# A Study to Explore the Relationship between Costs and Rates Associated with the Provision of Digital Data Transmission Services in Canada.

*APPENDICES*



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# APPENDIX A

## DATA TRANSMISSION RATE STRUCTURES

## BY SERVICE

There are three basic components to the rate structure of every data telecommunications service – installation charges, station equipment rentals and transmission charges. Numerous options also are available, varying with the particular service, but these have not been considered in the study.

The following tables provide a summary presentation of the rates for each service in terms of the three major components of the rate structure. Where a range of rates is possible, minimum and maximum rates are shown. The services are grouped for presentation as discussed in Section III of the report.

## SWITCHED LOW SPEED SERVICES

### TELEX AND DATA TELEX

**Installation Charges:** $25-$75

**Station Rentals:** $40-$391

**Transmission Charges:**

| Mileage Intervals * | Time Period | Rate |
|---|---|---|
| 0- 25 | 15 seconds | $.025 |
| 25- 75 | 10 | .025 |
| 75- 150 | 7.5 | .025 |
| 150- 225 | 6 | .025 |
| 225- 300 | 5 | .025 |
| 300- 500 | 4 | .025 |
| 500- 800 | 3.33 | .025 |
| 800-1100 | 2.86 | .025 |
| 1100-1400 | 2.5 | .025 |
| 1400-2000 | 2 | |
| 2000 + | 1.67 | |

* Rates are actually set for 23 defined areas. Mileages are approximate only.

### TWX

**Installation Charges:** $30

**Station Rentals:** $35-$124

| Telephone Area | Rate for 6 Seconds * |
|---|---|
| 709 to 709 | $.025 |
| 902 | .0375 |
| 506 | .04 |
| 418 | .045 |
| 514 | .05 |
| 819 | .05 |
| 613 | .055 |
| 416 | .06 |
| 705 | .06 |
| 519 | .065 |
| 807 | .075 |
| 204 | .08 |
| 306 | .09 |
| 403 | .105 |
| 604 | .12 |

* Typical rates from St. John's, Newfoundland to various Areas in Canada.

### DATACOM

**Installation Charges:** $30

**Station Rentals:** $46-$148

| Typical Mileages | Rates per Minute * |
|---|---|
| (local) 5 | $ - |
| 10 | .05 |
| 200 | .40 |
| 400 | .55 |
| 600 | .60 |
| 800 | .65 |
| 1000 | .75 |
| 1200 | .80 |
| 1400 | .80 |
| 1600 | .85 |
| 1800 | .90 |
| 2000 | .95 |
| 2500 | 1.00 |
| 3000 | 1.00 |

* Based on TCTS long distance rates

### DATAPHONE

**Installation Charges:** $37

**Station Rentals:** $27.05 - $51.05

**Transmission Charges:** Transmission charges are identical to those for DATACOM

## SWITCHED MEDIUM SPEED SERVICES

### BROADBAND

| | |
|---|---|
| Installation Charges | $ 70 - $180 |
| Station Rentals | $140 - $370 |
| Transmission Charges | |

| Mileage* Intervals | Rates per** Minute |
|---|---|
| 0 - 350 | $.10 |
| 350 - 700 | .15 |
| 700 - 1050 | .20 |
| 1050 - 1400 | .30 |
| 1400 - 1750 | .40 |
| 1750 - 2100 | .50 |
| 2100 - 2500 | .60 |
| 2500 + | .70 |

*Rates are actually set for 23 defined areas. Mileages are approximate only.

**These rates apply for 1800, 2000 and 2400 bps.
Telex rates apply for 4800 bps.

### MULTICOM

MEDIUM SPEED

| | |
|---|---|
| $ 43 - $60 | |
| $111 - $237 | |

RATE FOR 6 SECONDS

| Mileage Intervals | ≤2400 bps | >2400 bps |
|---|---|---|
| 0 - 200 | $.01 | $.015 |
| 200 - 425 | .01 | .025 |
| 425 - 650 | .015 | .035 |
| 650 - 1000 | .02 | .045 |
| 1000 - 1400 | .03 | .055 |
| 1400 - 1800 | .04 | .065 |
| 1800 - 2200 | .05 | .075 |
| 2200 + | .06 | .085 |

