.3 When railway roadbeds are crossed, if a trench is used, it shall be backfilled to the top of the subgrade with backfill material in layers not exceeding 150 mm, and each layer thoroughly compacted with suitable mechanical tampers until no further settlement is apparent. The track ballast shall be replaced under railway supervision.

8.6.3.4 Regulations in certain areas may require that special backfilling materials be used and that special methods of compacting be applied.

8.6.4 Installation of Mechanical Protection

8.6.4.1 General
Mechanical protection when in flat form shall be wide enough to extend at least 50 mm beyond the cables or ducts on each side. Normally, flat mechanical protection shall not be in direct contact with the cables or ducts but shall be separated by a 75-mm layer of sand or earth. The material used shall not corrode or react with the cable or duct material. The dimensions and type of material used shall provide adequate strength and not fracture during installation or after backfilling.

8.6.4.2 Examples
Examples of mechanical protection are:

(a) Cable brick;

(b) Concrete slabs with a minimum thickness of 50 mm;

(c) Treated planks at least 40 mm thick;

(d) Poured concrete with a minimum thickness of 50 mm;

(e) Concrete encased ducts;

(f) Thick wall duct;

(g) Steel or iron pipe;

(h) Certain types of plastic duct;

(i) Steel armour on cables.

It is recognized that varying degrees of mechanical protection are provided by these examples. For the more arduous duty and that duty involving reduced burial depth, concrete encased duct, steel or iron pipe, or concrete thicker than 50 mm shall be used.

8.6.5 Surface Grade
When underground systems are installed, the surface should be in its final graded condition. If this is not possible, the final grade shall be determined and adequate provision made with respect to final depth of burial, placing of surface-mounted installations, etc. Every effort shall be made to prevent future grading operations from changing the depth of cover over the cables, in order to avoid inadequate depth of burial.

8.6.6 Risers

8.6.6.1 Separation Between Risers of Communication and Supply Systems
If it is necessary to install risers for communication systems and risers for supply systems on the same pole, they shall be placed on different quadrants of the pole and grouped in such a manner that they do not interfere with the use of pole steps or lineman's climbers. On structures other than poles the separation between risers of communication and supply systems shall be great enough to permit maintenance of each plant without interference. When located on streets or highways, risers shall be placed so as to be in the location safest from damage by traffic.

Note: It is recommended that placing risers for communication systems and risers for supply systems on the same pole be avoided where practicable.

8.6.6.2 Mechanical Protection of Supply Cables
All riser cables of supply systems shall be protected by a covering that gives suitable mechanical protection for the full length of the run from at least 0.3 m below the surface of the earth.

Exception: Supply riser cables having a grounded metallic sheath or concentric neutral require no further protective covering above the 2.5 m *level for non-joint-use poles. On poles jointly used with communication, the protective covering shall be extended to at least* 1 m *above the communication plant.*

8.6.6.3 Mechanical Protection of Supply Grounding and Neutral Conductors
On non-joint-use poles, grounding and neutral conductors of supply systems shall be protected by a covering that gives suitable mechanical protection from at least 0.3 m below the surface of the earth to 2.5 m above. On poles jointly used for supply and communication plant, the protective covering shall be extended to at least 1 m above the communication plant.

8.6.6.4 Mechanical Protection of Communication Cables and Conductors
Although communication riser cables and conductors do not need mechanical protection for considerations of safety, adequate protection is required to prevent damage or service interruptions.

8.6.6.5 Insulation Covering for Supply Grounding and Neutral Conductors
In addition to the mechanical protection stipulated in Clause 8.6.6.3, supply grounding and neutral conductors shall be insulated or covered with a suitable insulating protective covering, to minimize the exposure of utility personnel to such grounded objects. The covering may provide the mechanical protection of Clause 8.6.6.3 if desired. On metallic structures, this insulating covering or insulation is not required.

8.6.6.6 Grounding of Riser Pipes and Guards
All exposed metallic riser pipes and guards in contact with supply cables shall be grounded, unless such cables are covered with a grounded metallic sheath.

8.6.7 Installation and Jointing of Cables

8.6.7.1 General
Cables installed in underground systems shall be designed for this purpose and for the system in which they are used. Terminations and all associated material and equipment shall have a voltage rating suitable for the phase-to-phase voltage of the system. In an underground system avoidance of leakage current is important and if this does occur, positive operation of the protective devices is essential.

All metallic sheaths and concentric neutrals shall be capable of carrying, without damage, the expected fault currents for the expected time of operation of the overcurrent devices protecting the cable.

8.6.7.2 Installation
Care should be taken to avoid damage to cables caused by too great a pulling tension or by dragging the cables over sharp objects in the trench or irregularities in the ducts. The minimum bending radius at turns, at entrances to equipment, and in ducts and manholes shall be adequate for the type of cable being installed.

8.6.7.3 **Protection Against Moisture**
At joints and terminals, protection shall be provided so that moisture will not enter the cable.

8.6.7.4 **Bonding Cable Sheaths**
Metallic sheathed cables shall be bonded and grounded at suitable intervals with a conductor of suitable size, electrolytic conditions permitting. Except as specified elsewhere in this Standard, supply cable sheaths need not be bonded to communication cable sheaths.

9. Underground — Direct Buried Systems

9.1 Separations

9.1.1 **General**
Direct buried supply and communication cables, individually or together, shall in general not be installed in the same vertical plane with other underground systems. A minimum horizontal separation of 300 mm shall be obtained. Where such horizontal separation cannot be obtained, extra precaution shall be taken to ensure the maximum possible separation and to prevent future contact.

9.1.2 **From Structures**
Supply and communication cables should have as great a horizontal separation from duct lines and the underground portion of overhead structures, such as fences, poles, or buildings, unless they are riser cables attached to these structures, as conditions permit but preferably not less than 300 mm.

9.1.3 **From Swimming Pools**

9.1.3.1 Supply and communication cables (except for bonding conductors or conductors supplying electrical equipment associated with the swimming pool) shall have the minimum horizontal separation from the inside walls of the swimming pool as shown in Table 37.

9.1.3.2 For voltages above 22 kV, a special engineering study shall be made to determine the effects of the pool installation.

9.1.3.3 If the separations shown in Table 37 cannot be obtained, the requirements of Clause 10.1.3 shall apply.

Table 37 (Page 100)—Revise to read:

Table 37
Minimum Cable Separations from Swimming Pools

Type of Installation	Minimum Separation in Metres
Communication cables	1.5
Supply cables:	
0 — 750 V	1.5
Over 750 V — 15 kV	3
Over 15 — 22 kV	4

9.1.4 **From Propane Tanks**
There shall be a minimum horizontal separation of 1.5 m from propane tanks of 7600 L aggregate capacity or larger to underground communication or supply cable.

Note: This requirement is similar to that included in CGA Standard B149.2, Installation Code for Propane Burning Appliances and Equipment.

9.1.5 **From Pipelines**
When laid parallel to, along, or near underground pipelines, supply and communication cables shall maintain a horizontal separation from the pipelines of at least 300 mm. Where these separations cannot be obtained, extra precaution shall be taken to ensure the maximum possible separation and to prevent future contact. If communication and/or supply cables and pipelines share the same trench, the above horizontal separation shall be obtained with the pipeline preferably at a lower level.

9.1.6 **Crossing Pipelines**
When approaching a crossing, the facility that is installed at the greater depth shall, where practicable, be in the lower position at the crossing. A minimum separation of 300 mm of well-tamped backfill shall be maintained at the point of crossing; where this is not practicable, extra precaution shall be taken to ensure the maximum possible separation and to prevent future contact. The cable or pipeline shall be installed at a uniform depth for the full width of any right-of-way concerned.

9.1.7 **Between Cables in Separate Trenches**
In case of separate ownership, the horizontal separation between supply cables, between communication cables, or between supply and communication cables that are not installed in a common trench shall be 300 mm.

9.1.8 **Between Cables in a Common Trench, Excluding Installations at Random Separation**

Note: For installations at random separation, see Clause 9.1.9.

9.1.8.1 **Communication Cables and Supply Cables 750 V (Phase-to-Phase) or Less**
Although some separation is desirable, contact is permitted between communication cables, between supply cables operating at a voltage of 750 V (phase-to-phase) or less, or between communication cables and supply cables operating at the voltage of 750 V (phase-to-phase) or less.

9.1.8.2 **Communication Cables and Supply Cables Over 750 V (Phase-to-Phase)**
Except as covered by Clause 9.1.9, the separation (horizontal or vertical) between communication cables and supply cables operating at over 750 V (phase-to-phase) shall consist of not less than 300 mm of well-tamped backfill, or 100 mm of brick, or 50 mm of concrete, or a treated wood plank 40 mm thick, or other mechanical protection of equivalent strength. Where a vertical arrangement of cables is used, the communication cables shall be in the upper position with the lower-voltage and higher-voltage supply cables progressively in the lower positions in the trench.

9.1.8.3 **Supply Cables of the Same Three-Phase Circuit**
Contact is permitted between supply cables of the same three-phase circuit regardless of voltage.

9.1.8.4 **Supply Cables of Different Voltages and Circuits**
Contact is permitted between supply cables of different voltages and circuits, provided that:

(a) The operating voltage of any cable does not exceed 22 kV. For voltages higher than 22 kV, special consideration shall be given to the cable design, grounding, overcurrent protection, and available fault current;

(b) If either cable operates above a voltage of 750 V (phase-to-phase), it shall form part of a multi-grounded neutral wye system, and such cables shall have a metallic sheath or concentric neutral that is connected to the system neutral.

9.1.8.5 **Other Supply Cables**
Except as covered by Clauses 9.1.8.1, 9.1.8.3, and 9.1.8.4, a minimum separation (horizontal or vertical) of 150 mm of well-tamped backfill shall be obtained between supply cables. Alternatively, one or both cables may be installed in duct, with random contact permissible between a cable outside the duct and the duct.

9.1.9 **Supply and Communication Cables — Random Separation**
Separation between supply and communication cables for supply system voltages above 750 V (phase-to-phase) is desirable, but either random separation or contact on a continuous basis is permissible, provided that:

(a) Supply systems are effectively grounded and the operating voltage does not exceed 22 kV;

(b) The supply cables form part of a multi-grounded neutral wye system and are equipped with either a grounded bare concentric neutral or grounded bare metallic sheath. In those locations where there is an overriding risk of damage to the concentric neutral or sheath, such as in corrosive earth or rocky areas, or due to the possibility of electrolytic corrosion with equipment tanks associated with the underground system, the concentric neutral or sheath shall be protected by a jacket. The application of an external jacket on concentric neutral power cables shall be subject to mutual agreement by the parties concerned.

9.1.10 Cable Crossings

9.1.10.1 General
For the cable types of Clauses 9.1.8 and 9.1.9 the separations stipulated shall be obtained at the crossings. For Clause 9.1.7 the separations obtained at the crossings shall be as stipulated in Clause 9.1.8. A minimum of 75 mm of well-tamped backfill is, however, preferred to a direct contact.

9.1.10.2 Supply and Communication Cables
When the separation consists of treated wood plank 40 mm thick, 50 mm of concrete, or 100 mm of brick, it shall extend along the route of the supply cable at least 600 mm in both directions from the point of crossing. Preferably, supply cables shall cross beneath communication cables.

9.2 Depth of Burial

9.2.1 General
Communication and supply cables shall be buried at a sufficient depth below the surface of the earth or bottom of ditches to minimize the probability of damage.

Note: In deciding the depth of burial, the following factors should be considered: the possibility of deep digging; deep frost-line conditions; special soil conditions; vibration from heavy traffic. Because of any of these conditions, greater depths than those indicated below, or mechanical protection, may be required.

9.2.2 **Communication Cables**
Communication cables shall be buried below the surface of the earth or bottom of ditches to a minimum depth of 600 mm, except that for drop cables, or for burial under parkways and lawns, this figure may be reduced to 450 mm. Greater depths may be required when roadways are crossed.

9.2.3 **Supply Cables**
Supply cables shall be buried below the surface of the earth or bottom of ditches to a minimum depth of 750 mm, except that, for cables not in excess of 750 V (phase-to-phase), this figure may be reduced to 600 mm. Under roadways the minimum depth for all voltages shall be increased to 1 m.

9.2.4 **Cable Crossings**
At cable crossings a reduction of 75 mm in the above burial depths is permissible, provided the minimum depths are obtained on either side of the cable crossing.

9.2.5 **Reduced Burial Depth**
In some instances the above depths are not practicable, in which case reduced burial depths may be used:

(a) If adequate mechanical protection over the cable is installed as provided in Clause 9.4; or

(b) By agreement between the parties concerned.

9.3 **Electrical Protection**

9.3.1 **Supply Cables**

9.3.1.1 **Supply Cables Operating at a Voltage in Excess of 750 V (Phase-to-Phase)**
These cables shall have continuous effectively grounded metallic sheath or concentric neutral capable of carrying without damage the maximum current that could develop in case of a cable fault.

9.3.1.2 Overcurrent Protection
Protection in case of faults on cables operating above a voltage of 750 V (phase-to-phase) shall be provided and selected, so that as fast a clearing time as practicable will be obtained.

There shall be no more than two automatic regulated reclosings before the faulted cable is de-energized; except for cables (e.g., station feeders) supplying overhead systems, which require more than two automatic reclosures.

9.3.1.3 Grounding
Grounding shall be provided for underground circuits and associated equipment. All exposed non-current-carrying metallic parts associated with the underground system shall be effectively grounded. This includes metal poles and the reinforcing steel of concrete poles.

9.3.2 Communication Cables
Communication cables that contain supply circuits operating at voltages exceeding 150 V line-to-ground or 300 V between any two points of the circuit, the transmitted power exceeding 150 W, and are used exclusively for the supply of communication circuits shall have continuous effecively grounded metallic shields or sheaths capable of carrying, without damage, the maximum current that could develop from a fault within the cables; and the supply circuits will be promptly de-energized in case of a cable fault.

9.3.3 **Supply Cables Over 750 V (Phase-to-Phase) and Communication Cables in a Common Trench**
These shall be installed as required by Items (a) to (d) below:

(a) Communication protective devices shall be adequate for the voltages and currents that may be impressed on them should there be a contact between the communication and supply conductors;

(b) At each transformer location, the metallic sheath or shield of communication cables shall be interconnected with available supply primary and secondary neutrals and supply cable sheaths, and the whole shall be effectively grounded. If this does not provide a connection between the communication cable sheath or shield and the primary neutral within 300 m of each communication terminal, additional connections shall be made to meet this requirement;

(c) At equipment ground locations other than transformers, adequate grounding of communication cables and supply secondary pedestals shall be made to the secondary neutral;

(d) Supply and communication cables at less than 300-mm separation, including random separation, or continuous contact, shall meet the requirements of co-ordinated protection.

9.4 Mechanical Protection

9.4.1 General

9.4.1.1 Mechanical protection to cables shall be employed, except for the deviation allowed under Clause 9.2.5, wherever:

(a) Reduced depth of burial is required; or

(b) There is a strong likelihood of deep digging.

9.4.1.2 To facilitate cable replacement and to minimize traffic-vibration damage, mechanical protection in the form of pipe or duct should be used when roads, railways, or paved areas are crossed.

9.4.2 Crossing Railways

9.4.2.1 Provision shall be made so that the maintenance of the cables can be carried out without disturbing the track ballast.

9.4.2.2 Supply cables shall be protected for the full width of the right-of-way by one of the following examples of mechanical protection:

(a) Cable brick;

(b) Concrete slabs with a minimum thickness of 50 mm;

(c) Treated plank at least 40 mm thick;

(d) Poured concrete with a minimum thickness of 50 mm;

(e) Concrete encased duct;

(f) Thick wall duct;

(g) Steel or iron pipe; or

(h) Certain types of plastic duct.

Any combination of these protections may be used, but if a pipe or duct is used under the tracks, it shall extend at least 2 m beyond each outside rail.

If type (e), (f), (g) or (h) mechanical protection is used, the requirements of Clause 10.4 shall apply.

9.4.2.3 Communication cables may be installed without any form of mechanical protection. Where a pipe or duct is used, it shall extend at least 2 m beyond each outside rail.

9.5 Railway Crossings

9.5.1 Supply and communication cables shall be located at a depth of not less than 1.1 m below the base of the rails. Where this depth is not obtainable, a reduced depth may be permissible but in no case shall the cables be less than 150 mm below the bottom of the ballast section, which is subject to working or cleaning, and in no case less than 450 mm below the base of the rail. The requirements for mechanical protection are stated in Clause 9.4.

9.5.2 Terminals and above-ground supply and communication facilities shall be located off the railway right-of-way. Where this is not practicable, the distance from the gauge side of the nearest rail to the nearest face of terminal poles and above-ground facilities shall be not less than 2.5 m, except that at sidings the distance may be not less than 1.9 m. At loading sidings, sufficient space as required shall be left for a driveway. When necessary for super-elevation, track curvature, the unobstructed view of signals and signs, etc., the Railway may require greater minimum distances than those specified above. These requirements do not apply to terminals and above-ground facilities associated with railway communication and signal circuits or with railway electric power circuits of 750 V (phase-to-phase) or less.

9.6 Construction

9.6.1 Installation of Cables

9.6.1.1 **General**
While under some circumstances it is desirable to "snake" cables during installation, they must not be kinked. At terminations, or where earth settlement is likely, adequate slack should be provided in the cables to prevent damage.

9.6.1.2 **Ploughing of Cables**
Supply and communication cables may be buried by ploughing individually or simultaneously, provided the separations and depths of burial stipulated in Clauses 9.1 and 9.2 are obtained.

9.6.2 **Cable Trench**
The trench shall be as straight as possible, with the bottom clean and free of any projecting stones. Depending upon the importance of the installation, a sand or screened earth bedding below and over the cables may be desirable. However, for all cables, a bedding of sand or backfill free of stones at least 75 mm deep above and below the cables, or a duct, shall be used in rocky ground or shale. Ridges or sharp changes in grade of the trench bottom, which could cause a "pressure point" on the cable, shall be avoided. When crossing other trenches or locations where earth settlement is likely, the trench bottom shall be well compacted or some type of mechanical reinforcement used to minimize future cable movement.

9.6.3 **Entering Buildings**
All cable entrances into buildings, subways, or other enclosed public areas shall be adequately sealed around the cable to prevent the entry of gas or water into the building.

10. Underground — Duct and Manhole Systems

10.1 Separations

10.1.1 **General**
The duct line shall in general not be installed directly above or below other underground systems. Where it is necessary for a duct line to cross over or under another underground facility, the crossing shall be made at right angles or as nearly so as circumstances will permit, and shall have as great a vertical separation as circumstances will permit but not less than 150 mm. A duct line paralleling another underground system or other underground structures shall have as great a horizontal separation as circumstances permit but not less than 300 mm. Where the above separations cannot be obtained, extra precaution shall be taken to ensure the maximum possible separation and to prevent future contact.

10.1.2 **From Pipelines**
When laid parallel to, along, or near underground pipelines, duct systems shall maintain a horizontal separation from the pipelines of at least 300 mm. Where these separations cannot be obtained, extra precaution shall be taken to ensure the maximum possible separation and to prevent future contact. If duct systems and pipelines share the same trench, the above horizontal separation shall be obtained, with the pipeline preferably at a lower level.

When approaching a crossing, the facility that is installed at the greater depth shall, where practicable, be in the lower position at the crossing. A minimum separation of 300 mm of well tamped backfill shall be maintained at the point of crossing; where this is not practicable, extra precaution shall be taken to ensure the maximum possible separation and to prevent future contact. The duct system or pipeline shall be installed at a uniform depth for the full width of any right-of-way concerned.

10.1.3 **From Swimming Pools**

10.1.3.1 Where supply cables (except for bonding conductors or those conductors supplying electrical equipment associated with the swimming pool) are installed in a concrete encased plastic duct bank, the minimum horizontal separations between the inside walls of the swimming pool and the nearest face of the duct bank shall be as shown in Table 38. For supply cables installed in other types of duct banks, the minimum separations shown in Table 37 shall apply.

10.1.3.2 Communication cables installed in a duct bank prescribed in Clause 10.4 shall have the minimum separations shown in Table 38.

10.1.3.3 For voltages above 22 kV a special engineering study shall be made to determine the effects on the pool installation.

Table 38
Minimum Duct Separations from Swimming Pools

Type of Installation	Minimum Separation in Metres
Communication cables	0.75
Supply cables:	
0 — 750 V	0.75
Over 750 V — 15 kV	1.5
Over 15 — 20 kV	2

10.1.4 **From Propane Tanks**
There shall be a minimum horizontal separation of 1.5 m from propane tanks of 7600 L aggregate capacity or larger to the nearest face of the underground duct bank.

Note: This requirement is similar to that included in CGA Standard B149.2, Installation Code for Propane Burning Appliances and Equipment.

10.1.5 **Iron or Steel Pipe as a Duct**
Where iron or steel pipe is used as a duct, it shall not be laid in contact with water, gas, steam, or other metallic pipe systems. Where the separation is less than 50 mm, the metallic duct shall be adequately separated from other metallic pipe systems by a barrier of suitable electrical insulating material, to minimize any current transfer that could give rise to electrolytic corrosion, or they shall be electrically bonded together at the point of least separation.

10.2 **Depth of Burial**
The distance between the top of a duct system and the top of the pavement or other surface under which the system is constructed shall be sufficient to protect the system from damage. Where practicable, a minimum cover of 600 mm shall be used when the system is or is likely to be subject to road traffic and 450 mm in other locations; where these depths cannot be obtained, other protection shall be used or the duct shall be encased in concrete. Particular legislation exists in some areas calling for specific depths of cover to be provided.

10.3 **Railway Crossings**

10.3.1 **Duct Material and Construction**
Duct material and construction shall be as specified in Clause 10.4, with the exception of preformed or cast multiple ducts, which shall be encased with 75 mm of concrete for at least 2 m beyond each outside rail, but preferably for the full width of the right-of-way.

10.3.2 **Depth Below Base of Rail**
The top of all duct banks shall generally be located at a depth of not less than 1.1 m below the base of the rails. Where this depth is not obtainable, a reduced depth is permissible but in no case shall the top of the duct banks be less than 150 mm below the bottom of the ballast section, which is subject to working or cleaning, and in no case less than 450 mm below the base of the rail.

Where unusual conditions exist or where proposed construction would interfere with existing construction, a greater depth than specified above may be required.

10.3.3 **Depth Below Surface of the Earth**
In no case shall the top of the duct bank be less than 450 mm below the surface of the earth or the bottom of ditches.

10.3.4 **Horizontal Distance from Rails**
Manholes and handholes as well as above-ground terminal facilities such as terminal poles, pedestals, housings, etc. shall be located off the railway right-of-way. Where this is not practicable, a reduced distance is permissible, but in no case shall the distance from the gauge side of nearest rail to the nearest face of above-ground facilities, manholes, and handholes be less than 2.5 m, except that, at sidings, the distance shall be not less than 1.9 m. At loading sidings, sufficient space as required shall be left for a driveway. When necessary for super-elevation, track curvature, unobstructed view of signals and signs, etc., the Railway may require greater distances than those specified above.

These requirements do not apply to terminals and above-ground facilities associated with railway communication and signal circuits or with railway electric supply circuits of 750 V (phase-to-phase) or less.

10.3.5 **Ducts Enclosed in Steel Pipes**
The steel pipes shall be of a minimum wall thickness as specified in orders of the appropriate railway regulatory authority and shall extend at least 2 m beyond each outside rail, but preferably the full width of the right-of-way.

10.4 **Construction of Duct Banks**

10.4.1 **General**
An underground duct bank may consist of one or more ducts:

(a) Encased in concrete;

(b) Enclosed in steel pipe;

(c) Requiring no additional protection;

(d) With additional protection.

10.4.2 **Materials**
Ducts shall be of such material, size, finish, and mechanical strength as to facilitate the installation and maintenance of cables. The mechanical strength may be inherent in the material or be achieved by some form of encasement. See CSA Standards C22.2 No. 134, Fibre Conduit, C22.2 No. 135, Asbestos-Cement Conduit, B196.1, Plastic Underground Power Cable Ducting, and B196.3, PVC Underground Telecommunication Cable Ducting.

10.4.3 **Ducts Encased in Concrete**

10.4.3.1 For normal construction in firm soils, ducts encased in concrete shall be separated from each other by at least 25 mm of concrete, and the duct bank shall be completely encased in concrete at least 50 mm thick; except that duct banks for the exclusive use of communication cables do not require separation of the ducts by concrete, providing the duct bank has adequate strength. Further protection, including steel reinforcing, may be required in fluid soils or other special circumstances. Concrete shall have a minimum strength of 20 MPa after 28 days.

10.4.3.2 At railway crossings, ducts shall be separated from each other by at least 25 mm of concrete, and the duct bank shall be completely encased in concrete at least 75 mm thick. Where the width of the duct bank exceeds 550 mm, additional strength may be required. The encasement shall extend at least 2 m beyond each outside rail, but preferably for the full width of the right-of-way. Concrete shall have a minimum strength of 20 MPa after 28 days.

10.4.4 **Ducts Enclosed in Steel Pipe**

10.4.4.1 When ducts are placed in a steel pipe, the space between the ducts and pipe shall be sealed at the ends of the pipe to prevent the entry of water.

10.4.4.2 Where ducts are to be occupied by supply cables, consideration shall be given to the prevention of overheating of the supply cables. Filling the space between the ducts and pipe with material of good thermal conductivity may assist in this.

10.4.5 **Ducts Requiring No Additional Protection**

10.4.5.1 Ducts with no additional mechanical protection may be placed in a trench, augered, or pushed, providing that sufficient mechanical strength is inherent in the duct material. At railway crossings where physical and chemical conditions permit, not more than two ducts, each not exceeding 100 mm in inside diameter, or one large-bore corrugated steel duct or reinforced concrete pipe, may be augered, pushed, or laid in the earth beneath the roadbed without any form of protection. At such railway crossings where the duct is placed by augering, the diameter of the hole shall not exceed the outside diameter of the duct by more than 25 mm. Backfill shall be rammed tightly around the outside surface of the duct at each end.

Such ducts at railway crossings shall extend at least 2 m beyond each outside rail, but preferably for the full width of the right-of-way.

10.4.5.2 Multiple ducts preformed or cast into a unit may be placed in an open trench, augered, or pushed, providing that sufficient strength is inherent in the material to withstand the loading to which it will be subjected.

10.4.6 **Ducts with Additional Protection**
Examples of mechanical protection are:

(a) Cable brick;

(b) Concrete slabs with a minimum thickness of 50 mm;

(c) Treated planks at least 40 mm thick;

(d) Poured concrete with a minimum thickness of 50 mm;

(e) Concrete encasement;

(f) Steel or iron pipe.

It is recognized that varying degrees of mechanical protection are provided by these examples. For the more arduous duty and that duty involving reduced burial depth, concrete encasement, steel or iron pipe, or concrete thicker than 50 mm shall be used.

10.4.7 **Grading of Ducts**
Where it is necessary for the ducts to drain, the grade of the ducts shall be from the high point in the line to one or both adjacent manholes, and such grade shall be not less than 1:400. Ducts terminating at buildings shall be graded to drain away from the building to the manhole. Where drainage to a manhole is impracticable, a drainage pocket shall be provided at the low point of the duct run.

10.4.8 **Settling**
Ducts shall be suitably reinforced or laid on a suitable foundation of adequate bearing strength where the condition of the soil might otherwise allow duct settlement.

10.4.9 **Backfilling**
Concrete-encased conduit may be backfilled and tamped before the concrete has taken its initial set. Where this is not practicable, backfilling shall be postponed for at least 24 hours. On warm sunny days, however, it is advisable to retard the evaporation of water from the concrete.

10.5 **Construction of Manholes**

10.5.1 **Strength**
The design and construction of manholes and handholes shall provide sufficient strength to sustain the loads that may reasonably be imposed on them.

10.5.2 **Dimensions**
Except as provided for in Items (c) and (d), the inside dimensions of manholes shall be not less than:

(a) Length and Width — 1.1 m, provided that a clear working space of not less than 0.9 m can be obtained;

(b) Headroom — 1.8 m, except in manholes where the edge of the roof opening is within 0.3 m of each side of the manhole;

(c) These dimensions may be reduced in manholes used exclusively for communication system equipment and cables and in all handholes;

(d) These dimensions do not apply to subsurface chambers so designed that the equipment housed therein is accessible from the surface of the earth.

10.5.3 **Duct Entrances into Manholes**
Ducts terminating in manholes, handholes, or other permanent openings of underground systems, shall be provided with an effective shield or bushing, or the surface at the duct entrance shall be so shaped as to provide a smooth outlet.

10.5.4 **Drainage**
Where drainage is into sewers, suitable traps shall be provided to prevent the entrance of sewer gas into the manhole. Where such drainage is not practicable, a sump shall be provided in the floor to facilitate drainage or pumping. Where danger of flooding exists, back-water valves should also be provided.

10.5.5 **Roof Openings**
Round access openings to any manhole shall be not less than 600 mm in diameter. Rectangular openings shall be not less than 500 mm × 600 mm, except that these dimensions may be reduced in the case of handholes.

10.5.6 **Frames and Covers**

10.5.6.1 Manholes and handholes shall be provided with frames and covers of sufficient strength to sustain such loads as may be imposed on them.

10.5.6.2 The covers shall have facility for removal and should be suitably marked to indicate ownership.

10.5.6.3 The covers shall be mechanically fixed in place or be of sufficient weight to discourage unauthorized removal.

10.5.7 **Hardware**

10.5.7.1 Pulling eyes should be installed in the walls of manholes opposite each duct bank entrance, as required, to assist in pulling in cables.

10.5.7.2 The walls of manholes shall be equipped as required with suitable devices to support adequately the cables and splices.

10.5.8 **Ventilation**

10.5.8.1 **Standard Manholes**
Manholes housing supply cables shall be vented to the air. Several holes in the cover may be used for this purpose.

10.5.8.2 **Special Manholes**
Adequate outside ventilation shall be provided for manholes that contain supply equipment and those from which any openings exist into subways entered by the public. Where such manholes house transformers, sectionalizing switches, or regulators, etc., the ventilators shall be cleaned at necessary intervals.

10.5.9 **Backfilling**

10.5.9.1 Backfilling around concrete manholes poured in place shall be delayed until the concrete has set, to allow the safe removal of the forms and the safe loading of the manhole.

10.5.9.2 Concrete made with normal Portland cement should be allowed to set for not less than 72 hours.

Concrete made with high early strength cement should be allowed to set for not less than 24 hours.

10.6 Terminating Ducts

10.6.1 General
Where ducts terminate, precautions shall be taken to prevent the unintentional entry into the ducts of water or foreign objects, which might result in damage to the cables or ducts.

For the protection of riser cables, the requirements of Clause 8.6.6 shall apply.

10.6.2 Entering Buildings
All ducts, whether they are occupied or not, entering buildings, subways, or other enclosed public areas shall be adequately sealed to prevent the entry of gas or water, either around the outside surface of the ducts or through the ducts.

10.7 Location of Supply and Communication Cables

10.7.1 Accessibility
Cables in manholes shall be reasonably accessible to workmen, and clear working space shall be maintained at all times, or the installation shall be designed for the convenient replacement of the cables from the surface of the earth.

10.7.2 Cables Carrying Large Currents
Cables intended to carry large currents should be located in outside ducts so that they will not dissipate heat solely through adjacent ducts.

10.7.3 Separation Between Cables

10.7.3.1 Cables of Different Voltages
Cables should be arranged and supported in ducts and manholes so that those operating at higher voltages will be separated as far as practicable from those operating at lower voltages. Supply cables of different voltages or circuits, or both, except neutrals, should not be placed in the same duct.

10.7.3.2 Cables of Supply and Communication Systems
Supply cables and communication cables shall normally be maintained in separate duct banks and particularly in separate manholes. Joint occupancy is only permissible when the requirements of Clause 10.7.3.3 and 10.7.3.4 are followed.

10.7.3.3 Communication cables and supply cables may occupy a common duct bank, provided that:

(a) Co-ordinated protection exists;

(b) The communication cables occupy individual ducts distinct and separate from the individual ducts occupied by the supply cables;

(c) The individual duct material or the materials separating the individual ducts occupied by the communication cables are of sufficient physical strength to prevent physical contact between the communication cables and the supply cables during the life of the conduit.

10.7.3.4 Supply cables and communication cables may occupy the same manhole, provided that:

(a) Co-ordinated protection exists;

(b) The supply and communication cables are segregated by using opposite sides of the manholes or other suitable means;

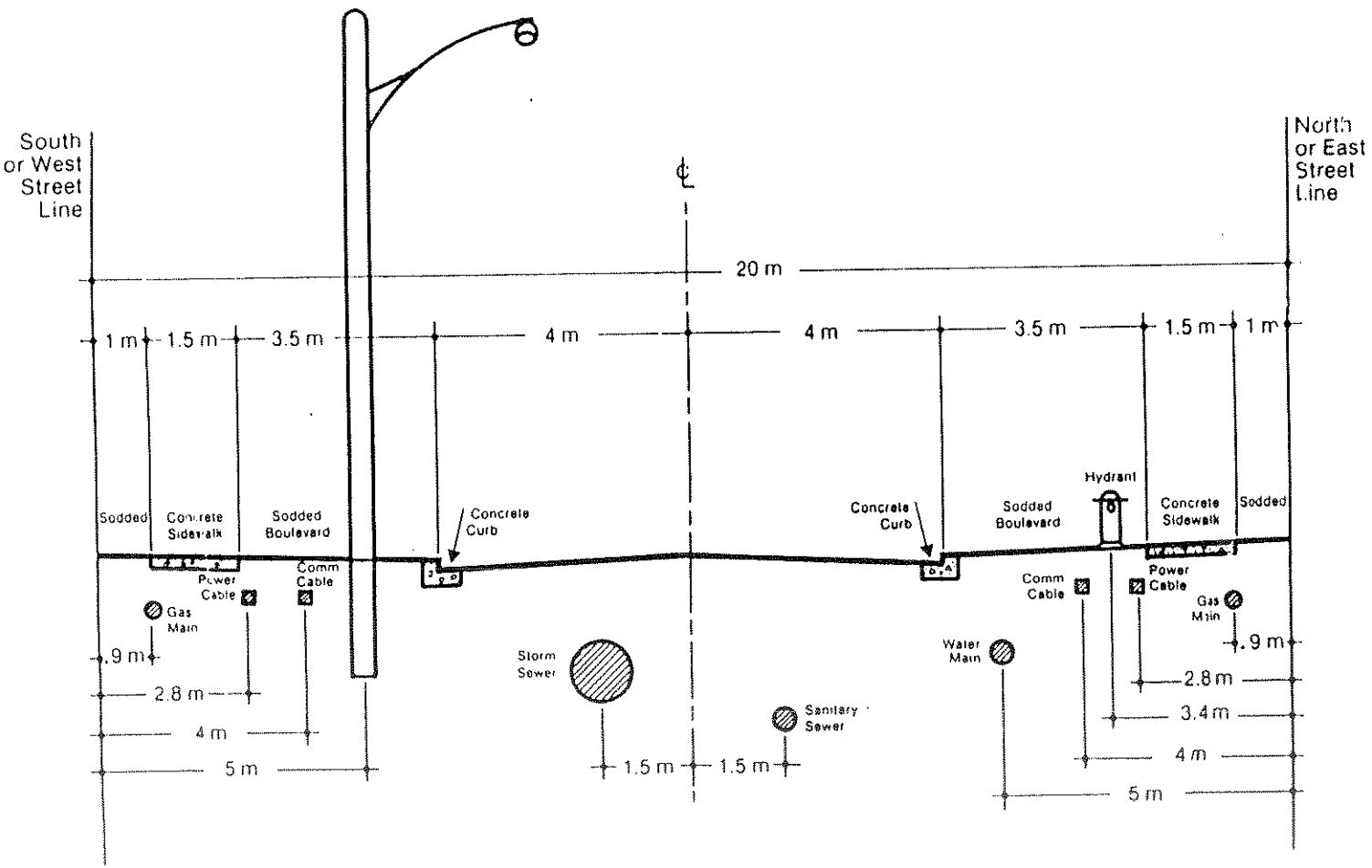
(c) Where supply cables and communication cables must cross, a separation of at least 300 mm is maintained.

10.8 Guarding of Live Parts in Manholes

10.8.1 Cable Joints or Terminals
Joints or terminals of supply cables shall be arranged so that there are no bare ungrounded current-carrying metal parts exposed to accidental contact within manholes or handholes.

10.8.2 Apparatus
Live parts of protective, control, or other apparatus installed and maintained in manholes shall be enclosed in suitably grounded cases or in cases having no exposed metallic parts.

Appendix B



Note: Dimensions shown are examples only and may vary for each municipality.

Figure B1
Typical Street Location of Various Services

APPENDIX B

- Guidelines for Applications to Cross Facilities of Interprovincial Pipe Line Inc.

GUIDELINES

For Application to Cross Facilities of

Interprovincial Pipe Line Inc. (IPL)

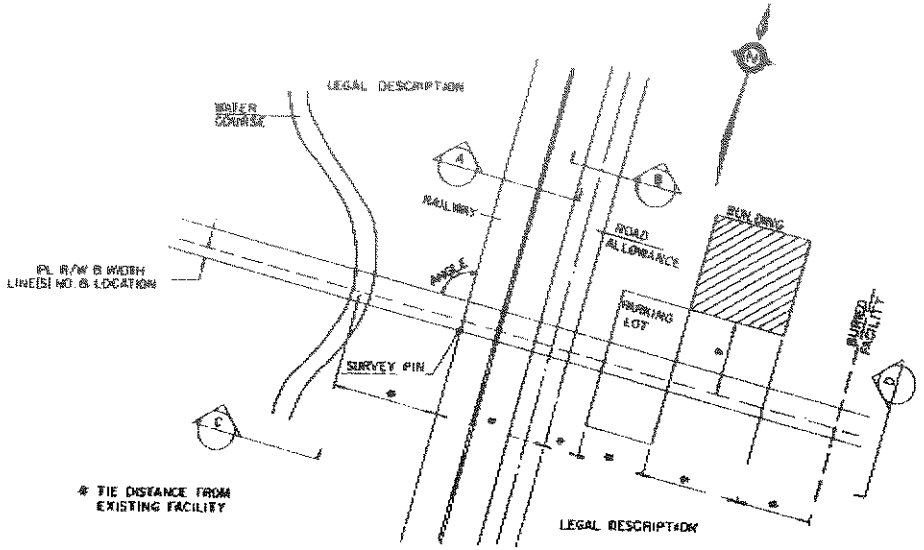
(For Details Refer to Section 112 of the National Energy Board Act (NEB) and The Pipeline Crossing Regulations, of the NEB.)

Procedure for Applicant	Sequence	Procedure for Interprovincial
INITIAL CONTACT. Advise type of crossing, geographic location and scheduled date of construction. **Correspondence To:** Interprovincial Pipe Line Inc. 10201 - Jasper Avenue P.O. Box 398 Edmonton, Alberta T5J 2J9 **Attention:** Crossings Coordinator **Phone:** (403) 420-5210	1	
	2	**PIPELINE INFORMATION.** Forward all pipeline data available including pipe specifications, right-of-way location, pipe locations, NEB Crossing Regulations, drawing requirements and District Office to contact for confirmation of pipe depths and restricted areas.
FIELD VERIFICATION. Contact IPL's District Office to verify pipe locations, depths and restricted area. **PIPE DEPTHS.** Review Probe Report from District Office. **APPLICATION.** Prepare and submit application with three (3) prints of the proposed crossing drawing(s) for approval.	3	
	4	**TECHNICAL REVIEW.** Return one (1) copy of the preliminary print indicating the necessary revisions or additions together with two (2) copies of IPL's crossing agreement outlining conditions of the crossing.
AGREEMENT. Review, sign and return both copies, of IPL's crossing agreements with three (3) copies of the revised crossing drawing(s).	5	
	6	**APPROVAL.** Sign and return one (1) copy of the agreement fully executed by IPL and send letter of approval granting permission for the crossing.
NOTIFICATION. Provide a minimum of three working days actual notice to IPL prior to the commencement of the crossing construction. (See crossing agreement for IPL contact).	7	
CONSTRUCTION. Crossing to be constructed in accordance with the approved drawing(s), the terms and conditions of IPL, and the Pipeline Crossing Regulations, of the NEB.	8	**SAFETY.** Review any special safety practices that must be followed on site prior to construction with the Contractor or Foreign Facility Representative. **CONSTRUCTION.** IPL Representative to be present and observe construction. **CROSSING REPORT.** IPL Representative to complete Crossing Report and illustrate As-Built information on the print(s) of the approved drawing(s).