*Multicom is the only switched high speed service

### DATAPHONE

$30 - $50

$32.35 - $136

| Typical Mileages | Rates per Minute* |
|---|---|
| (local) 5 | $ - |
| 10 | .05 |
| 200 | .40 |
| 400 | .55 |
| 600 | .60 |
| 800 | .65 |
| 1000 | .75 |
| 1200 | .80 |
| 1400 | .80 |
| 1600 | .85 |
| 1800 | .90 |
| 2000 | .95 |
| 2500 | 1.00 |
| 3000 | 1.00 |

*Based on TCTS long distance rates. Transmission charges are identical to those for DATACOM

### DATASPEED

$75 - $300

$91.30 - $379

Transmission charges are identical to those for DATACOM and DATAPHONE

## SWITCHED HIGH SPEED SERVICES

| | MULTICOM HIGH SPEED | |
|---|---|---|
| Installation Charges | $258 - $275 | |
| Station Rentals | $625 - $640 | $575 - $590 |

Transmission Charges

RATE FOR 6 SECONDS

| Half Group | Full Group |
|---|---|
| $.175 | $.35 |
| .225 | .45 |
| .275 | .55 |
| .325 | .65 |
| .375 | .75 |
| .40 | .80 |
| .40 | .80 |
| .40 | .80 |

## PRIVATE LOW SPEED SERVICE

| | TELEX COMPUTER INQUIRY SERVICE | DATALINE II | SCHEDULE 1 |
|---|---|---|---|
| Installation Charges | $25 - $ 50 | $74 - $150 | $20 - $ 180 |
| Station Rentals | $40 - $250 | $50 - $150 | $40 - $1139 |
| Transmission Charges | | | |

$300 per Port
Rates per Station*

| Mileage Intervals | 1 - 10 Stations | 11+ Stations |
|---|---|---|
| 0 - 50 | $ 40 | $ 15 |
| 51 - 125 | 50 | 20 |
| 126 - 225 | 75 | 30 |
| 226 - 350 | 100 | 40 |
| 351 - 550 | 135 | 50 |
| 551 - 750 | 185 | 75 |
| 751 - 950 | 235 | 95 |
| 951 - 1150 | 285 | 115 |
| 1151 - 1350 | 335 | 135 |
| 1351 - 1550 | 385 | 155 |
| 1551 - 1950 | 460 | 185 |
| 1951 - 2350 | 535 | 215 |
| 2351 + | 635 | 255 |

*Local service is a flat $15 per month per station

$300 per Access Line
Rates per Station

| Mileage Intervals | 1 - 10 Stations | 11+ Stations |
|---|---|---|
| 0 - 50 | $ 40 | $ 15 |
| 51 - 125 | 50 | 20 |
| 126 - 225 | 75 | 30 |
| 226 - 350 | 100 | 40 |
| 351 - 550 | 135 | 50 |
| 551 - 750 | 185 | 75 |
| 751 - 950 | 235 | 95 |
| 951 - 1150 | 285 | 115 |
| 1151 - 1350 | 335 | 135 |
| 1351 - 1550 | 385 | 155 |
| 1551 - 1950 | 460 | 185 |
| 1951 - 2350 | 535 | 215 |
| 2351 + | 635 | 255 |

Local
$1.50 per Channel

two points

- different property $.75/$\frac{1}{4}$ mile
- same property
  - two buildings $.60/channel
  - same building 0
- Morse different property $21/channel

Duplex requires two channels and is charged full rates for both

Inter-City
$5.00 per circuit

| Hours/Day \ Days/Week | Charges per Mile 5 | 6 | 7 |
|---|---|---|---|
| <4 | $ .69 | $ .83 | $ .88 |
| 4 - 8 | 1.10 | 1.32 | 1.40 |
| 8 - 12 | 1.32 | 1.58 | 1.68 |
| >12 | 1.47 | 1.76 | 1.87 |

Duplex surcharge of 25%

| Overtime | Per Circuit Per Mile |
|---|---|
| Extra day <4 hrs | $.0135 |
| 8 | .01 |
| 8 - 12 | .0075 |
| >12 | .0050 |

Extra hour

- continuous with regular service $.01
- not continuous $.02

Switching: $2.50 - $9.00 per month

PRIVATE LOW SPEED SERVICE (Continued)

| | SCHEDULE 2 | SCHEDULE 3 |
|---|---|---|
| Installation Charges | $20 - $ 180 | $20 - $ 180 |
| Station Rentals | $40 - $1139 | $40 - $1139 |