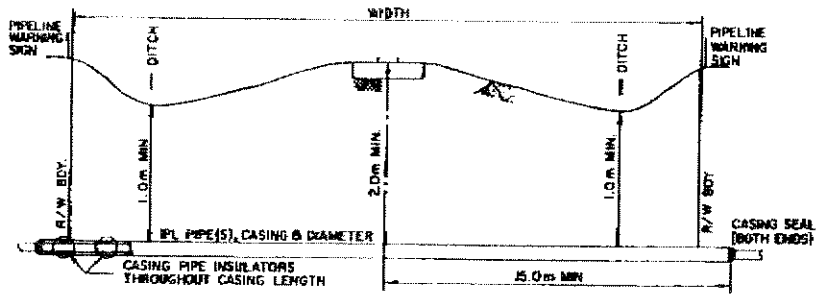
NOTE: Should the Applicant (Facility Owner) be denied permission to cross or considers the terms and conditions imposed by IPL to be inappropriate, after remediation the Applicant (Facility Owner) may make application for leave to cross to The National Energy Board at:

National Energy Board
311 - 6th Avenue S.W.
Calgary, Alberta
T2P 3H2

Phone: (403) 299-3665

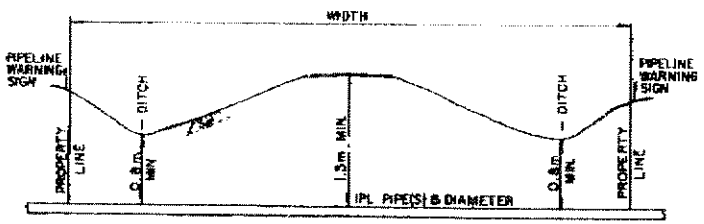


LOCATION PLAN



NOTE: ON SPUR LINE MINIMUM COVER FROM BASE OF RAILWAY 1.3m AND 0.8m IN DITCHES, AND CASING MINIMUM 10m FROM ℄ RAILWAY

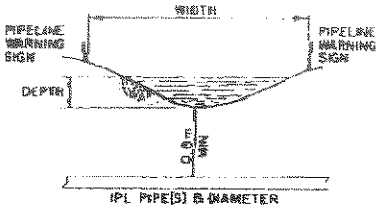
A TYPICAL MAIN LINE RAILWAY CROSSING



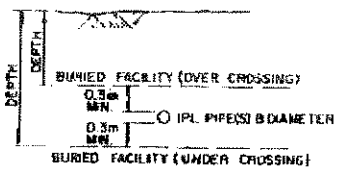
B TYPICAL ROAD CROSSING

NOTE:
1. "CAUTION HIGH PRESSURE PIPELINES"
2. IPL REPRESENTATIVE MUST BE PRESENT DURING CONSTRUCTION.

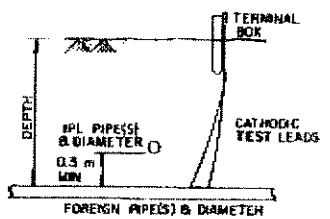
THIS DRAWING IS FOR REFERENCE ONLY. ACTUAL SITE DETAILS OR REQUIREMENTS MAY VARY



C TYPICAL WATER COURSE CROSSING



B TYPICAL FACILITY CROSSING



TYPICAL TEST LEAD CONNECTION
(STEEL PIPELINES)

Interprovincial Pipe Line Inc.
Interprovincial Pipe Line (NW) Ltd.
EDMONTON ALBERTA CANADA

TYPICAL CROSSING DETAILS

DRAWN ME	DATE 90-8-88	APPR
CHECK	APP'D	APPR
SCALE NOT TO SCALE		APPR

C-1.02-5052-0-0

Interprovincial Pipe Line Inc.
Interprovincial Pipe Line (NW) Ltd.

DRAWING REQUIREMENTS FOR THIRD PARTY CROSSINGS

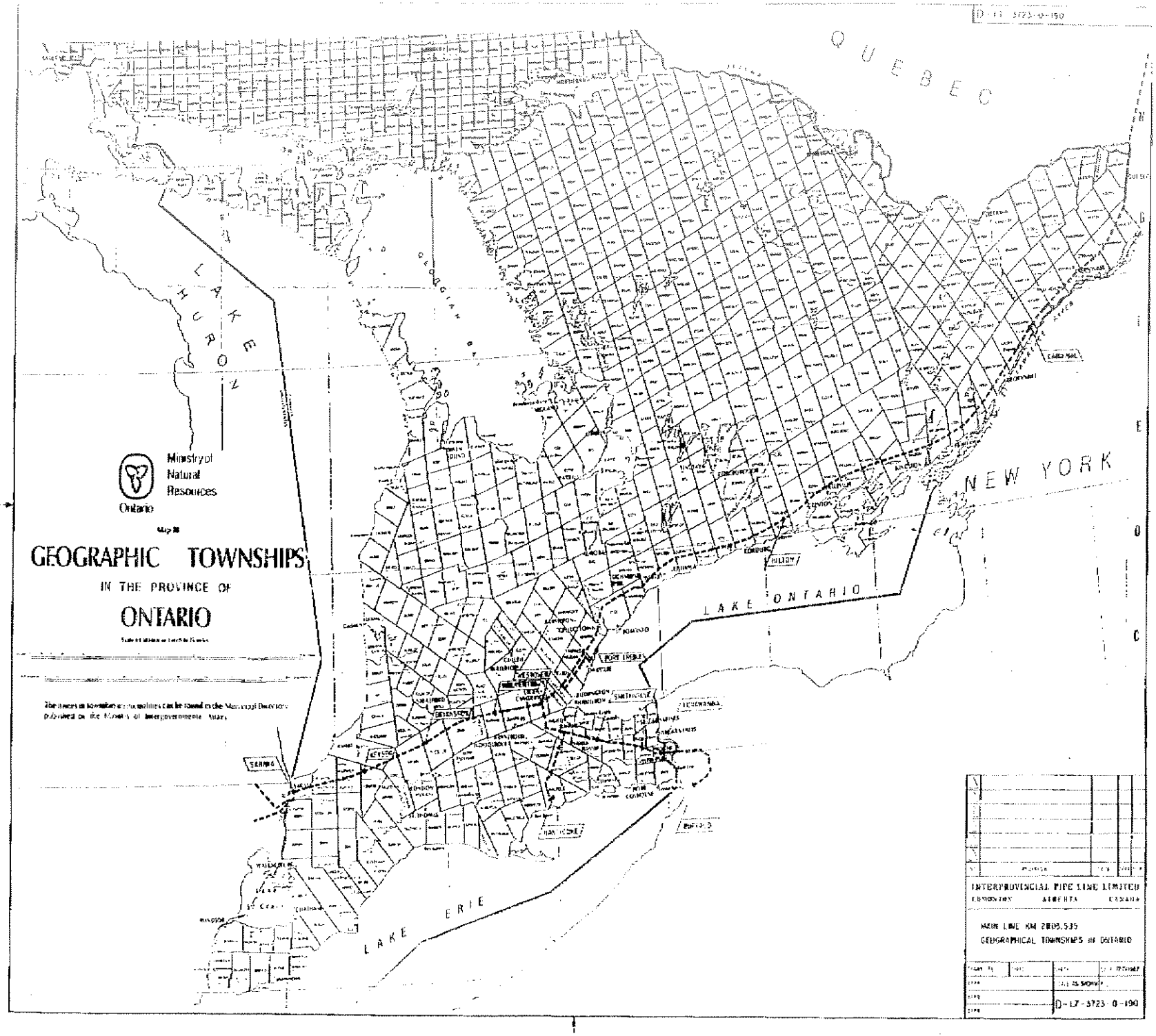
This represents the minimum information required when preparing drawings for crossing approvals. Dimensions on drawing(s) may be in Imperial or metric (if metric, one decimal point).

The applicant should contact the pipeline company at an early date for information and to discuss requirements with respect to the proposed crossing.

1. **Drawing with Revision Number and Date.**
2. **North Arrow**
3. **Complete Land Description**
4. **Plan view, show and identify:**
   a. pipeline(s), pipeline markers, and right-of-way; location of pipeline(s) within right-of-way.
   b. facilities (including all curbs, footings, guard rails, guy wires, poles, fences, etc.) with tie dimensions to lot or survey line (preferably along pipeline and or right-of-way boundary) and crossing angle. Crossing angle should be as close to 90° as possible.
   c. lot lines, road limits.
   d. location of cathodic test lead terminal box (if applicable).
   e. for parking lots, storage yards: nearest building with tie dimension to nearest pipeline and or right-of-way boundary.
   f. for parking lots, storage yards: describe barrier preventing access to unaffected right-of-way (eg. fence or concrete curb).
5. **Profile View**
   a. for surface structures: along pipeline(s) with highest elevation.
   b. for underground facilities: along facility.
   c. pipeline(s) and depth of cover.
   d. facilities and protective devices with minimum clearances from each to the pipeline(s) (minimum clearances: roads/parking lots/storage yards - 1.3m; railways - 2.0m; ditches -0.8m; underground utilities - 0.3m).
   e. all underground facilities must maintain the same elevation across the entire width of the right-of-way except for gravity type facilities.
6. **Specifications of Pipeline(s) being Crossed**
   a. give diameter(s)
   b. give diameter(s) of casing (if applicable)
   c. Warning statement eg. **"Caution High Pressure Pipeline(s)"**
   d. details of any protective devices for pipelines (concrete slabs, casings, pads, temporary structures, etc.) if requested by the company and shown on the plan and profile.
7. **Facilities Description**
   a. roads, parking lots, storage yards: wheel loading, surface, subgrade, name or number designation of roads (if any), materials to be stored (if any).
   b. fences: height, material, post locations (1.5m minimum from pipeline).
   c. ditches, open drainage systems: depth, width - top and bottom (existing and proposed), name or designation (if any).
   d. underground facilities: materials; diameter; maximum voltage; pressure; conduit structure - duct size, use and configuration - size and reinforcement (if any).

NOTES: The above information should be incorporated into all drawing(s) used for construction or a specific crossing drawing(s) must be prepared for approval. These drawing(s) must be available for reference on site.

For Reference, a typical crossing drawing of these minimum requirements is attached.



APPENDIX C

- Amtrak Requirements and Specifications for Pipeline Occupancy

C.E. 4

11/1/89

SPECIFICATIONS

FOR

WIRE, CONDUIT AND CABLE OCCUPATIONS

OF

NATIONAL RAILROAD PASSENGER CORPORATION

PROPERTY

INDEX

APPENDIX

1. SCOPE:

A. These specifications apply to the design of electric transmission wires and cables (power or communication) which are to be located over, under, across or upon Railroad property and facilities and tracks owned by others over which the Railroad operates its equipment.

2. APPLICATION FOR OCCUPANCY

A. Individuals, corporations, municipalities (known as the owner) desiring occupancy of Railroad property by such wire or cable occupations must agree, upon approval of the construction details by the Office of the Chief Engineer of Railroad, to execute an appropriate occupational agreement and pay any required fees and/or rentals outlined therein.

B. Application for an occupancy shall be by letter addressed to: Real Estate Department, National Railroad Passenger Corporation, 60 Massachusetts Avenue, N.E., Washington, D.C. 20002 giving the following:

(1) Name of individual, corporation or municipality desiring the occupancy.

(2) Complete mailing address of applicant.

(3) Name and title of person who will sign the agreement.

(4) The State in which the applicant is incorporated.

C. All applications shall be accompanied with eight (8) copies of all construction plans and three (3) copies of specifications and computations concerning the proposed occupancy.

3. APPROVAL OF PLANS

A. No entry upon Railroad property for the purpose of conducting surveys, field inspections, obtaining soil information, or any other purpose associated with the design and engineering of the proposed occupancy, will be permitted without a proper entry permit (Form CE-17) prepared by the Chief Engineer of the Railroad or his designated representative and executed by the applicant. It is to be clearly understood that the issuance of such a permit does not constitute authority to proceed with the actual construction which cannot begin until a formal agreement is finally executed by the Railroad Company and permission is received by the owner from the designated inspection agency of the Railroad to proceed.

B. Plans for proposed wireline or cable occupations shall be submitted to and meet the approval of the Chief Engineer of Railroad prior to start of construction. These plans are to be prepared in sizes as small as possible and are to be folded to an 8 1/2 inch by 11 inch size (folded dimensions) with a 1 1/2 inch margin on the left-hand side and a 1 inch margin on the top so that they can be secured in a file at the upper left-hand corner and still be unfolded to full size without being removed from the file.

Also, after folding, the title block and other identification of the plans shall be visible without the necessity of unfolding at the lower right-hand corner. Each plan shall bear an individually identifying number and an original date, together with subsequent revision dates, clearly identified on the plan so as to be readily apparent as to just what revisions were made and when.

All plans are to be individually folded and where more than one plan is involved, they shall be assembled into complete sets before submission to the Railroad.

C. Plans shall be drawn to scale and show the following: (See Plates I, II, III, IV and V, hereto attached).

(1) Plan view of crossing or occupation in relation to all Railroad facilities. (See Plate I).

(2) Location of wire or cable (in feet) from nearest Railroad Mile Post, center line of a Railroad bridge (giving Bridge Number), or center line of an existing or former passenger station. In all cases, the name of the County in which the proposed facilities are located must be shown. In States where Townships, Ranges and Sections are used, give distance in feet to the nearest Section line and identify the Section number, Township and Range.

(3) Profile of ground on center line of pole or tower line, showing clearances between top of rail and bottom of sag, as well as clearances from bottom wire or cable to top wire or cable of the Railroad's transmission, signal and communication lines, catenary, and third rail when present. If none of these facilities are in existence at the point of crossing, the plan should so indicate. Actual under-clearances are to be shown. (See Plate V for the required clearances).

(4) Show all known property lines. If wires, cables or conduits are within public highway limits, such limits should be clearly indicated with dimensions from center line.

(5) The plan must be specific, as to:

a. Base diameter, height, class and bury of poles. Poles shall be set no closer than 16'0" from face of pole to center line of nearest track. When necessary, however, each location will be analyzed to consider speed, traffic, etc.

b. Number of, size and material of power wires, as well as number of pairs in communication cables.

c. Nominal voltage of line.

d. Number of, location, size of, material of anchors and all guying for poles and arms.

NOTES: Double cross-arms are required on poles adjacent to track. Any tower designs must be accompanied by engineering computations and data.

4. CONSTRUCTION REQUIREMENTS

A. Power and communication lines shall be constructed in accordance with "Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines, National Electrical Safety Code Handbook, Part 2," (current issue), except as outlined in item 3 (c), Page 2 and except that casing pipes to contain power or communication wires or cables having an outside diameter of over four (4) inches shall be constructed in accordance with the current issue of Amtrak's "Requirements and Specifications for Pipeline Occupancy", USA, ENG 1604 dated Nov., 1987.

B. Under special conditions, Railroad will give consideration to occupations on its catenary structures, subject to the approval of the Chief Engineer, and the Railroad's policy governing such matters.

5. LONGITUDINAL OCCUPATIONS

Wires and cables running longitudinally along Railroad right of way shall be constructed as close to Railroad property lines as possible. For electrical power wires and cables with voltages of 34,500 or over and communication cables containing over 1800 pairs, the following information must be submitted in addition to the detail of the pole top configuration as called for on Plate IV of these specifications:

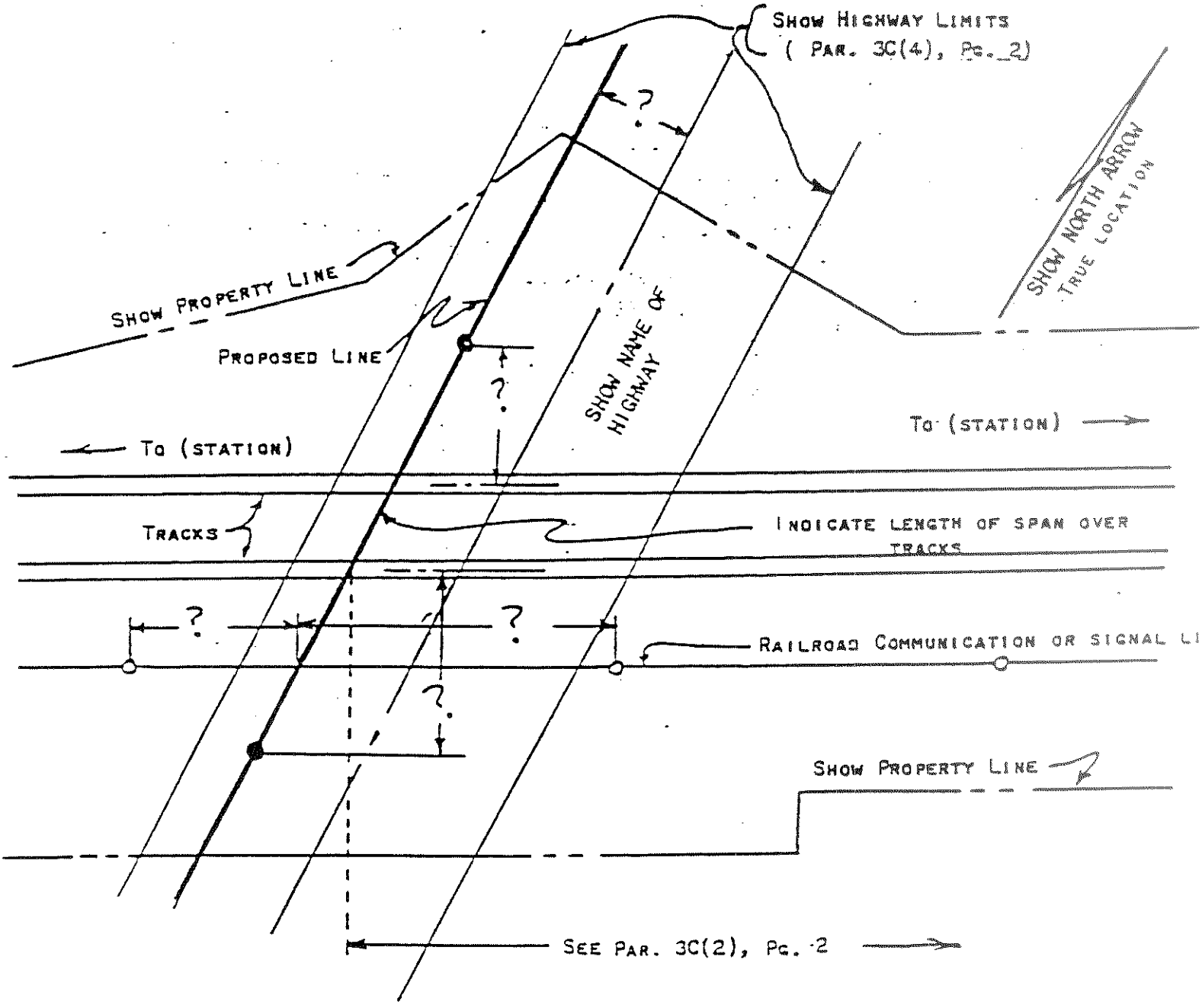
a. Voltage of circuit (s) or number of pairs.
b. Phase of electrical circuit (s).
c. Number of electrical circuits.
d. Size (AWG or CM) and material of wires or cables.
e. Length of spans clearly indicated on drawing.

Any facilities overhanging Railroad property must have approval of the Railroad and appropriate rental charges will be applied.

6. INDUCTIVE INTERFERENCE

On agreements covering longitudinal occupations, provisions will be included that the applicant will provide appropriate remedies, at his own expense, to correct any inductive interference with Railroad facilities.

INFORMATION TO BE SHOWN ON PLAN SECTION OF DRAWINGS WHEN FACILITY IS A CROSSING

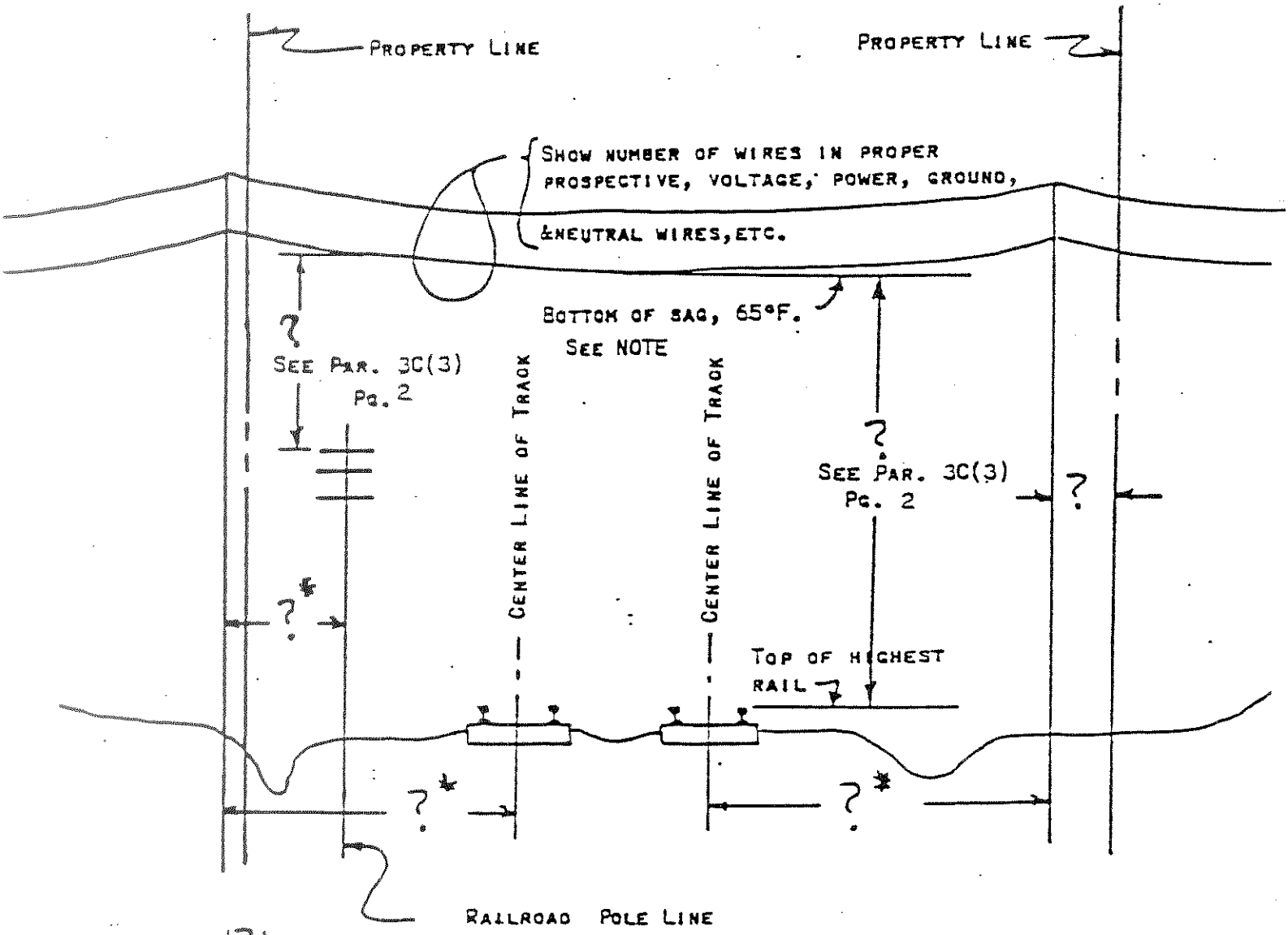


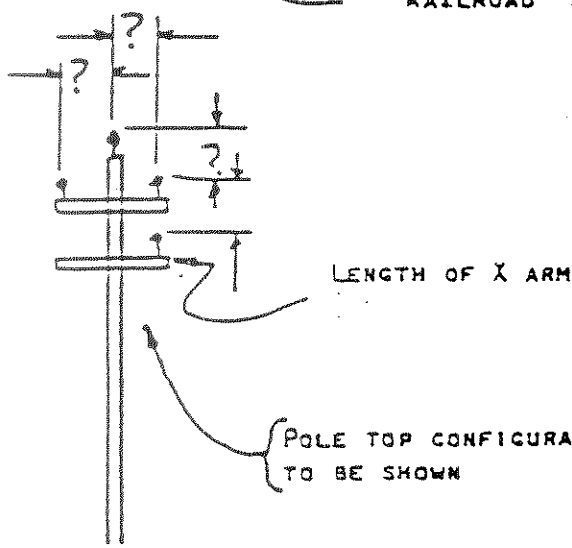
SCALE OF DRAWING TO BE SHOWN

NOTE: IF THE PROPOSED LINE IS TO SERVE A NEW DEVELOPMENT, A MAP SHOWING THE AREA IN RELATION TO ESTABLISHED AREAS AND ROADS IS TO BE SENT WITH THE REQUEST.

IF THE PROPOSED LINE IS NOT WHOLLY (OR PARTIALLY) WITHIN HIGHWAY LIMITS, THE SAM INFORMATION IS REQUIRED AS SHOWN ON THIS PLATE.

INFORMATION TO BE SHOWN ON PROFILE SECTION OF DRAWINGS - IN CASES OF CROSSINGS





SECTION LOOKING _____ (DIRECTION)

SCALE: H _____

V _____

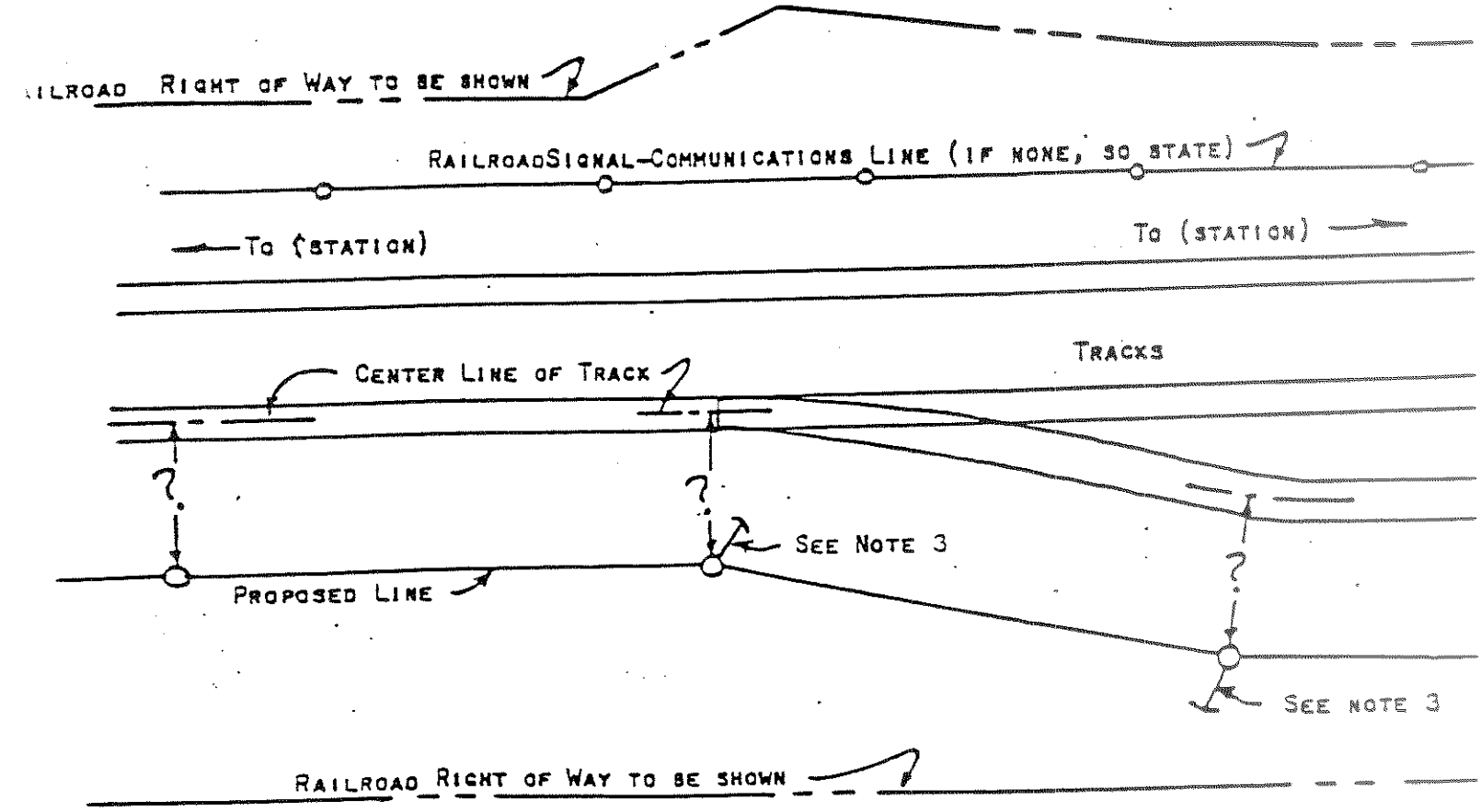
* AS MEASURED AT RIGHT ANGLES TO TRACK

NOTE: ALL TRANSMISSION, SIGNAL, COMMUNICATION LINES, AND THIRD RAIL SHOULD BE INDICATED AND PROPER CLEARANCES SHOWN.

NOTE: SHOW MAXIMUN SAG INCREASE OF POWER

PLATE III

INFORMATION TO BE SHOWN ON PLAN SECTION OF DRAWINGS IN CASES OF LONGITUDINAL OCCUPATIONS



SHOW NORTH ARROW TRUE LOCATION

SCALE OF DRAWING TO BE SHOWN

NOTE: (1) EACH END OF THE LINE MUST SHOW MEASUREMENTS AS CALLED FOR IN PAR. 3C(2), PG. 2.

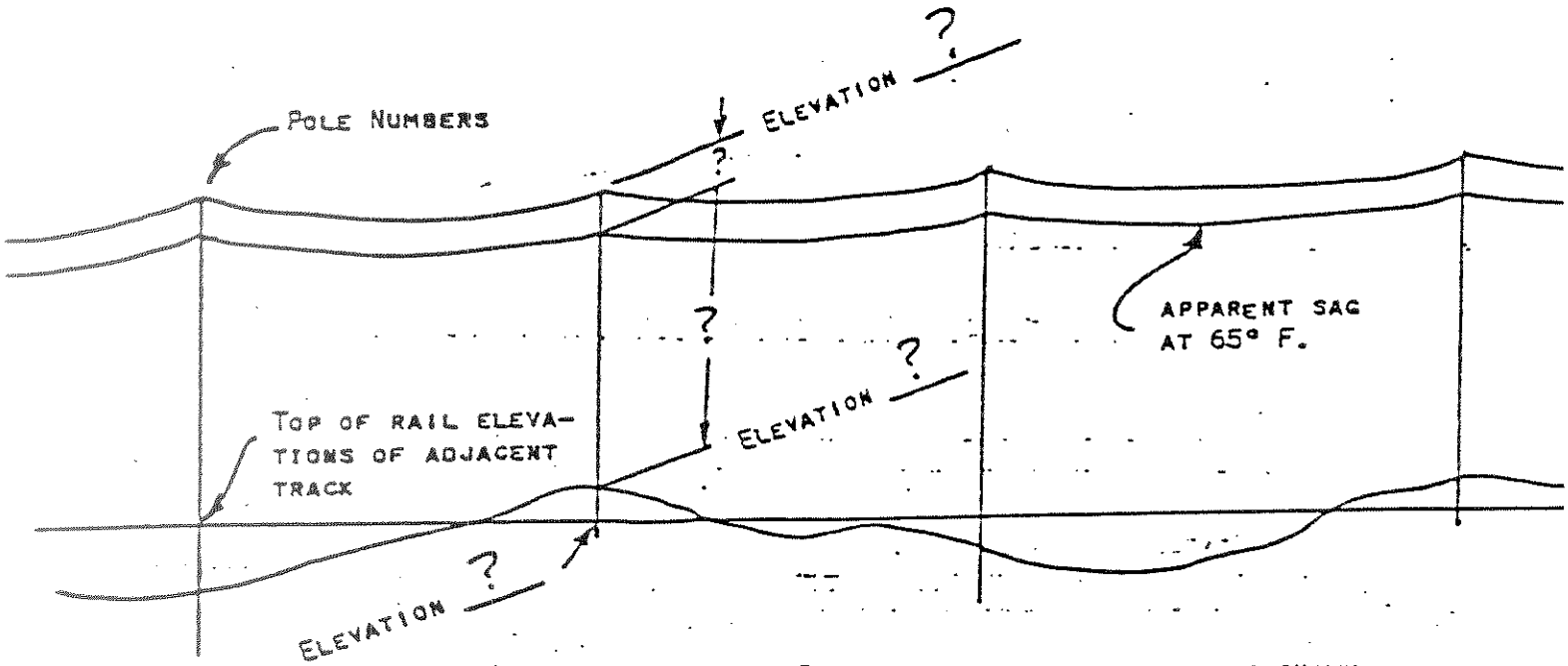
(2) IF POWER LINE CROSSES ANY TRACK, THEN THE INFORMATION SHOWN ON PLATE I IS ALSO REQUIRED.

(3) WHERE ANCHOR GUYS ARE REQUIRED, SEE PAR. 3C(3), PG. 2

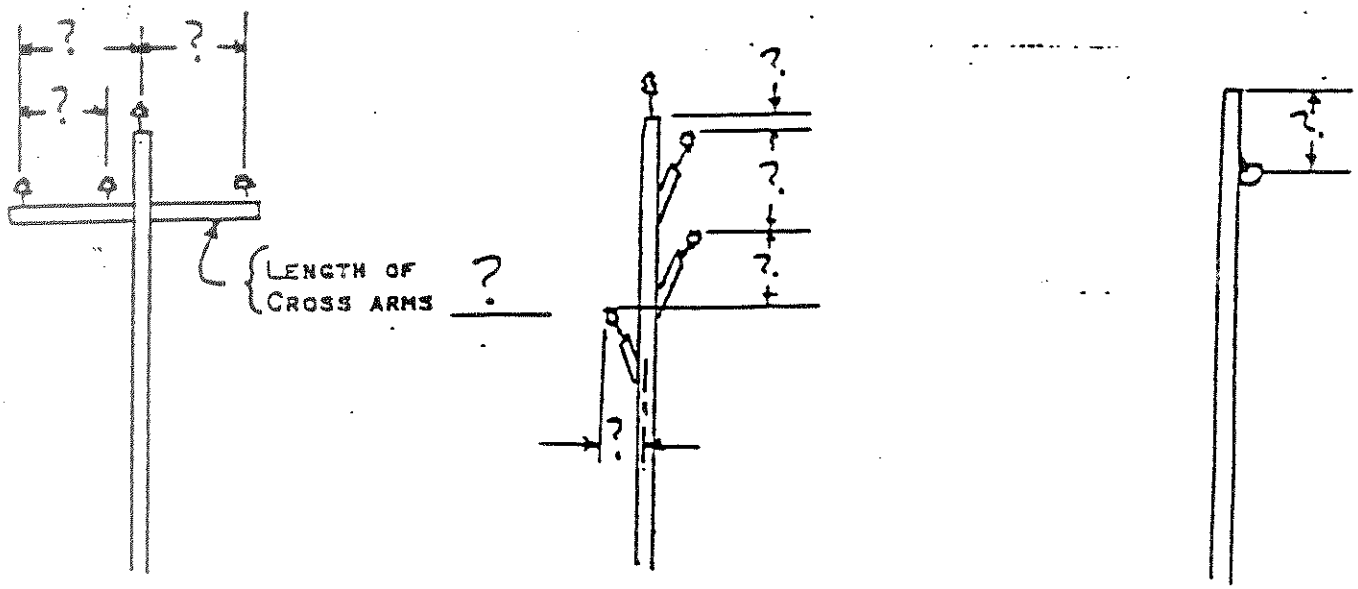
(4) THE DISTANCE BETWEEN EACH POLE IS TO BE SHOWN

(5) ASSIGNED POLE NUMBERS TO BE SHOWN AT EACH POLE

INFORMATION TO BE SHOWN ON PROFILE SECTION OF DRAWINGS IN CASES OF LONGITUDINAL OCCUPATIONS



DISTANCE BETWEEN POLES TO BE SHOWN



POLE TOP CONFIGURATION TO BE SHOWN SIMILAR TO SAMPLES ABOVE

NOTE: IF POWER LINE CROSSES ANY TRACK, THEN INFORMATION SHOWN ON PLATE II IS ALSO REQUIRED

PLATE V

VOLTAGE	OVERHEAD CLEARANCE (Top of Rail to Bottom of Sag)
0-750	27'0"
751-15,000	28'0"
15,001-50,000	30'0"
69,000	30'8"
115,000	32'2"
138,000	33'0"
345,000	39'10"
500,000	45'0"
745,000	53'2"
765,000	53'10"

Calculation is 30'0" + 0.4" per 1,000 volts over 50,000 volts.

APPENDIX D

- Specifications for Wire, Conduit and Cable Occupations of Amtrak Property

USA,ENG 1604

NOV., 1987

REQUIREMENTS & SPECIFICATIONS

FOR

PIPELINE OCCUPANCY

Amtrak

NATIONAL RAILROAD PASSENGER CORPORATION

RECOMMENDED:

H. F. Longhelt

DEPUTY CHIEF ENGINEER

APPROVED:

G E Ellis

ASST. VICE PRESIDENT &
CHIEF ENGINEER

RECOMMENDED:

R E Johnson

ASST. CHIEF ENGINEER
DESIGN & CONSTRUCTION

PIPELINE OCCUPANCY

REQUIREMENTS AND SPECIFICATIONS
Northeast Corridor

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SPECIFICATIONS

APPENDICES

* * * *

TOPICAL INDEX

TOPICAL INDEX
(continued)

* * * *

SECTION 01100 GENERAL REQUIREMENTS

1.01 DESCRIPTION OF WORK LOCATION

A. These Specifications apply to the design and construction of pipelines carrying flammable and non-flammable substances and to casings over 4-inches in diameter containing pipelines, wires, or cables, under, across or along Railroad property, facilities and tracks or tracks owned by others over which the Railroad operates its equipment.

1.02 DEFINITIONS

A. The terms "Amtrak" or "Railroad" are used synonymously throughout these specifications, and refer to the National Railroad Passenger Corporation, Office of the Chief Engineer, 400 North Capitol Street, NW, Washington, DC 20001.

B. The term "Chief Engineer" refers to the Amtrak Chief Engineer or his designated representative.

C. The term" Applicant" refers to individuals, Corporations, or Municipalities desiring occupancy of railroad property by a pipeline.

D. The term "Occupant" refers to individuals, corporations or municipalities who have a current agreement with the Railroad to occupy an existing pipeline under, across or along Railroad property.

1.03 REFERENCED STANDARDS AND SPECIFICATIONS

A. Wherever standards or specifications issued by a recognized industry association or regulatory body are referenced in these Specifications, the reference shall be interpreted as incorporating the referenced standard or specification in total into these Specifications as applicable. In the event of a difference between referenced standard or specifications and these Specifications, the more stringent shall govern.

B. Technical Reference Abbreviations - Whenever in these Specifications the following terms, or pronouns in place of them, may be used, the intent and meaning shall be interpreted as follows:

ANSI - AMERICAN NATIONAL STANDARDS INSTITUTE, INC.
1430 Broadway
New York, NY 10018

ASTM - AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 Race Street
Philadelphia, PA 19103
AREA - AMERICAN RAILROAD ENGINEERING ASSOCIATION
50 F Street, N.W.
Washington, D.C. 20001
AWWA - AMERICAN WATER WORKS ASSOCIATION, INC.
6666 W. Quincy Avenue
Denver, CO 80235
CSI - CONSTRUCTION SPECIFICATIONS INSTITUTE
NACE - THE NATIONAL ASSOCIATION OF CORROSION ENGINEERS
Houston, TX 77026

1. When reference is made to the specifications or standards of any of the above organizations, federal agencies, trade associations, or others, reference is made to the edition current as of the date of approval of application for pipeline occupancy.

1.04 PERMIT TO ENTER RAILROAD PROPERTY

A. No entry upon railroad property for the purpose of conducting surveys, field inspections, obtaining soil information, or any other purpose associated with the design and engineering of the proposed occupancy, will be permitted without a proper entry permit (Amtrak Form CE-17) prepared by the Chief Engineer and executed by the Applicant.

B. The issuance of such an entry permit does not constitute authority to proceed with the actual construction which cannot begin until a formal agreement is finally executed by the Railroad and written permission is received by the Applicant from the designated inspection agency of the Railroad to proceed.

C. All persons entering railroad property must first attend an Amtrak safety orientation class conducted by the Amtrak Safety Department.

1.05 WORK ON RAILROAD PROPERTY

A. The safety and continuity of operation of trains shall be of the first importance. The Applicant shall arrange the work so that trains will be protected and safeguarded at all times. Whenever the work may affect the safety and movement of trains, the method, sequence and time schedule of performing such work shall be submitted to the Chief Engineer for approval 30 days in advance to allow for proper coordination and sequencing of the work by the Applicant.

B. In the event the work affects other railroads or transit authorities, all contacts with them shall be made by the applicant.

C. The Applicant waives all claims against Amtrak for delays or any interference occasioned by railroad traffic.

D. All Applicant-designed temporary construction on railroad property, whether such property belongs to either Amtrak or to other railroads, shall be designed in accordance with the appropriate railroad criteria and all construction performed on, under, or over railroad property will be subject to the inspection and approval of the Chief Engineer.

E. At least twenty-one days advance written notice shall be given to the Chief Engineer prior to the entering upon, or commencing of any work on, under or over railroad property.

F. Amtrak will furnish such qualified flagman, signalman, or protection men, other than crossing watchmen, as may be required to insure complete protection of train operations and railroad facilities. The need for this type of service will be determined by the Chief Engineer on the basis of railroad regulations and the Applicant's approved construction schedule. No work shall proceed without proper protection on the site.

G. All expenses incurred in connection with protection of railroad facilities by railroad employees will be borne by the Applicant. Billings for such services or expenses, including labor, materials and equipment will be made directly to the Applicant for payment.

H. During construction, railroad traffic shall be maintained at all times without interruption, except when interruption is approved in advance, in writing, by the Chief Engineer.

I. All operations shall be conducted so as not to interfere with, interrupt, or endanger the integrity of railroad facilities. All work on and near railroad property shall be conducted in accordance with railroad safety rules and regulations. The Applicant shall secure and comply with the Railroad safety rules and shall give written acknowledgement to the Railroad that they have been received, read, and understood by the Applicant and his employees. Operations will be subject to Railroad inspection at any and all times.

J. All cranes, lifts, or other equipment that will be operated in the vicinity of the Railroad's electrification and power transmission facilities shall be electrically grounded as directed by the Railroad, and/or required by OSHA.