**Transmission Charges**

**SCHEDULE 2**

Local
$1.67 per channel

two points:

- different property $.83/$\frac{1}{4}$ mile
- same property
  - two buildings $.60/channel
  - same building ~~0~~
- Morse different property $21/channel

Duplex requires two channels and is charged full rates for both

Inter-City
$5.50 per circuit

| Hours/Day \ Days/Week | Charges per Mile 5 | 6 | 7 |
|---|---|---|---|
| ≤4 | $ .76 | $ .91 | $ .96 |
| 4 - 8 | 1.21 | 1.45 | 1.54 |
| 8 - 12 | 1.45 | 1.73 | 1.85 |
| >12 | 1.62 | 1.95 | 2.06 |

Duplex surcharge of 25%

Other charges identical to Schedule 1

**SCHEDULE 3**

Local
$1.88 per channel

two points:

- different property $.94/$\frac{1}{4}$ mile
- same property
  - two building $.60/channel
  - same building ~~0~~
- Morse different property $21/channel

Duplex requires 2 channels

Other charges identical to Schedule 1

Inter-City
$6.25 per circuit

| Hours/Day \ Days/Week | Charge per Mile 5 | 6 | 7 |
|---|---|---|---|
| ≤4 | $ .86 | $1.04 | $1.32 |
| 4 - 8 | 1.38 | 1.65 | 1.75 |
| 8 - 12 | 1.65 | 1.98 | 2.10 |
| >12 | 1.84 | 2.20 | 2.34 |

## PRIVATE LOW SPEED SERVICE (Continued)

### SCHEDULE 3A

| | |
|---|---|
| Installation Charges | $20 - $ 180 |
| Station Rentals | $40 - $1139 |
| Transmission Charges | |

Local
$10 per channel

Duplex add 25%

Inter-City

| Hours/Day \ Days/Week | Charges per Mile 5 | 7 |
|---|---|---|
| 8 | $1.75 | $2.00 |
| 24 | 2.25 | 2.50 |

Duplex surcharge of 25%

Other charges identical to Schedule 1

## CHANNEL DERIVING ARRANGEMENTS

### COMPUTER ACCESS

~~0~~

~~0~~

- $60 per channel
- Rates same as Schedule 4
- Surcharge of 25% for quantities in excess of 8 channels

### TELEPRINTER

$25 - $ 50

$40 - $250

- $25 per service point for 82.5 to 180 bps
- Rates same as Schedule 4
- Plus up to 180 bps

| | Non-Simultaneous | Simultaneous |
|---|---|---|
| - first channel | $45 | $55 |
| - each additional channel | 10 | 15 |

- Additional duplex charges
  - up to 82.5 bps 1/32 of mileage charge
  - 82.5 to 180 bps 1/16 of mileage charge

## PRIVATE MEDIUM SPEED SERVICE

### DATALINE III

| | |
|---|---|
| Installation Charges | $ 60 - $180 |
| Station Rentals | $250 - $450 |
| Transmission Charges | $450 per access line |

| Mileage Intervals | Rate per Station |
|---|---|
| 0 - 50 | $ 50 |
| 51 - 125 | 100 |
| 126 - 225 | 150 |
| 226 - 350 | 200 |
| 351 - 550 | 275 |
| 551 - 750 | 350 |
| 751 - 950 | 425 |
| 951 - 1150 | 500 |
| 1151 - 1300 | 575 |
| 1351 1550 | 650 |
| 1551 - 1950 | 725 |
| 1951 - 2350 | 800 |
| 2351 + | 900 |

### SCHEDULE 4

$50 - $ 620

$87.50 - $1746

Local

first $\frac{1}{4}$ mile $3
additional $\frac{1}{4}$ miles $1

Duplex:
first $\frac{1}{4}$ mile $3
additional $\frac{1}{4}$ miles $2

Inter-City

| Representative* Mileages | Monthly Charge per Channel |
|---|---|
| 10 | $ 44.30 |
| 200 | 678 |
| 350 | 1084 |
| 700 | 1920 |
| 1000 | 2368 |
| 1400 | 2674 |
| 1700 | 2800 |
| 2000 | 2908 |
| 2400 | 2976 |
| 2700 | 3044 |
| 3000 | 3112 |
| 3400 | 3146 |

Duplex surcharge of 25%

*There are actually 123 individual charges associated with mileage intervals. See full schedule in tariff books.