K. At all times when the work is being progressed, a field supervisor for the work with no less than 12 months experience in the operation of the equipment being used shall be present. If boring, drilling, or similar machines are being used, the machine operator also shall have no less than 12 months experience in the operation of the equipment being used. Certification of the above is to be submitted to the Chief Engineer upon request.

L. Whenever equipment or personnel are working closer than 15 feet to the centerline of an adjacent track, that track shall be considered as being obstructed. Insofar as possible, all operations shall be conducted no less than this distance. Operations closer than 15 feet to the centerline of a track shall be conducted only with the permission of, and as directed by, a duly qualified railroad employee present at the site of the work. [The contractor shall erect a temporary fence, or other barrier, 15 feet from the centerline of near track as directed by the Chief Engineer or his authorized representative].

M. Crossing of tracks at grade by equipment and personnel is prohibited except by prior arrangement with, and as directed by, the Railroad's Chief Engineer.

N. All tunneling, jacking and boring operations within Railroad influence lines (see Plate II) will be done continuously on a 24 hour/day basis, until the operation is completed to minimize Railroad exposure to construction hazards.

1.06 COORDINATION

A. The Applicant shall coordinate his work with his contractors, sub-contractors, utility companies, governmental units, Amtrak, and any other affected railroads or transit authorities with regard to site access, establishment and use of temporary facilities, work schedules, and other elements of the specified work which require interfacing with others.

1.07 LAYOUT OF WORK

A. The Applicant shall lay out his work true to lines and grades indicated on the drawings and shall be responsible for all measurements in connection therewith. The Applicant will be held responsible for the execution of the work to such lines and grades indicated on the approved construction Drawings or such other lines and grades as may be directed or established by the Chief Engineer.

1.08 INDEMNIFICATION

A. The Applicant shall indemnify and hold harmless Amtrak, its officers, employees, agents, successors and assigns, regardless of any negligence on their part, from and against any and all loss, damage, claims, demands, action, suits at law or in equity judgements, liability or expenses, including attorneys' fees, for damages for personal injury, including death, to any person whatsoever, and for damage to property of any person whatsoever, including loss or destruction or loss of use thereof, arising out of any accident or occurrence, howsoever caused, directly or indirectly, in the course of or as a consequence of work performed by the Applicant, its officers, employees, agents, contractors or subcontractors. If any part of this section shall be held unlawful, invalid or unenforceable, that part shall be deemed deleted and without prejudice to the lawfulness, validity and enforceability of the remaining parts hereof.

B. In any and all claims against Amtrak or any of its officers or employees by any employee of the Applicant, any contractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, the indemnification obligation under this action shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the Applicant or any contractor under workmen's compensation acts, disability benefit acts or other employee benefit acts.

1.09 INSURANCE

A. Before being permitted to start work, applicant must provide satisfactory evidence of minimum financial responsibility to Amtrak's Tax and Insurance Office, or other designated office, with regard to financially protecting Amtrak during construction operations.

B. Refer to PLATE VIII of these Specifications for information with regard to Amtrak's Insurance Requirements.

1.10 SCIENTIFIC OR HISTORIC ARTIFACTS

A. The Applicant shall immediately notify the Chief Engineer of discovery of scientific or historical artifacts and shall protect same until identified and removed by the appropriate authorities exercising jurisdiction.

1.11 RECORD DOCUMENTS

A. The Applicant shall furnish Amtrak with one reproducible copy of each approved Construction Drawing, marked to indicate all changes and deviations from same and annotated as "As Built" and dated and signed by applicant.

B. All project record documents shall be received and accepted by Amtrak prior to or at the final inspection.

* * END OF SECTION * *

SECTION 01300 SUBMITTALS

1.01 APPLICATION FOR OCCUPANCY

A. Individuals, Corporations and Municipalities (referred to as the "Applicant") desiring occupancy of railroad property by such pipe line occupations will be required, upon approval of the construction details by the Chief Engineer, to execute an appropriate occupational agreement and pay any required fees and/or rentals outlined therein.

B. Application for an occupancy shall be by letter addressed to the Manager Pipe & Wire Agreements, Real Estate Department - National Railroad Passenger Corporation, 400 North Capitol Street, N.W., Washington, D.C. 20001, (cc: to Senior Director, Engineering Construction, 6th Floor, 2000 Market Street, Philadelphia, PA 19103). The Application letter shall include:
   1. Name of Individual, Corporation or Municipality desiring the occupancy.
   2. Complete mailing address of applicant.
   3. Name and title of person who will sign the agreement.
   4. The State in which the applicant is incorporated, if applicable.

C. All applications shall be accompanied with eight (8) copies of all proposed construction plans and three (3) copies of specifications and computations concerning the proposed occupancy.

1.02 SUBMISSION OF CONSTRUCTION PLANS AND SPECIFICATIONS

A. Plans for proposed pipeline occupations shall be submitted to and meet the approval of the Chief Engineer prior to start of construction. These plans are to be prepared in sizes as small as possible and are to be folded to an 8-1/2 inch by 11-inch size (folded dimensions) with a 1-1/2 inch margin on the left hand side and a 1-inch margin on the top so that they can be secured in a file at the upper left hand corner and still be unfolded to full size without being removed from the file.
   1. After folding, the title block and other identification of the plans shall be visible at the lower right hand corner. Each plan shall bear an individual identifying number and an original date, together with subsequent revision dates, clearly identified on the plan so as to be readily apparent as to just what revisions were made and when.

2. All plans are to be individually folded and where more than one plan is involved, they shall be assembled into complete sets before submission to the Railroad. Plans that are approved must include the Railroad File Number assigned by the Railroad.

B. Draw plan to scale and show the following (see attached Plates I, II, III, & IV).
   1. Plan view of proposed pipeline in relation to all Railroad facilities including in electrified territory, catenary pole foundations and guy anchors. The C&S Duct Line and other underground facilities shall be located by the applicant by hand excavation in the presence of a designated Railroad employee. (see Plates I, II & III.
   2. Location of pipe (in feet) from nearest Railroad milepost, centerline of a Railroad bridge (giving bridge number), or centerline of an existing or former passenger station. In all cases, the name of the County in which the proposed facilities are located must be shown. In States where Townships, Ranges, and Sections are used, give distance in feet to the nearest Section line and identify the Section number, Township and Range.
   3. Profile of ground on centerline of pipe from field survey showing relationship of pipe and casing to ground level, tracks and other facilities (see Plate II). For longitudinal occupations, the profile of adjacent track or tracks must be shown (see Plate III).
   4. All Railroad property lines. If pipeline is in a public highway, the limits of the right-of-way for the highway shall be clearly indicated with dimensions from centerline of the highway.
   5. The angle of crossings in relation to centerline of tracks.
   6. Location of valves or control stations of the pipeline.
   7. Complete "Pipe Crossing Data Sheet", (Plate IV), and put on plan.

C. The plan must be specific (both on Railroad property and under tracks that are not on Railroad property) as to:
   1. Method of installations (see Section 02862).
   2. Size and material of casing pipe.
   3. Size and material of carrier pipe.

D. The three (3) required items specified in paragraph "C" above shall not have an alternative. Any application received indicating such options will not be processed. Once an application is approved by the Chief Engineer., no variance from the plans, specifications, method of construction, etc., as approved in the occupancy document will be considered or permitted without the imposition by the Railroad of additional handling charges.

E. Location and dimensions of jacking, boring, or tunneling pits shall be shown with details of their sheeting and shoring. If the bottom of the pit excavation nearest the adjacent track intersects a line from a point 4.5 feet horizontally from center line of adjacent track at the plane of the base of rail drawn on a slope of 1-1/2 horizontal to 1 vertical, submit design and details of the pit construction to the Railroad for approval, complete with computations prepared by a Registered Professional Engineer. In any event, the face of the pit shall be no less than 25 feet from adjacent track, unless otherwise approved by the Chief Engineer. Pits shall be fenced, lighted, and otherwise protected as directed by the Chief Engineer.

F. All plans and computations, including plans and computations submitted by contractors, shall bear the seal of a Registered Professional Engineer licensed in the state in which the work is being performed. If not so imprinted, they will be given no further consideration.

G. Computations for all structures involving the support or protection of Railroad track, embankment and facilities shall be prepared by and bear the seal of a Registered Professional Engineer licensed in the state in which the work is being performed and shall be submitted with the construction plans.

H. When computer calculations are included with design calculations the following documentation shall be furnished as a minimum:

1. A synopsis of the computer program(s) stating briefly required input, method of solution, approximations used, second order analysis incorporated, specifications or codes used, cases considered, output generated, extent of previous usage or certification of program(s) and program(s) author.
2. Identification by number, indexing and cross referencing of all calculation sheets, including supplemental "long-hand" calculation sheets.
3. Fully identified, dimensioned, and annotated diagram of each member or structure being considered.

4. Clear identification and printing of all input and output values, including intermediate values if such values are necessary for orderly review.
5. Identification of the processing unit, input/output devices, storage requirements, etc., if such supplemental information is significant and necessary for evaluation of the submittal.

I. Specifications shall conform to Construction Specifications Institute (CSI) 16 Division, 3-part Section Format.

J. If other than American Railway Engineering Association (AREA), American Society for Testing and Materials (ASTM), or American National Standards Institute (ANSI) specifications are referred to for design, materials or workmanship on the construction plans and specifications for the work, then copies of the applicable sections of such other specifications referred to shall accompany the construction plans and specifications for the work.

* * END OF SECTION * *

SECTION 01500 TEMPORARY FACILITIES AND CONTROLS

1.01 REQUIREMENTS OF REGULATORY AGENCIES

Applicant shall:

A. Obtain and pay all costs for all permits as required for installation and maintenance of temporary facilities and controls. Applicant shall maintain such permits in force throughout duration of use or requirement for item for which each permit was obtained.

B. Comply with all applicable Federal, State and local codes, regulations and ordinances and those of American Railroad Engineering Association.

C. Comply with regulations and requirements of all utility or service companies from which temporary utilities or services are obtained, and pay all costs incurred therewith.

1.02 INSTALLATION AND COORDINATION-GENERAL

Applicant shall:

A. Install all temporary facilities and controls in a neat and orderly manner.

B. Make structurally and functionally sound throughout.

C. Construct temporary facilities and controls to give continuous service and to provide safe working conditions.
   1. Enforce conformance with applicable standards.
   2. Enforce safe practices.

D. Modify, extend or relocate temporary facilities and controls as work progress requires.

E. Locate temporary facilities and controls to avoid interference with, or hazards to:
   1. Work or movement of railroad personnel or traffic.
   2. Vehicular traffic.
   3. General Public.
   4. Work of other contractors.

F. Obtain easements as may be required across non-Amtrak property, and pay all costs (if any) in connection therewith.

G. Materials for temporary facilities and controls must be adequate for the purpose intended and shall not violate requirements of applicable codes and shall not create unsafe conditions, and must be approved by the Chief Engineer.

1.04 SANITARY FACILITIES

A. Prior to starting the work, the Applicant shall furnish for use of his contractors and the work, necessary toilet conveniences, secluded from public observation. They shall be kept in a clean and sanitary condition and comply with the requirements and regulations of the area in which the work is performed.

1.05 LIGHT AND POWER

A. Applicant shall make his own arrangements for obtaining temporary light and power as required for the work, and shall maintain such temporary facilities in a proper and safe condition, including compliance with applicable codes.

1.06 TEMPORARY WATER

A. Applicant shall make his own arrangements for obtaining all temporary water service as required for the Work.

1.07 TEMPORARY TRAFFIC CONTROLS

A. Applicant shall cooperate with the directives of the Chief Engineer regarding vehicular traffic control, and provide any temporary controls or devices required to eliminate or minimize congestion or obstruction of vehicular traffic caused by the work, including use of designated routes of ingress and egress from the work area.

1.08 TEMPORARY WORK AND STORAGE AREAS

A. The areas designated by the Chief Engineer as the Temporary Parking, Work and Storage Area(s) will be provided to the Applicant in accordance with the terms of the Occupancy Agreement. Additional space, if required, shall be obtained by the Applicant at no cost to Amtrak.

B. All designated temporary parking, work and storage areas used by the Applicant shall be restored to their original condition prior to completion of the Work, unless specifically waived by the Chief Engineer.

1.09 POLLUTION ABATEMENT CONTROLS

A. Conduct operations in a manner to minimize pollution of the environment surrounding the area of work by every means possible. Specific controls shall be provided as follows:

1. Vehicles: All vehicles and material transport trucks leaving the site and entering paved public streets shall be cleaned of mud and dirt clinging to the body and wheels of the vehicle. Trucks arriving at or leaving the site with materials shall be loaded in a

manner which will prevent dropping of materials or debris on the streets. Spills of materials in public areas shall be removed immediately at no cost to the Railroad.

2. Waste Materials: No waste or erosion materials shall be allowed to enter natural or man-made water or sewage removal systems. Erosion materials from excavations, borrow areas or stockpiled fill shall be contained within the work area. The Applicant shall develop methods for control of waste and erosion which shall include such means as filtration, settlement and manual removal to satisfy the above requirements. Do not dispose of machinery lubricants, fuels, coolants, and solvents on the site.
3. Burning: No burning of waste shall be allowed without prior written permission. In cases where permission is granted, burning shall be conducted in accordance with the regulations of the appropriate Jurisdictional Agency.
4. Dust Control: The Applicant shall at all times control the generation of dust by his operations. Control of dust is mandatory and shall be accomplished by water sprinkling or by other methods approved by the Chief Engineer.
5. Noise Control: The Applicant shall take every action possible to minimize the noise caused by his operation. When required by agencies having jurisdiction, noise producing work shall be performed in less sensitive hours of the day or week as directed by the Chief Engineer or as required by local ordinance.

B. For all piping carrying non-potable liquids, gases or other pollutants, submit a program for pollution control to the Chief Engineer for his approval prior to beginning operations.

1.10 PROTECTION OF PERSONS AND PROPERTY

A. Safety Requirements

1. The Applicant shall be responsible for ensuring that the most stringent provisions of the applicable statutes and regulations of the political subdivision in which the work is being performed, and the Department of Labor-Occupational Safety, Health Administration provisions, pertaining to the safe performance of the work are observed and further, that the methods of performing the work do not involve undue

danger to the personnel employed thereon, railroad employees, the public, or to public and private property. Should charges of violation of any of the above be issued to the Applicant in the course of the work, a copy of each charge shall immediately be forwarded to the Chief Engineer. The Applicant shall immediately take corrective action to remedy the complaint and shall pay all fines and penalties levied against him.

2. The Applicant shall erect and maintain, as required by existing conditions and progress of the work, all reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards, promulgating safety regulations and notifying owners and users of adjacent utilities.

B. Safety of Persons and Property - The Applicant shall take all reasonable precautions for the safety of, and shall provide all reasonable protection to prevent damage, injury or loss to:
   1. All employees on the Work and all other persons who may be affected thereby.
   2. All the Work and all materials and equipment to be incorporated therein, whether in storage on or off the site, under the care, custody or control of the Contractor or any tier of sub-contractor associated with the Project.
   3. Other property at the site or adjacent thereto, including walks, pavements, roadways, structures, and utilities not designated for removal, relocation or replacement in the course of construction. Any damage to such items shall be restored to original condition by the Applicant at no cost to the Railroad.

C. First Aid
   1. Maintain adequate first aid supplies at the site as prescribed by Federal, State, or Local codes and regulation.

D. Use of Explosives
   1. The use of explosives will not be permitted.

E. Site Security
   1. Maintain a secure work site protecting the Railroad's interests and property from claims arising from trespass, theft and vandalism.
   2. The Applicant shall permit access to the site only to his employees or contractors working on the site and to those persons having business with the Applicant related to the Work or to others as may be authorized by the Chief Engineer.

3. The Applicant shall provide such security measures as he may require to protect his tools, equipment and property and that of his subcontractors (if any) from damage, theft or vandalism.

1.11 VERMIN CONTROL

A. Do not permit food scraps, lunch bags, food wrappers or other items which would attract rats or other vermin to be left laying around the site. Deposit such items in closed, rat-proof metal containers for disposal on a regular basis.

1.12 RUBBISH AND DEBRIS REMOVAL

A. Neatly pile rubbish and debris resulting from the Work in a single location on the site and remove from this location at least once a week and legally disposes of same off the site. Remove on a more frequent basis if such rubbish or debris interferes with railroad activities, the work of others or creates a fire or safety hazard.

B. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains or upon the site.

C. Do not dispose of wastes into streams or waterways.

* * END OF SECTION * *

SECTION 02860 PIPELINE OCCUPANCY GENERAL CRITERIA

1.01 GENERAL REQUIREMENTS

A. Pipelines under Railroad tracks and across Railroad operating right-of-way shall be encased in a larger pipe or conduit called the casing pipe as indicated in Plate II.

B. Casing pipe will be required for all pipelines carrying oil, gas, petroleum products, or other flammable or highly volatile substances under pressure, and all non-flammable substances which, from their nature or pressure, as determined by the Chief Engineer, might cause damage if escaping on, under, over, or near Railroad property.

C. For non-pressure sewer or drainage crossings where the installation can be made without interference to Railroad operations, as determined by the Chief Engineer, the casing pipe may be omitted when the pipe strength is capable of withstanding Railroad loading hereinafter specified.

D. The casing pipe shall be laid across the entire width of the right-of-way. Casing pipe shall extend beyond the right-of-way when the right-of-way line on either side of the tracks is less than the minimum length of casing specified in Section 02862, Para. 1.02-E.

E. Pipelines laid longitudinally on railroad right-of-way shall be located as far as practicable from any tracks or other important structures and as close to the Railroad property line as possible. If located within 25 feet of the centerline of any track or closer than 45 feet to nearest point of any bridge, building or other important structure, the carrier pipe shall be encased (see also Section 02862 Para. 3.01 and Plate III).

F. Pipelines shall be located, where practicable, to cross tracks at approximate right angles thereto, but preferably at not less than 45 degrees.

G. Pipelines shall not be placed within a culvert, under Railroad bridges, nor closer than 45 feet to any portion of any Railroad bridge, building, or other important structure, except in special cases, and then by special design, as approved by the Chief Engineer.

H. Pipelines carrying liquified petroleum gas shall, where practicable, cross the Railroad where tracks are carried on embankment.

I. Any replacement or modification of an existing carrier pipe and/or casing shall be considered a new installation, subject to the requirements of these Specifications.

J. Where laws or orders of public authority prescribe a higher degree of protection than specified herein, then the higher degree so prescribed shall be deemed a part of these specifications.

K. Pipelines and casings shall be suitably insulated from underground conduits carrying electric wires on Railroad property.

1.02 INSPECTION AND TESTING

A. For pipelines carrying flammable or hazardous materials ANSI Codes B 31.8 and B 31.4, current at time of constructing the pipeline, shall govern the inspection and testing of the facility on Railroad property, except that proof-testing of strength of carrier pipe shall be in accordance with the requirements of ANSI Code B 31.8 for location Classes 2, 3, or 4 or ANSI Code B 31.4, as applicable, for all pipelines carrying oil, liquified petroleum gas, natural or manufactured gas, and other flammable substances.

1.03 CATHODIC PROTECTION

A. Cathodic protection shall be applied to all pipelines and casings carrying flammable substances.

B. Where casing and/or carrier pipe is cathodically protected by other than anodes, the Chief Engineer shall be notified and suitable test shall be made, witnessed by the Railroad to insure that other Railroad structures and facilities are adequately protected from the cathodic current in accordance with the recommendations of Reports of Correlating Committee on Cathodic Protection, current issue by the National Association of Corrosion Engineers.

1.04 SOIL INVESTIGATIONS

A. For all pipe crossings 36 inches in diameter and larger under tracks, and at other locations, the Chief Engineer will require soil borings, or other soil investigations be made to determine the nature of the underlying material. The location and method of soil boring or other soil investigations must be submitted to the railroad for approval. (See Section 01100 and 01300 relative to Procedures)

B. For pipe crossings less than 36 inches in diameter under tracks, and at other locations, as the Chief Engineer may require soil borings or other approved investigations may be required when, in the judgment of the Chief Engineer, they are necessary to determine the adequacy of the design and construction of the facilities. The location and method of soil boring or other soil investigations must be submitted to the railroad for approval.

C. Borings shall be made on each side of the tracks, on the centerline of the pipe crossing, and as close to the tracks as practicable. (See Sections 01100 and 01300 relative to Procedures)

D. Soil borings shall be in accordance with the current issue of the American Railway Engineering Association Specifications, Chapter 1, Part 1, "Specifications for Test Borings." Soils shall be investigated by the split-spoon and/or thin-walled tube method and rock by the Coring method specified therein, as appropriate.

E. Soil boring logs shall clearly indicate All of the following:
   1. Boring number as shown on boring location plan.
   2. Elevation of ground at boring, using same datum as the pipeline construction plans.
   3. Description of soil classification of soils and rock encountered.
   4. Elevations or depth from surface for each change in strata.
   5. Identification of where samples were taken and percentage of recovery.
   6. Location of ground water at time of sampling and, if available, subsequent readings.
   7. Natural dry density in Lbs./Sq.ft. for all strata.
   8. Unconfined compressive strength in Tons/Sq.ft. for all strata.
   9. Water content (Percent). Liquid limit (Percent) and Plastic limit (Percent).
   10. Standard penetration in Blows/ft.

F. The location of the carrying pipe and casing shall be superimposed on the Boring logs before submission to the Chief Engineer.

G. Soil investigation by auger, wash, or rotary drilling methods are not acceptable.

H. Soil Boring logs shall be accompanied by a plan drawn to scale showing location of borings in relation to the tracks and the proposed pipe location, the elevation of ground surface at each boring, and the elevation of the base of rail of the tracks.

1.05 SUPPORT OF TRACKS

A. When the jacking, boring or tunneling method of installation is used, and depending upon the sizes and location of the crossings, the existing soil conditions and elevation of ground water, temporary track supporting structures shall be installed at the direction of the Chief Engineer and at the expense of the Applicant.

B. The type of temporary track supporting structures to be installed shall be approved by the Chief Engineer.
C. Unless otherwise agreed, all work involving rail, ties and other track material will be performed by the Railroad's employees at the Applicant's expense.
D. Track supports shall be supplied by the applicant and delivered to a site approved by the Railroad. Provisions for unloading will be provided by the Applicant at no expense to the Railroad. The Applicant will provide necessary labor to handle the material for pre-installation inventory.
E. Prior to the start of construction the applicant must deliver a stock pile (minimum 10 tons) of approved railroad ballast to an area designated by the railroad at the project site.

1.06 PIPELINES ON BRIDGES
A. Pipelines carrying flammable substances or non-flammable substances which by their nature might cause damage if escaping on or near railroad facilities or personnel, shall not be installed on bridges over railroad tracks or bridges carrying railroad tracks.
B. In special cases when it can be demonstrated to the Chief Engineer's satisfaction that such an installation is necessary and that no practicable alternative is available, the Chief Engineer may permit the installation and only by special design approved by him.
C. Pipelines on bridges shall be so located as to minimize the possibility of damage from vehicles, railroad equipment, vandalism and other external causes. They shall be encased in a casing pipe. Where appropriate, permanent barriers shall be constructed at each end of the bridge to prevent trespassers from crossing the bridge via the pipe casing.

1.07 BONDING AND GROUNDING OF PIPELINES IN ELECTRIFIED TERRITORY
A. Carrier pipe shall be enclosed in a metal casing that is isolated from carrier pipe by approved insulators having a dielectric value of not less than 25 KV. that provide an air gap between carrier pipe and casing of not less than 2 inches.
B. Carrier pipe supporting hangers, mountings or cradles shall provide an insulation value of not less than 25 KV. and an air gap of not less than 2 inches between casing and any portion of mounting assembly.
C. Casing shall be bonded to Railroad's return at each end through bridge steel or direct when girders are of non-conductive material, conforming to Amtrak Drawing E.T.

11200 C (Details for Power Bonding of Structures), and Plate V.

D. Pipeline may be pre-coated as per the attached H.C. Price Co. "Pritec" Specification revised October 23, 1978 or approved equal (Plate VI).

E. Pipeline may be field wrapped as per the attached suggested procedures to hand wrap field joints with Servi-wrap P.500 or approved equal. Minimum of two wraps required - see Plate VII.

F. Fiberglass conduit made by the Ciba - Geigy Corp. known as Dualoy T & D conduit is also acceptable as an isolation means subject to approval of the Chief Engineer.

G. Any grounding or isolation methods used must have a minimum dielectric value of 25,000 volts.

1.08 ABANDONED PIPELINES AND/OR FACILITIES

A. For all pipe crossings under track or near other railroad structures, the owner of the pipeline shall notify the Chief Engineer, in writing, of the intention to abandon such pipeline. Upon abandonment, the carrier pipe shall be removed and the casing shall be filled with cement grout, compacted sand or other material as may be approved by the Chief Engineer. If it is impracticable to remove the carrier pipe then the carrier must be filled along with the annular space between the casing and carrier.

B. Facilities other than pipelines will be removed or altered at abandonment to the satisfaction of the Chief Engineer.

1.09 DRAINAGE

A. Occupancies shall be designed, and their construction shall be accomplished, so that adequate and uninterrupted drainage of Railroad right-of-way is maintained. If, in the course of construction, it may be necessary to block a ditch, pipe or other drainage facility, the Contractor shall install temporary pipes, ditches or other drainage facilities as required to maintain adequate drainage, as approved by the Chief Engineer. Upon completion of the work, the temporary drainage facilities shall be removed and the permanent facilities restored.

B. Water may not be pumped or disposed of on Railroad Right of Way unless discharged into an existing drainage facility and providing discharge does not cause erosion.

* * END OF SECTION * *

SECTION 02861 CARRIER PIPE

PART 1 GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE
- A. Inspection and Testing - Section 02860, Art. 1.02.
- B. Cathodic Protection - Section 02860, Art. 1.03.
- C. Bonding and grounding of pipelines in electrified territory - Section 02860, Art. 1.07.
- D. Casing Pipe - Section 02862, Entire Section.
- E. Miscellaneous General Criteria - Section 02860, Art. 1.01.

1.02 DESIGN CRITERIA
- A. If the maximum allowable stress in the carrier pipe on either side of the occupancy of Railroad property is less than as specified in Section 02860, Art. 1.01 above, the carrier pipe on Railroad property shall be designed at the same stress as the adjacent carrier pipe.
- B. Requirements for carrier pipe under Railroad tracks shall apply for a minimum distance equal to that of the casing pipe as specified in Section 02862.
- C. Carrier pipes within a casing shall be designed according to Railroad Specifications as if they were not encased.
- D. All pipes, ditches and other structures carrying surface drainage on Railroad property and/or crossing under Railroad tracks shall be designed to carry the run-off from a one hundred (100) year storm. Computations indicating this design and suitable topographic plans, prepared by a Registered Professional Engineer, licensed in the state in which the work is being performed shall be submitted to the Chief Engineer for approval. If the drainage is to discharge into an existing drainage channel on or under Railroad right-of-way, an hydraulic analysis of the existing structures must be included. Submit with the computations formal approval of the proposed design by the appropriate governmental agency.

PART 2 PRODUCTS

2.01 GENERAL - All pipes shall be designed for the external and internal loads to which they will be subjected. The dead load of earth shall be considered 120 pounds per cubic foot. Railroad live loading shall be Cooper's E-80 with 50% added for impact. In any event on Railroad property or where Railroad loading will be experienced, the following shall be the minimum requirements for carrier pipes:

A. Reinforced concrete pipe - ASTM Spec. C-76, Class V, Wall C.
B. Ductile Iron Pipe - ANSI Spec A21.51, Class 6.
C. Cast Iron Pipe - For Culverts and Gravity Sewers - ASTM Spec. A-716 Extra Heavy.

2.02 OIL AND GAS PIPES

A. Pipelines carrying oil, liquefied petroleum gas, natural or manufactured gas and other flammable products shall conform to the requirements of the current ANSI B 31.4, with Addenda, Liquefied Petroleum Transportation Piping Systems," ANSI B 31.8, "Gas Transmission and Distribution Piping Systems," and other applicable ANSI Codes, except that the maximum allowable stresses for design of steel pipe shall not exceed the following percentages of the specified minimum yield strength (multiplied by the longitudinal joint factor) of the pipe as defined in the ANSI Codes:
   1. Steel pipe within a casing, under Railroad tracks, across Railroad rights-of-way, and longitudinally on Railroad rights-of-way. (The following percentages apply to hoop stress):
      a. Seventy-two percent for installation on oil pipelines.
      b. Fifty percent for pipelines carrying liquefied petroleum gas and other flammable liquids with low flash point.
      c. Sixty percent for installations on gas pipelines.
   2. Steel pipe without a casing laid longitudinally on Railroad rights-of-way or on Railroad property. (The following percentages apply to hoop stress):
      a. Sixty percent for installations on oil pipelines.
      b. Forty percent for pipelines carrying liquefied petroleum gas and other flammable liquids with low flash point.

B. Design computations showing compliance with the requirements of Paragraph 2.02 A above, and prepared by a Registered Professional Engineer licensed in the state in which the work is being performed, shall accompany the application for occupancy.

2.03 CAST IRON PIPE - for water and other materials under pressure, shall conform to the current ANSI specifications A-21 Series 21/45 Iron strength with plain end, compression type or mechanical joints. The strength to sustain external Railroad and other loadings shall be computed in accordance with the current ANSI A-21.1 "Thickness Design of Cast Iron Pipe".

2.04 VITRIFIED CLAY PIPE - ASTM Spec. C-700, Extra Strength.

2.05 CORRUGATED METAL PIPE - AREA Spec. Chapter 1, Part 4.

2.06 ASBESTOS CEMENT PIPE -
Non-pressure: ASTM Spec. C-428, Cl. 5000 Min.
Pressure: AWWA Spec. C-400, Cl. 150 Min.

2.07 OTHER - Other miscellaneous piping not specified above shall be as approved by Chief Engineer.

2.08 SHUT-OFF VALVES

A. Provide accessible emergency shut-off valves at each side of the railroad within distances and at locations as directed by the Chief Engineer.

B. Where pipelines are provided with automatic control stations and within distances approved by the Chief Engineer, no additional valves will be required.

2.09 SIGNS

A. Prominently identify all pipelines (except those in streets where it would not be practical to do so) at rights-of-way by durable, weatherproof signs located over the centerline of the pipe. Mark pipelines at undercrossings on both sides of track. Signs shall show the following:
1. Name and address of pipeline Owner.
2. Contents of Pipe.
3. Pressure in Pipe.
4. Depth below grade at point of sign.
5. Emergency telephone in event of pipe rupture.
6. RR File Number.

B. For pipelines running longitudinally on Railroad property, place signs over the pipe (or offset) appropriately marked at all changes in direction of the pipeline. Locate such signs so that when standing at one sign, the next adjacent marker in either direction is visible. In no event shall pipeline identification signs be placed more than 500 feet apart, unless otherwise directed by the Chief Engineer.

C. Submit details of signs (materials, size, method of support, etc.) to the Chief Engineer for approval with the application.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install carrier pipes in accordance with approved Construction Drawings, requirements of this specification, and all applicable codes and ordinances.

B. Install carrier pipes with sufficient slack so that they are not in tension.

* * END OF SECTION * *

SECTION 02862 CASING PIPE

PART 1 GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE
- A. Miscellaneous General Criteria - Section 02860.
- B. Carrier Pipe - Section 02861.

1.02 DESIGN CRITERIA
- A. Casing pipe and joints shall be of metal and of leakproof construction.
- B. Casing pipe shall be designed for the earth and/or other pressures present, and for railroad live load. The dead load of earth shall be considered 120 pounds per cubic foot. Railroad live load shall be Cooper E-80 with 50% added for impact.
- C. The inside diameter of the casing pipe shall be such as to allow the carrier pipe to be removed subsequently without disturbing the casing or the roadbed. For steel pipe casings, the inside diameter of the casing pipe shall be at least two (2) inches greater than the largest outside diameter of the carrier pipe joints or couplings, for carrier pipe less than six (6) inches in diameter; and at least four (4) inches greater for carrier pipe six (6) inches and over in diameter.
- D. For flexible casing pipe, a minimum vertical deflection of the casing pipe, of 3% of its diameter plus 1/2 inch, shall be provided so that no loads from the roadbed, track, traffic or casing pipe itself are transmitted to the carrier pipe. When insulators are used on the carrier pipe, the inside diameter of the flexible casing pipe shall be at least two (2) inches greater than the outside diameter of the carrier pipe for pipe less than eight (8) inches in diameter; at least 3-1/4 inches greater for pipe 8 inches to 16 inches, inclusive, in diameter; and at least 4-1/2 inches greater for pipe 18 inches and over in diameter. In no event shall the casing pipe diameter be greater than is necessary to permit the insertion of the carrier pipe.
- E. Casing pipe under Railroad tracks and across Railroad rights-of-way shall extend the GREATER of the following distances, measured at right angles to centerline of track:
  1. Across the entire width of Railroad right-of-way (See Section 02860, Paragraph 1.01, D.)
  2. Three (3) feet beyond ditch line.
  3. Two (2) feet beyond toe of slope.

4. A minimum distance of 25 feet each side from centerline of outside track when casing is sealed at both ends.
5. A minimum distance of 45 feet from centerline of outside track when casing is open at both ends.
6. The distance 1.5 times the depth of invert of casing as indicated on plate II.

F. If additional tracks are constructed in the future, the casing shall be extended correspondingly at the expense of the Applicant.

G. Table of Live Loads.

LIVE LOADS, INCLUDING IMPACT, FOR VARIOUS HEIGHTS OF COVER FOR COOPER E 80

COVER(FT)	LOAD(PSF)	COVER(FT)	LOAD(PSF)	COVER(FT)	LOAD(PSF)
2	3800	10	1100	20	300
5	2400	12	800	30	100
8	1600	15	600		

1.03 PROTECTION AT ENDS OF CASING

A. Casings for carriers of flammable substances shall be suitably sealed to the outside of the carrier pipe. Details of seals shall be shown on the plans.

B. Casings for carriers of non-flammable substances shall have both ends of the casing blocked up in such a way as to prevent the entrance of foreign material, but allowing leakage to pass in the event of a carrier break.

C. Where ends of casings are at or above ground surface and above high water level, they may be left open, provided drainage is afforded in such a manner that leakage will be conducted away from railroad tracks and structures.

1.04 VENTS

A. Sealed casings for flammable substances shall be properly vented. Vent pipes shall be of sufficient diameter, but in no case less than two (2) inches in diameter, and shall be attached near each end of the casing and project through the ground surface at right-of-way lines or not less than 45 feet (measured at right angels) from centerline of nearest track.

B. Vent pipes shall extend not less than four (4) feet above the ground surface. Top of vent pipe shall have a down-turned elbow, properly screened, or a relief valve. Vents in locations subject to high water shall be extended above the maximum elevation of high water and shall be supported and protected in a manner approved by the Chief Engineer.

C. Vent pipes shall be at least four (4) feet (vertically) from aerial electric wires.
D. When the pipeline is in a public highway, street-type vents shall be installed.

PART 2 PRODUCTS

2.01 STEEL PIPE - minimum yield strength of 35,000 psi. Smooth wall pipes with a nominal diameter of over 54 inches will not be permitted. When steel casing pipe is used, the ends shall be beveled with a single V-groove for field welding. Pipe joints shall be butt welded by a certified welder with a full penetration weld on the outside circumference of the pipe. The single V-groove butt weld shall conform to the latest A.W.S. Welding Code.

TABLE OF MINIMUM WALL THICKNESS FOR STEEL CASING PIPE
(for Information Only)

Nominal Thickness-Inches			Nominal Thickness-Inches		
Coated or Cathodically Protected	Uncoated and Un-protected	Nominal Diameter Inches	Coated or Cathodically Protected	Uncoated and Un-protected	Nominal Diameter Inches
0.375	0.375	22&Under	0.469	0.532	34-36
0.375	0.407	24	0.500	0.563	38-42
0.375	0.438	26	0.564	0.626	48
0.406	0.469	28-30	0.625	0.688	54
0.438	0.501	32			

2.02 CAST IRON PIPE - may be used for a casing, provided the method of installation is by open trench only. Cast iron pipe shall conform to ATSM Specification A-716, Extra Heavy. The pipe shall be of the mechanical joint type or plain end type with compression type couplings.

2.03 CORRUGATED METAL PIPE AND CORRUGATED STRUCTURAL PLATE PIPE - may be used for casing only when emplaced by the open-cut method. Jacking or boring through Railroad embankment is not permitted. Pipe shall be asbestos-bonded, bituminous coated and shall conform to American Railway Engineering Association Specifications Chapter 1, Part 4.

2.04 REINFORCED CONCRETE PIPE - shall conform to ASTM Specification C-76, Class V, Wall C. It shall be used only in the open cut and jacking methods of installation.

If concrete pipe is to be jacked into place, it must be smooth wall with grout holes tapped for no smaller than 1-1/2 inch

pipe, spaced at approximately 3 feet around the circumference and approximately 4 feet longitudinally cast into the pipe at manufacture. Immediately upon completion of jacking operations, the installation shall be pressure grouted as specified in Paragraph 3.02, C, 3 below.

2.05 TUNNEL LINER PLATES - shall be four flange and otherwise conform to American Railway Engineering Association Specifications Chapter I, Part 4. In no event shall the liner plate thickness be less than 0.1046 inches. Tunnel liner plates are to be used only to maintain a tunnelled opening until the carrier pipe is installed, and after the carrier pipe is installed, the annular space between the carrier and liner must be filled with 1:6 cement grout or lined with 6 inches of concrete, reinforced with 6x6-6/6 wire mesh for tunnels up to 108 inches in diameter. Required thickness of lining for larger tunnels will be determined by span and structural analysis. Manufacturer's Shop Detail plans and manufacturer's computations showing the ability of the tunnel liner plates to resist the jacking stresses shall be submitted to the Chief Engineer for approval.

PART 3 EXECUTION

3.01 DEPTH OF INSTALLATION

A. Casing pipe under Railroad tracks and across Railroad rights-of-way shall be not less than 5-1/2 feet from base of rail to top of casing at its closest point, except that under secondary or industrial tracks this distance may be 4-1/2 feet as approved by the Chief Engineer. On other portions of rights-of-way where casing is not directly beneath any track, the depth from ground surface or from bottom of ditches to top of casing shall be not less than three (3) feet, unless otherwise specified herein.

B. Pipelines laid longitudinally on Railroad rights-of-way 50 feet or less from centerline of track, shall be buried not less than five (5) feet from ground surface to top of pipe for pipelines carrying oil, gas, petroleum products, or other flammable or highly volatile substances under pressure and all non-flammable substances which by their nature or pressure in the judgment of the Chief Engineer may be hazardous to life or property. For pipelines carrying water, sewage and non-flammable substances, the distance from surface of ground to top of pipe may be four (4) feet. Pipelines should be a minimum of three (3) feet from existing ditches and C&S duct lines.

C. Pipelines are considered to be subject to Railroad loading and shall require a casing or be of special design approved by the Chief Engineer when within the line of track live load influence as shown on Plate III.

D. Where pipeline is laid more than 50 feet from centerline of track, the minimum cover shall be at least three (3) feet.

3.02 CONSTRUCTION

A. Casing pipe shall be so constructed as to prevent leakage of any substance from the casing throughout its length, except at ends of casing where ends are left open, or through vent pipes when ends of casing are sealed. Casing shall be installed so as to prevent the formation of a waterway under the Railroad, and with an even bearing throughout its length, and shall slope to one end (except for longitudinal occupancy.

B. Installations by open trench method will be permitted only with the approval of the Chief Engineer and Division General Superintendent and shall comply with American Railway Engineering Association Specifications, Chapter 1, Part 4, "Installation of Pipe Culverts".

C. Installation of casing pipe will be performed only by contractors who have demonstrated to the satisfaction of the Chief Engineer that they have had previous successful experience with casing installations by the method chosen. Casing pipes shall be installed by one of the following methods:

1. Jacking
   a. This method shall be in accordance with American Railway Engineering Association Specifications, Chapter 1, Part, "Jacking Culvert Pipe through Fills." This operation shall be conducted without handmining ahead of the pipe and without the use of any type of boring, auguring, or drilling equipment.
   b. Bracing and backstops shall be so designed, and jacks of sufficient rating used, so that the jacking can be progressed without stoppage (except for adding lengths of pipe) until the leading edge of the pipe reaches the location where the invert elevation intersects the Track Live Load Influence Line as shown on Plate II and as described in Section 01300., para. 1.02-E.
   c. During jacking, an earth plug 1.5 times the diameter of casing is to be maintained at all times. Unless otherwise approved by the Chief Engineer, jacking operations shall be conducted continuously on a 24 hour a day basis until the jacking operations are completed.
2. Drilling - This method employs the use of an oil field type rock roller bit or a plate bit made up of individual roller cutter units which is solidly welded

to the pipe casing being installed and which is turned as it is advanced. The pipe is turned for its entire length from the drilling machine through to the ground being drilled. A high density slurry (oil field drilling mud) is injected through a small supply line to the head which acts as a cutter lubricant. This slurry is injected at the rear of the cutter units to prevent any jetting action ahead of the pipe. The drilling machine runs on a set of steel rails and is advanced (thus advancing the pipe) by a set of hydraulic jacks. The method is the same whether earth or rock is being drilled. Methods of similar nature shall be submitted to the Chief Engineer for approval. Unless otherwise approved by the Chief Engineer, drilling operations shall be conducted continuously on a 24 hour a day basis until the drilling operations are completed.