### SCHEDULE 4A

$50 - $685

$87.50 - $1798

Rates same as for Schedule 4

PRIVATE MEDIUM SPEED SERVICE (Continued)

| | SCHEDULE 4B | SCHEDULE 4C |
|---|---|---|
| Installation Charges | $50 - $ 775 | $50 - $ 775+ |
| Station Rentals | $87.50 - $2191 | $87.50 - $2191+ |
| Transmission Charges | Local: first $\frac{1}{4}$ mile $3, additional $\frac{1}{4}$ miles $2<br>Duplex: first $\frac{1}{4}$ mile $3, additional $\frac{1}{4}$ miles $4<br>Inter-City: Rates same as for Schedule 4 | Rates same as for Schedule 4B |

May be custom built

## PRIVATE HIGH SPEED SERVICES

| | TELPAK A | | TELPAK B | TELPAK C |
|---|---|---|---|---|
| | Simplex | Duplex | | |
| Installation Charges* | $45 - $105 | $55 - $115 | Same as for Telpak A | Same as for Telpak A |
| Station Rentals* | $10 - $ 35 | $15 - $ 40 | Same as for Telpak A | Same as for Telpak A |
| Transmission Charges | Flat rate $25 per mile | | Flat rate $40 per mile | Flat rate $55 per mile |
| | Additional duplex charges: | | Additional duplex charges: | Additional duplex charges: |
| | voice grade channel | $.50 per mile | voice grade channel - $.40 per mile | voice grade channel - $.25 per mile |
| | data channel 82.5 - 180 bps | $.14 per mile | data channel 82.5 - 180 bps - $.10 per mile | data channel 82.5 - 180 bps - $.06 per mile |
| | data channel to 82.5 bps | $.07 per mile | data channel to 82.5 bps - $.05 per mile | data channel to 82.5 bps - $.03 per mile |

*Rates are for each channel terminal

PRIVATE HIGH SPEED SERVICES (Continued)

## TELPAK S

| | |
|---|---|
| Installation Charges* | Same as for Telpak A |
| Station Rentals* | Same as for Telpak A |
| Transmission Charges | Flat rate $70 per mile |

Additional duplex charges:

| | |
|---|---|
| voice grade channel | - $.15 per mile |
| data channel 82.5 - 180 bps | - $.04 per mile |
| data channel to 82.5 bps | - $.02 per mile |

*Rates are for each channel terminal

# APPENDIX B

# DETAILED ANALYSIS

# OF

# DATA TRANSMISSION RATE STRUCTURES

## A. INTRODUCTION

Section IV of the Report includes a summary and major conclusions for each of the fourteen services. This Appendix contains the detailed analysis of the rate structure for each service supported by relevant tables and graphs. The assumptions made and factors considered in the following analysis have been discussed in the introduction to Section IV.

The data appearing in the following tables represents typical user situations, within the assumptions already expressed. All the graphs are semi-logarithmic showing rate of change as well as absolute charges.

## B. SWITCHED LOW SPEED SERVICES

### 1. Telex and Data Telex

The rates for these two services are identical and are established on the basis of mileage intervals. For this analysis, a representative mileage was set for each interval. The only price-related difference between Telex and Data Telex reflects differences in speed - 50 bps vs. 180 bps, respectively. The effect of this difference will be analyzed later.

Total charges for these services for one month can vary from $46 for a short distance and minimum utilization to almost $10,000 for long distances and high utilization. At low utilization, charges increase very gradually over distance but this rate of increase is greater at higher utilization. This effect is due to the influence of fixed station charges when usage is low.

As hours of usage increase for selected distance, total charges increase substantially. When utilization is high, this rate of increase is the same at all mileages while at low utilizations, charges climb less rapidly at shorter distances because of the greater influence of station rentals.

Monthly billings of Telex and Data Telex services include installation charges (in the first month only), station equipment rentals, and transmission charges. Installation charges at $25 to $75 have no appreciable effect on total monthly billings. Station charges are significant at low utilization but become less significant as utilization increases, particularly where average transmission distances also are greater. For very short distances, station equipment charges are significant only over short distances accompanied by low utilization.