3. Tunneling
   a. Tunneling operations shall be conducted as approved by the Chief Engineer. Care shall be exercised in trimming the surface of the excavated section in order that the steel liner plates fit snugly against undisturbed material. Excavation shall not be advanced ahead of the previously installed liner plates any more than is necessary for the installation of the succeeding liner plate. The vertical face of the excavation shall be supported as necessary to prevent sloughing. At any interruption of the tunneling operation, the heading shall be completely bulkheaded. Unless otherwise approved by the Chief Engineer, the tunneling shall be conducted continuously, on a 24-hour basis until the tunnel liners extend at least the distance 1.5 times the depth of invert from end of tie of last track.
   b. While driving tunnel, tight breasting must be maintained on the upper 180° of the face and, depending on soil conditions, the lower 180°. On any shutdowns (under or beyond railroad influence line, see plate II), the entire face will be fully breasted and packed with hay.
   c. The tail void shall be filled with pea gravel (or other approved material) simultaneously with each advancement of the shield.
   d. An ample supply of hay and/or sand bags must be kept at the site to fill any voids caused by the removal of large stones or other obstructions extending outside the shield.

e. A uniform mixture of 1:6 cement grout shall be placed under pressure behind the liner plates, in addition to the previously placed pea gravel. Grout holes, tapped for no less than 1-1/2 inch pipe and spaced 3 feet ± around the tunnel liner, shall be placed in every other ring, or an equal number of grout plugs evenly spaced in every ring. Grouting shall start at the lowest hole and proceed upwards. A threaded plug shall be installed in each grout hole as the grouting is completed at that hole.

f. Grouting shall be kept as close to the heading as possible, using grout stops behind the liner plates, if necessary. Grouting shall proceed as directed by the Chief Engineer, but must be executed at a minimum of every 24 hours and in no event shall more than six lineal feet of tunnel be progressed beyond the grouting.

4. Tunneling Shields

a. All pipes 60 inches and larger in diameter shall be emplaced with the use of a tunneling shield, unless otherwise approved by the Chief Engineer. Pipes of smaller diameter may also require a shield when, at the sole discretion of the Chief Engineer, soil or other conditions indicate its need.

b. The shield shall be of steel construction, designed to support railroad track loading as specified in Paragraph 1.02 B herein, in addition to other loadings it must sustain. The advancing face shall be provided with a hood, extending no less than 20 inches beyond the face and extending around no less than the upper 240° of the total circumference. Installations made with liner plates shall be provided with a full 360° shield. It shall be of sufficient length to permit the installation of at least one complete ring of liner plates within the shield before it is advanced for the installation of the next ring of liner plates. The annular space between the inside diameter of the tail section of the shield and the outside diameter of the tunnel liner or pipe must not exceed 1" around the periphery.

c. It shall be adequately braced and provided with necessary appurtenances for completely bulkheading the face with horizontal breastboards, and arranged so that the excavation can be benched as may be necessary. Excavation shall not be advanced beyond the edge of the hood, except in rock.

d. Manufacturer's Shop Detail plans and manufacturer's computations showing the ability of the tunnel liner plates to resist the jacking stresses shall be submitted to the Chief Engineer for approval.

e. For jacking reinforced concrete pipe, the shield shall be fabricated as a special section of reinforced concrete pipe with the steel cutting edge, hood, breasting attachments, etc., cast into the pipe. The wall thickness and reinforcing shall be designed for the jacking stresses.

f. Grout holes tapped for no less than 1-1/2 inch pipe, spaced at approximately 3 feet centers around the circumference of the shield (or the aforementioned special reinforced concrete section) and no more than 4 feet centers longitudinally shall be provided.

g. Detail plans sufficient to determine the adequacy of the Shield, accompanied with design calculations prepared by a Registered Professional Engineer, shall be submitted to the Chief Engineer for approval and no work shall proceed until such approval is obtained.

5. Boring

a. This method consists of pushing the pipe into the fill with a boring auger rotating within the pipe to remove the spoil. When augers, or similar devices, are used for pipe emplacement, the front of the pipe shall be provided with mechanical arrangements or devices that will positively prevent the auger from leading the pipe so that there will be no unsupported excavation ahead of the pipe. The auger and cutting head arrangement shall be removable from within the pipe in the event an obstruction is encountered. The over-cut by the cutting head shall not exceed the outside diameter of the pipe by more than one-half inch. The face of the cutting head shall be arranged to provide reasonable obstruction to the free flow of soft or poor material.

b. The use of water or other liquids to facilitate casing emplacement and/or spoil removal is prohibited.

c. Plans and descriptions of the auger stop arrangement to be used shall be submitted to the Chief Engineer for approval, and no work shall proceed until such approval is obtained and the arrangement is inspected in the field by the Railroad.

WORK STARTED PRIOR TO THIS INSPECTION WILL BE HALTED AND THE INSTALLED CASING ABANDONED IN PLACE IN ACCORDANCE WITH SECTION 02860, PARAGRAPH 1.08

d. Any method which employs simultaneous boring and jacking or drilling and jacking for pipes over 8 inches in diameter which does not have the above arrangement WILL NOT BE PERMITTED. For pipes 8 inches and less in diameter, augering or boring without this arrangement may be considered for use only as approved by the Chief Engineer.

D. If an obstruction is encountered during installation to stop the forward action of the pipe, and it becomes evident that it is impossible to advance the pipe, operations will cease and the pipe shall be abandoned in place and filled completely with grout.

E. Bored or jacked installations shall have a bored hole essentially the same as the outside diameter of the pipe plus the thickness of the protective coating. If voids should develop or if the bored hole diameter is greater than the outside diameter of the pipe (plus coating) by more than approximately 1 inch, grouting or other methods approved by the Chief Engineer shall be employed to fill such voids.

F. Pressure grouting of the soils or freezing of the soils before or during jacking, boring, or tunneling may be required at the direction of the Chief Engineer to stabilize the soils, control water, prevent loss of material and prevent settlement or displacement of embankment and/or tracks. Grout shall be cement, chemical or other special injection material selected to accomplish the necessary stabilization. The Grouting Contractor shall be a specialist in the field with a minimum of five (5) continuous years experience of successfully grouting soils.

G. The materials to be used and the method of injection shall be prepared by a Registered Professional Soils Engineer, or by an experienced and qualified company specializing in this work and submitted for approval to the Chief Engineer before the start of work. Proof of experience and competency shall accompany the submission.

H. When water is known or expected to be encountered, pumps of sufficient capacity to handle the flow shall be maintained at the site and, upon approval of the Chief Engineer to operate them, they shall be in constantly attended operation on a 24-hour basis until, in the sole judgment of the Chief Engineer, their operation can be safely halted. When dewatering, close

observation shall be maintained to detect any settlement or displacement or railroad embankment, tracks, and facilities.

I. The dewatering system shall lower and maintain the ground water level a minimum of two (2) feet below the invert at all times during construction by utilizing well points, vacuum well points, or deep wells to prevent the inflow of water or water and soil into the heading. Ground water observation wells may be required to demonstrate that the dewatering requirements are being complied with.

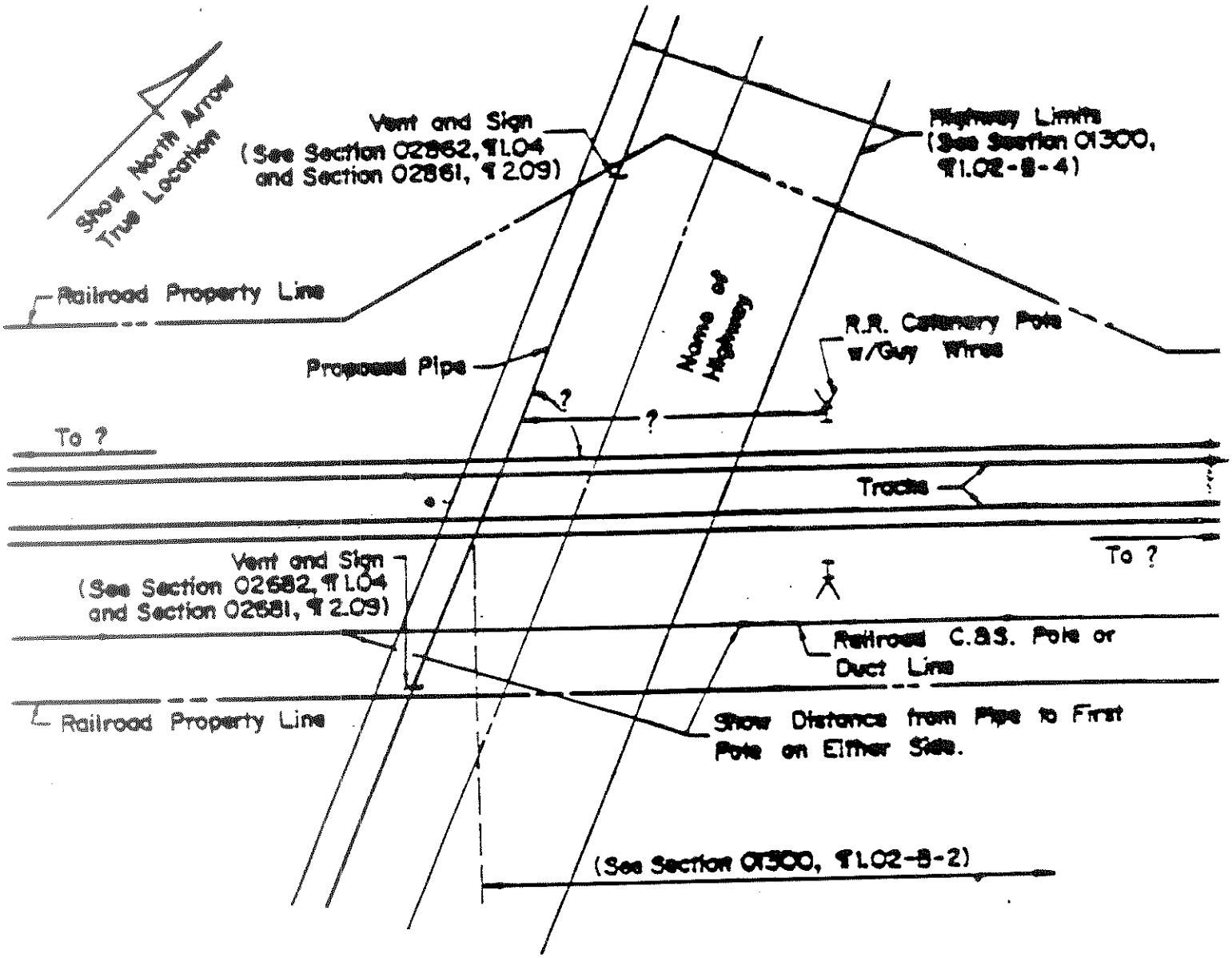
J. Proposed methods of dewatering must be submitted to the Chief Engineer for approval prior to implementation. The discharge from the dewatering operations in the vicinity of the Railroad shall be carefully monitored, and if in the opinion of the Chief Engineer, there is an excessive loss of fine soil particles at any time during the dewatering process, the dewatering will be halted immediately. The dewatering operation cannot resume until the unsatisfactory condition is remedied to the satisfaction of the Chief Engineer.

* * END OF SECTION * *

PLATE I

1604

INFORMATION TO BE SHOWN ON PLAN SECTION OF DRAWING



NOTE:

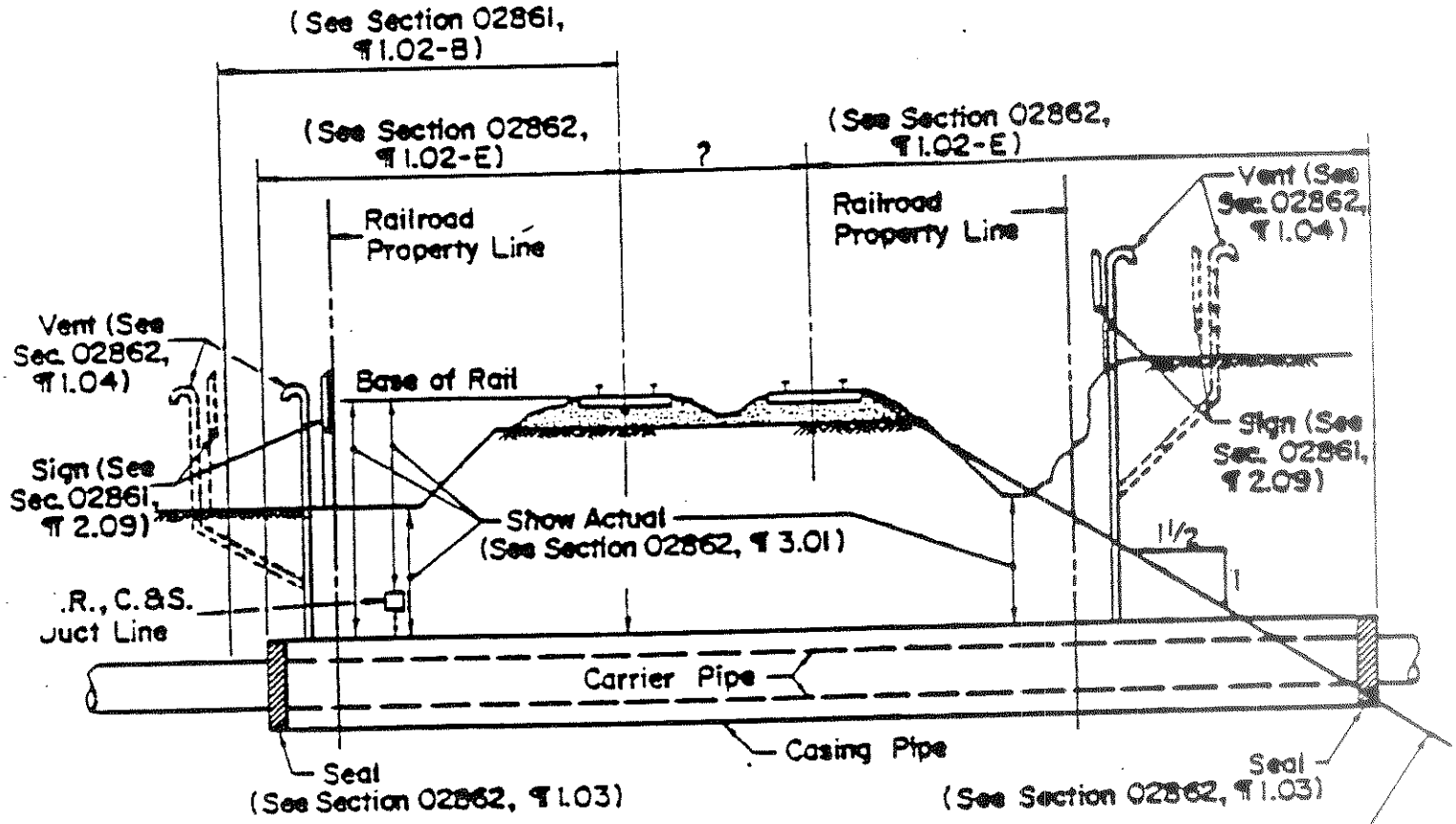
If Manholes are Placed on Railroad Property, Details of same, with Clearances to near Rails are to be shown on the Drawings.

If the Proposed Pipe is to serve a new Development, a Map showing the Area in Relation to Established Areas and Roads is to be sent with the Request.

If the Proposed Pipe is not wholly within Highway Limits, the same Information is Requirs shown on this Plate.

PLATE II

1604



SECTION

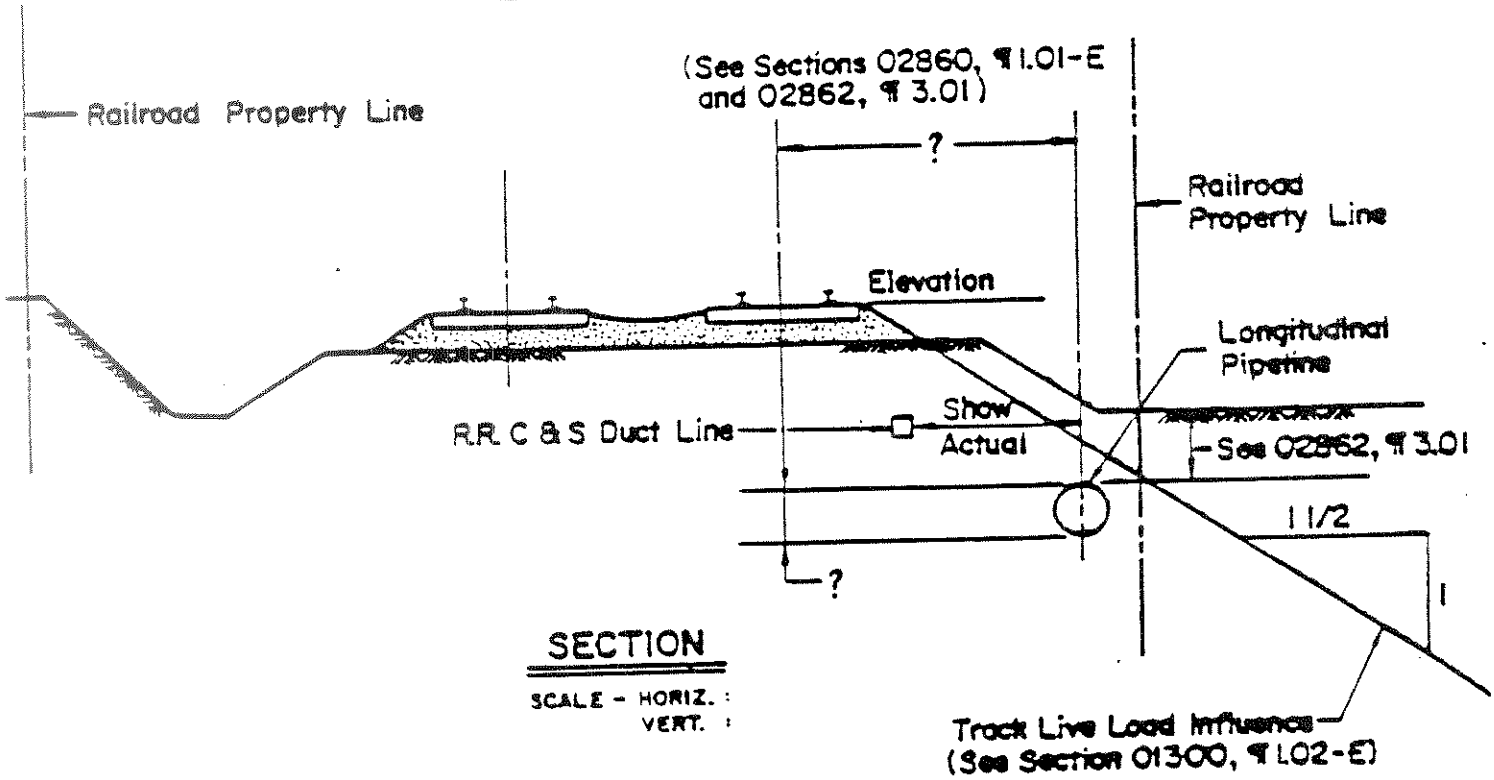
SCALE :

INFORMATION TO BE SHOWN ON PROFILE SECTION OF DRAWING

PLATE II

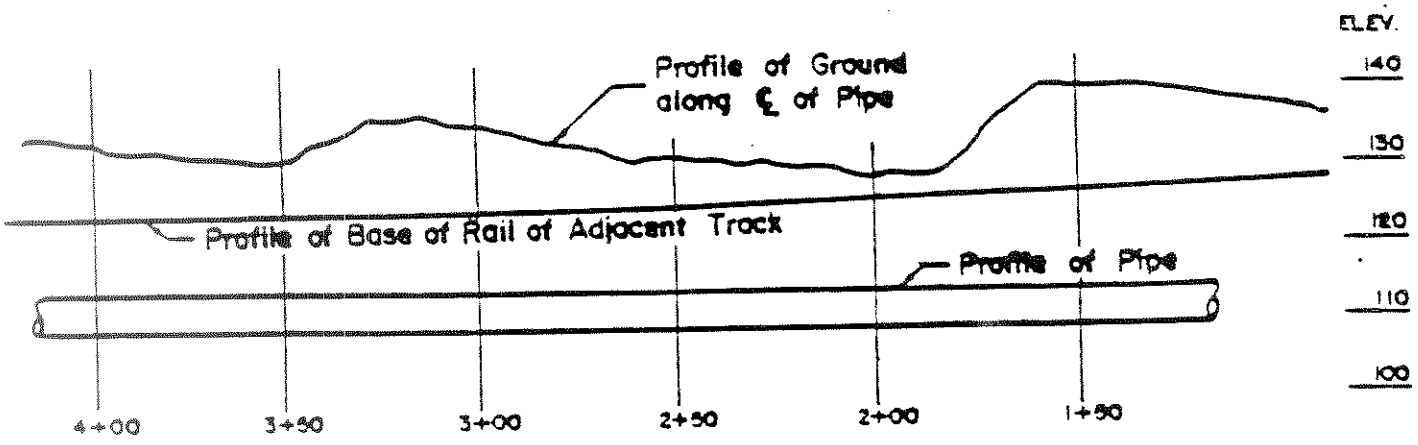
1604

LONGITUDINAL OCCUPANCY



SECTION

SCALE - HORIZ. :
VERT. :