The other component of total monthly billings is transmission charges. Under most circumstances transmission or usage charges would account for the largest proportion of the monthly service cost. This is particularly true as utilization and/or distance increase, in which case the more critical factor is time. An increase in the transmission distance causes an increase in overall charges to the user, but not to the same extent as does an increase in utilization. Therefore, from the point of view of a user, Telex and Data Telex rates change more rapidly due to changes in usage than due to differences in distance.

The basic measure of service charges is the charge per bit mile. This measure indicates to the user the true economy of his data transmission service. In addition, it allows him to estimate incremental costs. With Telex and Data Telex, this charge declines over the complete range of distances. This rate of decline is about the same for all levels of utilization because rates are set in terms of cents per second for each mileage band. Economies of scale can be realized only as distances grow, and not as hours of usage increase.

The difference in speed between Telex and Data Telex (50 bps vs. 180 bps, respectively) is reflected in the charge per bit mile. Since the rates for the two services are identical, the charge per bit mile is inversely proportional to the service speeds. Therefore, Data Telex with its greater speed and consequent higher capacity, is considerably cheaper for a given volume of data sent over a given distance.

See Tables 1 and 2 and Graphs 1 to 4.

## 2. TWX

The rates for this service are set on the basis of long distance telephone Areas across Canada. For this analysis, each Area was expressed in terms of representative airline mileage from St. John's, Newfoundland (Area 709) to one major urban centre in each other Area. For example, 1400 miles represents St. John's (709) to Ottawa (613) but this mileage could also represent Calgary (403) to Sault Ste. Marie (705), or any other similar distance. Since Areas do not reflect distance alone, it is not possible to define precisely what the mileage intervals should be. Therefore, the TWX rates were treated as continuous functions of distance. Total monthly TWX charges can vary from a minimum at low mileage and utilization of approximately $50 to a high of almost $13,000 at maximum mileage and utilization.

The total monthly charge is proportional to the average distance of transmission, regardless of utilization. At very low utilizations the effect of the flat rate for station equipment dominates the charges. At higher utilizations the transmission charges are dominant. In either case, usage has a very strong influence on total monthly charges. It is also significant that the rate of increase in total charges as usage increases is about the same at all mileages. Usage is a more influential factor in the calculation of monthly TWX charges than is distance.

Installation charges for TWX equipment, at $30, are inconsequential. Station equipment charges for TWX service vary from $35 to $124 per month. At very low utilizations these charges can represent a large proportion of total monthly billings. Their relative importance drops as utilization increases. Transmission charges increase gradually with distance, changing substantially only as a result of increase in utilization.

The basic measure of the service is the charge per bit mile. This charge drops considerably as mileage increases up to about 1000 miles and then levels off somewhat to the maximum mileage. At very low utilizations this levelling off effect is not so pronounced, with the result that savings continue. This implies that for transmissions under 1000 miles both distance and utilization have an effect on the economics of operation, whereas neither distance nor usage has much effect on the charge per bit mile over 1000 miles. Speed is not a factor in considering TWX, since only one speed (110 bps) is offered.

See Tables 3 and 4 and Graphs 5 to 7.

3. Datacom, Dataphone

These two services employ the telephone network for data transmission. Therefore, the transmission rates for these services are identical, being the local and long distance telephone rates. The relationships and trends for both services follow a common pattern, the only rate differentials being the installation charges and station rentals.

Long distance telephone rates vary depending on whether the transmission is entirely within the territory of one telephone company or is inter-company. For this analysis, all transmissions have been assumed to be inter-company. Long distance rates are broken down into a large number of rate categories based on mileage intervals. A number of representative average mileages have been chosen arbitrarily for this analysis.

Total monthly charges for these services can vary from under $100 to over $10,000 depending on mileage and utilization. At low utilization the fixed station equipment charge remains a significant proportion of total charges, keeping them relatively stable as distances increase. At higher utilization, however, charges increase more

sharply at low mileages and tend to level off after 400 miles. In general, the rate of increase of total charges climbs with mileage more quickly at high utilizations than at low. Similarly, as the hours of usage increase for a given transmission distance, total charges climb more quickly for longer distances than for shorter ones. While there is a direct relationship between total charges and distance, usage is the more influential factor in the determination of total charges.

Installation charges are inconsequential. Fixed monthly charges for station equipment plus a service charge in the case of Datacom and telephone exchange service charges are of somewhat greater importance. This fixed monthly charge can be significant at very low utilizations and particularly for local service where there is no transmission charge. Usage charges, the remainder of the monthly charge, are based on distance and time, with the latter the most influential component.

Charges per bit mile decline as distance increases, dropping more rapidly at low mileages and becoming almost linear in slope over 500 miles. The rate at which these charges decline is about the same at all levels of utilization. In terms of hours of usage and for selected mileages the charge per bit mile is almost constant in most cases at utilization rates above 32 hours per month. At very low usage the rates drop rapidly. Usage is therefore a more critical factor than distance in the total charge. Slight economies of scale occur with increasing distances but not with increasing utilization.

Since Datacom is a single speed service (110 bps), speed is not relevant in determining charges. Dataphone is available at both low and medium speeds. The transmission charges per bit mile decrease as higher speeds are employed. Apart from short distances and low utilizations where station rentals have a disproportionate effect, the charges per bit mile are very similar for these services when employed at the same speeds.

See Tables 5 to 8 and Graphs 8 to 15.

## C. SWITCHED, MEDIUM SPEED SERVICES

### 1. Broadband

Broadband and Datel are identical services, the latter being simply an extension of Broadband service to overseas subscribers via C.O.T.C. Broadband itself is available in four speeds, 1800 bps, 2000 bps, 2400 bps and 4800 bps. Not all combinations of speed, distance and time have been considered in this analysis. Representative combinations were chosen to illustrate ranges and trends. Because its rates differ from those of the other speeds, the 4800 bps service was considered separately.

Total monthly charges can vary from $146 to almost $10,000, depending on time and distance. In the case of Broadband, the crucial factors determining the charges for this service are time and distance. As distances increase total charges climb, but the rate of change differs depending on utilization. At very low utilization the rate of increase in total charges is quite small, mainly because of the influence of the constant station rental, whereas at higher utilizations the rate of increase is greater.

As the hours of usage increase, the total cost of the service at selected mileages climbs rapidly, but this rate of increase drops off at higher utilizations. At low utilization the charges increase at a higher rate for longer distances, although beyond 32 hours usage per month the differences are less significant.

Rates are identical for all speeds but 4800 bps. In the latter case, Telex rates are used and these are, in most instances, considerably higher than Broadband rates. Total charges for the 4800 bps service are higher than are those for the lower speed services. However, considerably more data can be handled and the charge per bit transmitted is much lower. Hours of usage (holding time) is the dominant rate determinant, although distance becomes more important at higher levels of usage. Speed is not taken into account in the rate structure, except at 4800 bps where the rates change to a different and higher base.

Installation charges vary from $70 to $180. This charge is only significant at low utilizations when the first month installation charges might equal or even exceed the total of station equipment charges and transmission charges. Over a number of months, however,

installation charges become insignificant. Station equipment rentals, on the other hand, can represent a significant portion of the total charges under certain circumstances. At low utilizations a large proportion of the total monthly charge can be attributed to station rentals. Even at high utilizations and low mileage, these charges can represent one-quarter to one-third of total monthly charges.

The charges per bit mile as distances increase drop rapidly at lower mileages, but level off for greater distances in the case of three lower speed services. For the 4800 bps service, however, the charges per bit mile keep declining as distances increase, although the rate of decline slows. As distances increase charges at very low utilization do not level off to the same extent as at higher utilization. With the exception of the 4800 bps service, the transmission rates for a given mileage are the same for all levels of usage. Therefore, any change in the charge per bit mile will reflect only the effect of station equipment rentals.

Because transmission charges are the same for all speeds except 4800 bps, the relationship between charges per bit mile and speed is inversely proportional. This relationship would be distorted somewhat by the need for more costly modems at higher speeds. Therefore, from a user's point of view, economies of scale cannot be realized by buying a higher speed service unless high speed or greater throughput are needed.

When comparing rates and speeds for 2400 bps and 4800 bps, the relationship is not proportional because the rate for the higher speed service is different. In fact, the charges per bit mile are similar for both, permitting a greater volume of data to be sent at the higher speed for the same total charge.

See Tables 9 to 13 and Graphs 16 to 18.