STATIONING

PROFILE - (See Section 01300, ¶ 1.02-B-3)

SCALE - HORIZ. :
VERT. :

PLATE IV

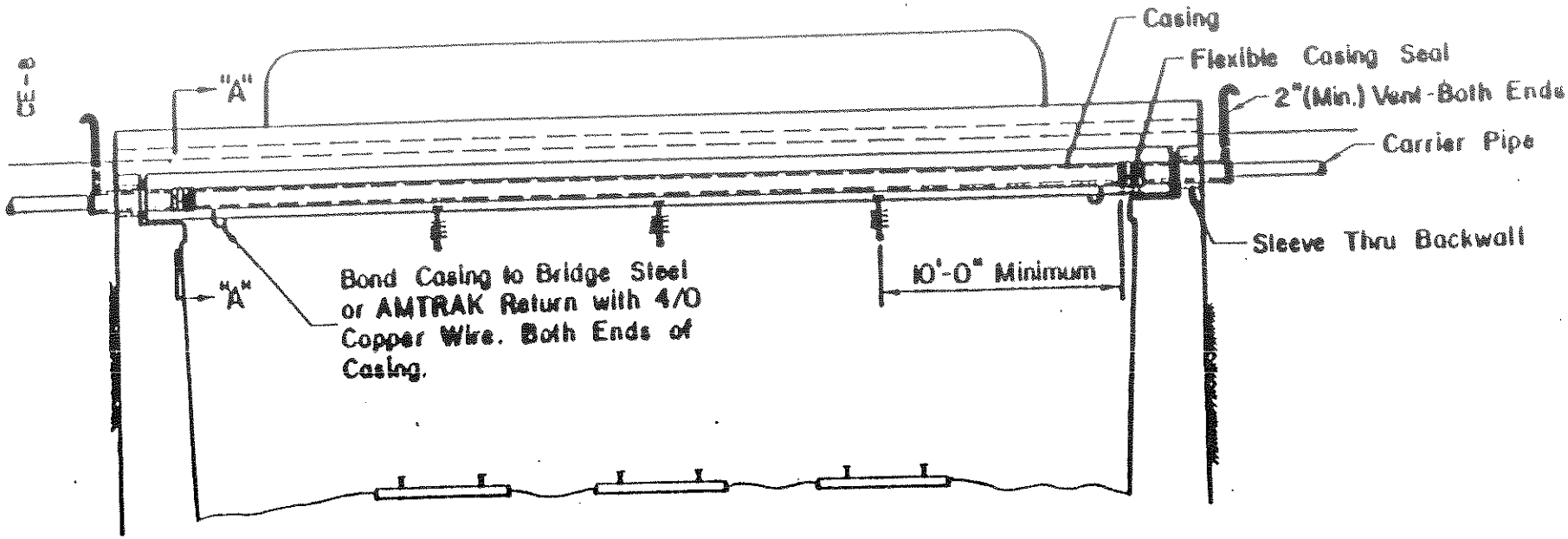
1504

PIPE CROSSING - DATA SHEET

In addition to plan and profile of crossing, drawings submitted for Railroad's approval shall contain the following information:

	Pipe Data	
	Carrier Pipe	Casing Pipe
Contents To Be Handled		
Normal Operating Pressure		
Normal Size of Pipe		
O.S. Diameter		
I.S. Diameter		
Wall Thickness		
Weight Per Foot		
Material		
Process of Manufacture		
Specification		
Grade or Class		
Test Pressure		
Type of Joint		
Type of Coating		
Details of Cathodic Protection		
Details of Seal or Protection at Ends of Casing		
Method of Installation		
Character of Subsurface Material At the Crossing Location		
Approximate Ground Water Level		
Source of Information on Subsurface Conditions (Borings, Test Pits or Other)		

NOTE: Any soil investigation made on railroad property or adjacent to tracks be carried on under the supervision of Railroad Company's Chief Engineer.

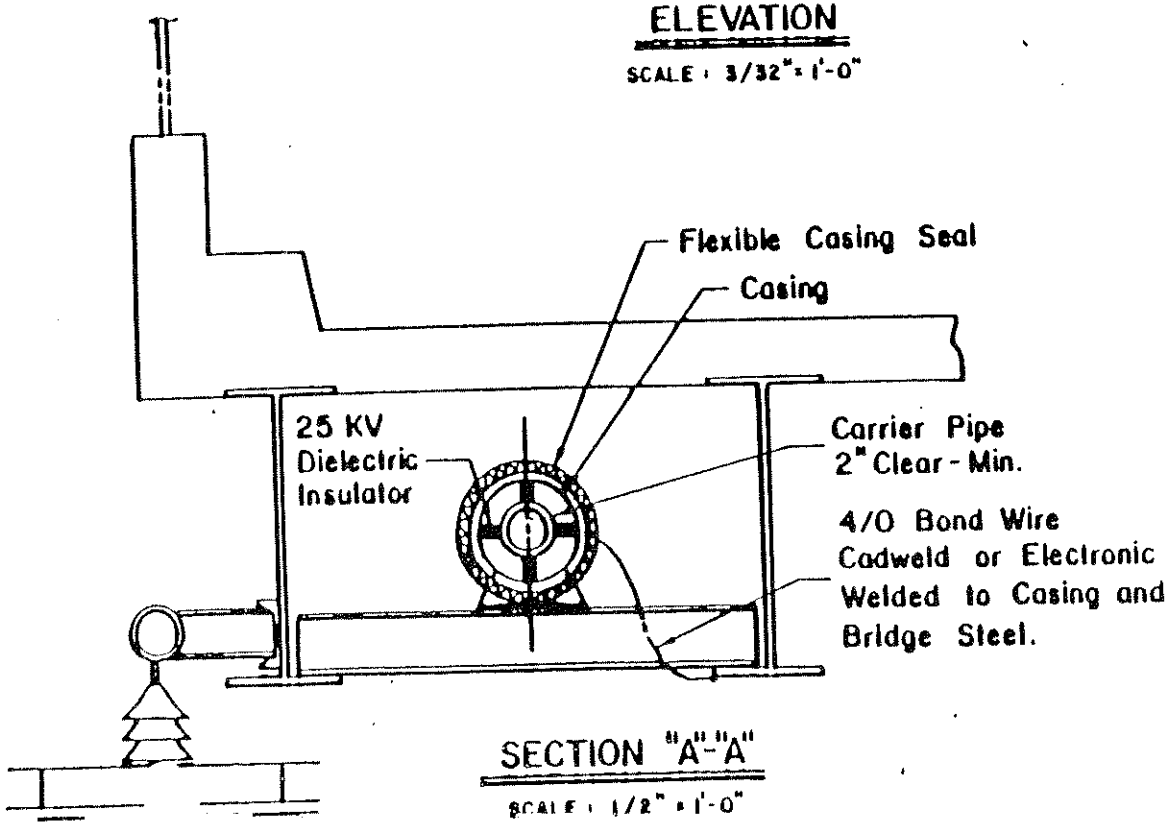


ELEVATION

SCALE : 3/32" = 1'-0"

NOTE:

Pritec (TM), or Approved Equal, may be used in Lieu of 25 KV Dielectric Suspension Type Insulator. (See Plates VI & VII)



SECTION "A"-"A"

SCALE : 1/2" = 1'-0"

PLATE V

SPECIFICATIONS FOR BONDING AN GROUNDING OF PIPELINES IN ELECTRIFIED TERRITORY

PLATE VI

1 of 2
1504

H. C. PRICE CO.
PIPE COATING SPECIFICATION FOR USE ON AMTRAK RAILROAD BRIDGES

REVISED
October 23, 19[illegible]

1.0 Scope
This specification covers material requirements, and application procedures for the application of an extruded butyl and an extruded polyethylene pipe coating for protection against external corrosion while possessing high electrical strength to withstand electrical stress if it comes in contact with rail power lines.

2.0 Material Selection
Butyl rubber adhesive material shall be approved by Midwest Research Institute, Kansas City, Missouri.
Polyethylene shall be high molecular weight resin such as Phillips TR 418B or equal, possessing tough, impact-resistant and resistant to environmental stress cracking properties.

3.0 Preparation of Surfaces
3.1 Pipe should be ordered bare, free of mill preservatives.

3.2 The exterior of the pipe shall be free of all mill scale, rust, rust preventatives, or other foreign matter. This shall be accomplished by thoroughly blasting the pipe's surface with a sand, grit, or shot to a NACE No. 3 Commercial blast cleaned surface finish. "A NACE No. 3 is a surface from which all oil, grease, dirt, rust scale, and foreign matter have been completely removed and all rust, mill scale, and oil paint have been removed [illegible]xcept for slight shadows, streaks, or discolorations caused by rust stain or [illegible]ill scale oxide binder. At least two-thirds of the surface area shall be [illegible]ree of all visible residues and the remainder shall be limited to light discoloration, slight staining, or light residues mentioned above. If the surface is pitted, slight residues of rust or paint are found in the bottom of pits. "1

4.0 Coating
A 20 mil thickness of hot butyl rubber adhesive shall be extruded spirally around the pipe in two layers. Immediately after the adhesive, a 60 mil thickness of virgin black polyethylene shall be extruded spirally around the pipe in three layers producing a bonded coating with a thickness of 80 mils (nominal thickness less 10% tolerance).

5.0 Testing
5.1 Pipe coating shall be 100% inspected for pinholes and holidays immediately after application with holiday detector adjusted to provide sufficient voltage to produce a spark through a pinhole in the coating (20 KV ac).

5.2 Repairs to small holidays may be made by using Servi-Wrap P-500 Pipe Wrap material approved for this purpose. Repairs will be reinspected with a holiday detector.

5.3 Defective external coating shall be recoated to meet all requirements of this specification, at the expense of the applicator.

[illegible]ACE T-10 D-8 Proposed NACE Standard Recommend Practice for "Application of [illegible]rganic Coatings to the External Surface of Steel Pipe for Underground Service".

SUGGESTED PROCEDURES TO HAND WRAP FIELD JOINTS AND FITTINGS FOR PRITEC (R) PIPE COATING USING SERVI-WRAP P-500 PIPE WRAP OR EQUIVALENT TO PROVIDE A DIELECTRIC OF 25,000 VOLTS MINIMUM.

1. SURFACE PREPARATION: Surface must be clean and dry. Wire brush to remove any loose rust and scale, dust or dirt. Oil and grease are to be removed with a suitable safety approved solvent such as trichlorethylene.

2. PRIMING: A compatible primer such as Servi-Wrap primer should be applied at a rate of approximately 400 Sq. Ft. per gallon. Prime the entire surface to be wrapped beginning 4" to 6" back from the mill applied PRITEC (R) coating. Let primer dry before applying Servi-Wrap.

3. TAPE APPLICATION: Servi-Wrap is applied by removing release paper and spirally wrapping under tension with a 55% overlap. On fittings or uphill sections of pipeline, start at the bottom or lower section and work up. First apply a wrap over the weld seam for extra protection. On the initial turn, double wrap while maintaining tension. On the final lap, a double wrap should be applied but the second lap should be without tension and the tape ends should be pressed into position.

4. INSPECTION: Tape should be applied in a smooth workmanlike manner and no wrinkles are permitted. Pipe coating shall be 100% inspected for pinholes and holidays with an approved holiday detector adjusted to provide sufficient voltage to produce a spark through a pinhole in the coating (approximately 15 KV ac.).

PLATE VII

1 of 2

1604

GRACE

Construction Products Division

SERVI-WRAP® P-500

COLD APPLIED, SELF ADHESIVE, ANTI-CORROSION PIPE WRAP

EXCEPTIONAL ADHESION
DUAL SEAL OF PROTECTION
FAST AND SIMPLE TO APPLY

DESCRIPTION

SERVI-WRAP P-500 is a tough, pliable, waterproof pipe wrap. It provides a dual seal of a "cross laminate," high density polyethylene film combined with a thick, factory-controlled layer of adhesive-consistency, bituminous rubber compound. SERVI-WRAP P-500 is supplied in rolls interwound with a special release paper which protects the adhesive surface until ready for use.

ROLL SIZE

Length - 30 l. f. or to order
Width - 2", 4", 6", 9" or to order up to 36"

TYPICAL PHYSICAL PROPERTIES

Property	Value	Test Method
Color	Dark Grey-Black	
Thickness	Compound 40 Mils	
	Film 8 Mils	
	Total 48 Mils	
Tensile Strength	5800 psi	ASTM D-882-56T
Elongation at Break	293%	ASTM D-882-56T
Impact Resistance (1)		
Single Layer	19 Kg. Cm.	ASTM G-14
Double Layer	71	
Puncture Resistance (2)	118 lbs.	ASTM E-154
Adhesion to Steel - Initial	6 lbs./in.	DIN30670 Modified
30 Min.	8 lbs./in.	
Adhesion to Self - Initital	3 lbs./in.	
30 Min.	4 lbs./in.	
Permeance - Perms (3)	0.05 Max.	ASTM E-96 Method B
Pliability (4)	Pass	ASTM C-711
Exposure to Fungi		
In Soil - 16 Weeks	Unaffected	
Alkali & Acid Resistance	Excellent	
Dielectric Breakdown	17,900 Volts	ASTM D-149
Resistance to Cathodic Disbondment	Excellent	ASTM G-8
Conformability	Very Good	
Operating Temperature Range	-25°F. to 150°F.	
Application Temperature Range	40°F. to 120°F.	

Notes: (1) Film Break
(2) Stretched by Blunt Object
(3) Grains/Sq. Ft./Hr./In. Hg
(4) 180° Bend Over 1/4" Mandrel @ -35°F.

APPLICATION INSTRUCTIONS

1. The pipe surface should be completely free of rust, scale, weld spatter, grease, dirt, dust and oil. It must be completely dry at time of application.

2. The dry pipe surface should be primed with one coat of quick drying SERVI-WRAP PRIMER. The Primer should be completely dry at the time of application of the SERVI-WRAP P-500. No primer is needed when wrapping pipe insulation.

3. Peel back the release paper from the first 9 inches of SERVI-WRAP P-500 and begin wrapping (adhesive side of wrap to pipe surface). Remove the release paper as the SERVI-WRAP P-500 is applied.

4. Pull the wrap tightly to ensure a snug fit to the surface being covered.

5. Overlap successive winds at least 1 inch, or more as specified, maintaining tight, continuous contact with both pipe, and the overlapped membrane. The end lap should be a minimum of 6".

SERVI-WRAP PRIMER

A quick drying (2 to 5 minutes) brush applied primer which is usually required prior to application of all grades of SERVI-WRAP.

Package:	1 - Gal. and 5 - Gal. Cans
Coverage:	300 Sq. Ft. per Gallon

SERVI-WRAP MOLDING PUTTY

Cold applied plastic putty designed for hand molding around bolted flanges, certain types of valves, etc. to provide a suitable profile for wrapping.

Color:	Black
Package:	50-lb. Packs
Filling Capacity:	18.5 Cu. In. per Lb.

CONSTRUCTION PRODUCTS DIVISION, W. R. GRACE & CO.
P. O. BOX 2585, HOUSTON, TEXAS 77001 713/223-8353

June 6, 1977

Pipeline Products

INSURANCE REQUIREMENTS

NATIONAL RAILROAD PASSENGER CORPORATION

(AMTRAK)

Revised as of April 1987

DEFINITIONS: Whenever in these Special Provisions or in the plans or contract documents the words "Company", "Railroad", or "Amtrak" are used, the same shall mean National Railroad Passenger Corporation.

INSURANCE: The contractor shall procure and maintain, at his own cost and expense, during the entire period of performance of the Project, the types of insurance specified below. The contractor shall submit a certificate of insurance giving evidence of the required coverages, prior to commencing work. All insurance shall be procured from insurers authorized to do business in the jurisdiction where operations are to be performed. The contractor shall require all subcontractors to carry the insurance required herein, and contractor may, at his option, provide the coverage for any or all subcontractors, and if so, the evidence of insurance submitted shall so stipulate. In no event shall work be performed until the required certificate(s) of insurance have been furnished. If the insurance provided is not in compliance with the requirements listed below, Amtrak maintains the right to stop work until proper evidence is provided. The insurance shall provide for 30 days prior written notice to be given to Amtrak in the event coverage is substantially changed, cancelled or non-renewed.

A. WORKERS' COMPENSATION INSURANCE: A policy complying with the requirements of the statutes of the jurisdiction(s) in which work will be performed, covering all employees of the contractor. Employer's Liability coverage with limits of liability of not less than $500,000 each accident or illness shall be included.

B. GENERAL LIABILITY INSURANCE: A policy issued to and covering liability imposed upon the contractor with respect to a all work to be performed and all obligations assumed by the contractor, under the terms of this permit. Products-completed operations, independent contractors, and contractual liability coverages are to be included, and all railroad exclusions are to be deleted.

Amtrak is to be named as an additional insured with respect to operations to be performed and the policy shall contain a waiver of subrogation against Amtrak, its employees or agents. Coverage under this policy, or policies, shall have limits of liability of not less than $2 million per occurrence, combined single limit for bodily injury, (including disease or death), personal injury and property damage (including loss of use) liability.

C. AUTOMOBILE LIABILITY INSURANCE: A policy issued to and covering the liability of the contractor arising out of the use of all owned, non-owned, hired, rented or leased vehicles which bear, or are required to bear, license plates according to the laws of the jurisdiction in which they are to operated, and which are not covered under the contractor's General Liability Insurance. The policy shall name Amtrak as an additional insured with respect to operations to be performed in connection with this permit, and shall contain a waiver of subrogation against Amtrak, its employees or agents. Coverage under this policy shall have limits of liability of not less than $1 million per occurrence, combined single limit, for bodily injury, and property damage liability.

D. RAILROAD PROTECTIVE LIABILITY INSURANCE: The Contractor shall provide, with respect to the operations he or any of his subcontractors perform within 50 feet vertically or horizontally of railroad's tracks, Railroad Protective Liability Insurance, AAR-AASHTO (ISO/RIMA) Form, in the name of National Railroad Passenger Corporation. The policy shall have limits of liability of not less than $2 million per occurrence, combined single limit, for Coverages A and B, for losses arising out of injury to or death of all persons, and for physical loss or damage to or destruction of property, including the loss of use thereof. A $6,000,000 annual aggregate may apply.

If coverage is provided on the London claims-made form, the following provisions shall apply:

1. The limits of liability shall be not less than $3 million per occurrence, combined single limit. A $9 million annual aggregate may apply.

2. Declarations Item 6, Extended Claims Made Date, shall allow an Extended Claims Made Period no shorter than the length of the original policy period plus one year.

3. If equivalent, or better, wording is not contained in the policy form, the following endorsement must be included:

It is agreed that "Physical Damage to Property" means direct and accidental loss of or damage to rolling stock and their contents, mechanical construction equipment or motive power equipment, railroad tracks, roadbed, catenaries, signals, bridges or buildings.

E. CLAIMS-MADE INSURANCE: If any insurance specified above shall be provided on a claims-made basis, then in addition to coverage requirements above, such policy shall provide that:

1. Policy retroactive date coincides with or precedes the contractor's start of work (including subsequent policies purchased as renewals or replacements).

2. Contractor will make every effort to maintain similar insurance for at least two years following project completion, including the requirement of adding Amtrak as an additional insured.

3. If insurance is terminated for any reason, contractor agrees to purchase an extended reporting provision of at least two years to report claims arising from work performed in connection with this permit.

4. Policy allows for reporting of circumstances or incidents that might give rise to future claims.

All insurance specified above shall remain in force until all work to be performed is satisfactorily completed, all contractor personnel and equipment have been removed from railroad property, and the work has been formally accepted. Failure to carry or keep such insurance in force as stipulated shall constitute a violation of the project contract.

The Contractor shall furnish to Amtrak the original of the policy for Railroad Protective Liability Insurance and a Certificate of Insurance for all other coverages fifteen days prior to commencing work. The fifteen-day advance notice of coverage may be waived in situations where such waiver will benefit Amtrak, but under no circumstances should the Contractor actually begin work without providing evidence of insurance. Such evidence of insurance shall be sent to Mr. R. D. Johnson, Assistant Chief Engineer-Design and Construction, 2000 Market Street, Philadelphia, Pennsylvania 19103. Work may not proceed on Amtrak property until all insurance requirements have been met to the satisfaction of Amtrak Assistant Chief Engineer-Design and Construction or his duly authorized representative.

For the following types of activities: core borings, field surveys and appraisals, routine bridge inspections, minor maintenance and repair of bridges, bridge painting, erection or removal of billboard signs, replacement or removal of billboard advertisement, installation or removal of pipe and wire, and minor station maintenance, repair or construction, the permittee may request that Amtrak waive the requirement to provide the Railroad Protective Liability Insurance specified in paragraph D above.

As a condition of the waiver of the obligation to provide the above Railroad Protective Liability Insurance, the Permittee agrees to pay Amtrak _____ dollars ( ). This fee is in addition to the consideration paid for the preparation of this permit.