## 2. Multicom

This service is offered in both medium and high speed forms. The following analysis applies to both versions. A minimum of five speeds exist and four different rate schedules based on speed. In addition, rates vary depending on utilization and mileage. For this analysis representative speeds, utilization and mileages were chosen within the range of minimum and maximum speeds. Although one set of medium speed rate applies to speeds equal to or less than 2400 bps and another

set to speeds greater than 2400 bps, we have used 2400 bps with the lower rates and 4800 bps with the higher. Calculations at 40,800 bps have been omitted.

Total monthly charges for this service can vary from $117 to over $85,000. Total charges increase with mileage. However, the rate of increase depends on the station equipment rentals, the speed and utilization. At low utilization the rate of increase is quite low regardless of speed, primarily because of the effect of station equipment rentals. With increased hours of usage the charges relative to distance increase more rapidly. Total monthly charges also increase with utilization. The actual rate of increase is highest at low utilizations and high speeds. With usage greater than about 32 hours per month, the rate of increase is only slightly higher for higher speed services. Speed is an important factor in the consideration of Multicom rates because charges climb as speed increases, although not necessarily in direct proportion. The most important factor in determining total monthly charges is the level of utilization. The least important factor is distance, with speed the intermediate factor.

Station equipment for Multicom varies depending upon the speed of service. This variation is reflected in both installation charges and monthly station equipment charges. For both medium and high speed services, installation charges are insignificant. The charges for station equipment are a substantial proportion of total charges at low utilization in the case of both medium and high speeds. As usage increases, particularly if it is accompanied by greater transmission distances, station equipment rentals drop to a small percentage of the total charge.

With increasing mileages charges per bit mile drop. The rate of decline is less as distances increase and nearly identical for all speeds and levels of usage. At a given distance and speed the charges per bit mile will be almost constant for all utilizations. The reason for this is that rates per unit of time are constant.

The four different rate structures are not precisely inversely proportional to the speed of service. In other words, while 19,200 bps is four times faster than 4800 bps, there is a much greater spread between the charges for the two services. The high speed services generally have a higher charge per bit mile than do the medium speed services for comparable utilizations and distances. From the users point of view, potential economies of scale are greatest at the higher speeds except that any saving will be somewhat offset by increased modem costs.

See Tables 14 to 18 and Graphs 19 to 22.

3. Dataspeed, Dataphone

Dataphone service was discussed previously in the section relating to switched low speed services, and the same analysis applies to this service in the switched medium speed context. The discussion presented here is equally applicable to Dataspeed, since both services utilize the telephone network for data transmission under the tariffs published for telephone use. The relationships and trends for both services follow a common pattern, the only rate differentials being the installation charges and station rentals.

See Tables 7, 8, 19, 20 and Graphs 12 to 15 and 23 to 26

## D. SWITCHED HIGH SPEED SERVICES

This service was discussed in the previous section. Tables 14 to 18 and Graphs 19 to 22 are applicable. Multicom is the only high speed switched service currently available in Canada.

## E. PRIVATE LOW SPEED SERVICES

### 1. Telex Computer Inquiry Service

It has been assumed with this service, as with all others, that station rentals increase with the numbers of stations and transmission distance. In this analysis charges are calculated on the basis of a single user with one port and one station. Local service has been included and is assumed to be ten miles.

Total monthly charges for this service range from $355 for local service and one station in the system to $12,000 for 30 stations and transmission over 29,000 miles. Total charges increase with mileage. The fewer stations in the system, the less is this increase, both absolutely and in percentage terms. As a system acquires more stations, the charges increase at a much more rapid rate relative to distance. The reason for the lower rate of increase with fewer stations is that the fixed charges, both station equipment rentals and access line charges, are a much greater percentage of total charges when the number of stations is few. With an increasing number of stations, the charge to each user goes up rapidly. This is not as noticeable for local service because the rate per station is quite low but it becomes more evident as mileages increase.

The rate of increase in charges is particularly high in the case of systems with up to ten stations because it is at this point that the price break occurs. Beyond this point, rates per station are considerably lower. Neither the hours of usage nor the speed are factors in the total charge for this service. Ignoring situations where there are few stations or mileages, total charges rise rapidly with mileage or the number of stations in the system. In fact, these two factors, distance and number of stations, have an approximately equal effect on total charges.

Installation charges per station at $25 - $50 are insignificant. Even monthly station rentals are less than the monthly charge of $300 for each access line. Charges for systems with few stations or low mileage are composed predominantly of the fixed monthly charges for station equipment and access lines. With increasing distance and number of stations the transmission charges become predominant.

As mileage increases, charges per mile and per station decline rapidly at lower mileages and level off somewhat for greater distances. The rate of decline for systems with different numbers of stations is almost identical. Similarly, for a given mileage, the charges per station per mile decline as more stations are added to the system. The decline in this case is more linear, after a rapid drop at the low end. Charges per bit mile per station were not calculated since the trends are proportionately identical to the charges per mile per station.

Since speed is not a consideration in this case, the user will realize economies of scale when transmitting over greater distances or upon adding stations to the system, the economies being almost the same in either case. Speed becomes relevant only when the user is approaching the capacity of the service.

See Tables 21 and 22 and Graphs 27 and 30.

2. Dataline II

This service is almost identical to Telex Computer Inquiry Service. A major difference in the pattern of monthly charges is the Dataline II minimum requirement of five access lines and ten originating data stations, with a minimum of two stations in one mileage band. The subscriber has six months to build his system up to meet the minimum requirements. For the purposes of this analysis, each station is treated as a separate subscriber, with one access line and one station.

Total cost of this service can vary from $390 to almost $11,000 with the maximum number of 30 stations. Total monthly charges climb with increases in transmission distances and the number of stations. With very few stations total charges reflect the influence of fixed amounts, specifically access line charges and station equipment rentals. As more stations are added to the system and as transmission distances increase, the fixed charges become a smaller percentage of total charges. The most rapid rise in charges is observed when the system contains up to ten stations, since this is the point at which a price break comes into effect. After this, the rate of increase in charges declines.

Hours of usage and speed of transmission are not important factors in the rate structure of this service. The important factors are distance and the number of stations. Each has about the same effect on total charges.

Installation charges of about $75 - $150 are of little consequence. Monthly charges consist of three components – station equipment rentals, access line charges and transmission charges. The relative importance of each component changes as distance and number of stations increase.

Initially, the dominant component is the monthly access line charge of $300. However, as mileage increases and as more stations are incorporated, this charge assumes less importance until at maximum total charges of over $10,000 a month this component becomes insignificant. To a lesser extent station equipment rentals can be important when the average transmission distance is short. Transmission charges which are small with few stations and low mileage become dominant at higher mileages and/or a greater number of stations.

Charges per mile per station as distances increase drop in both absolute and percentage terms. The rate of decrease is particularly noticeable at low mileages, levelling off somewhat at greater distances. This rate of decrease is almost the same for all systems except those with very few stations. Charges per mile per station decrease as the number of stations in the system increase. Again the most dramatic decreases occur where fewer stations are involved. As with Telex Computer Inquiry Service, charges per bit mile per station are unnecessary and were not calculated.

This analysis indicates that the greatest economies of scale occur at the low mileages and in systems with few stations. It also confirms that distance and station numbers have about the same relative effect on economies of scale.

See Tables 23 and 24 and Graphs 31 and 34.

3. Schedules 1, 2, 3, 3A

The rate structures for these four schedule services are essentially the same since the rates and speeds increase with the schedule number.

For the purposes of this discussion, it is possible to deal with Schedule 1 alone, since the relationships and trends established for it also are valid for the other three services. However, calculations have been done for Schedule 3 also in order to study the effect of the different speeds. A variety of rates are available to a subscriber depending on the location of his station equipment. For the sake of simplicity, two rate groups have been selected – a local service with two points on different property and an inter-city service. It was further assumed that these were standard services without duplex, switching options or overtime. It was also necessary to choose arbitrarily certain representative mileages. For inter-city services three different per-mile charges were chosen. Moreover, although charges are made for incremental

increases in usage, it is also likely that at higher utilizations more circuits and more expensive station equipment would be needed. This partly accounts for the higher rates shown as usage increases.

The total charges for Schedule 1 vary from $44 for local service to $7,500 for inter-city service at maximum mileage and utilization. These charges are a function of time and distance. Charges increase with distance more rapidly in the case of inter-city service than they do for local service. The increase in charges for local service is linear, as is that for inter-city, although the latter is much greater.

Total charges for local service do not change as usage increases. However, incremental changes do occur in inter-city service as the user chooses different combinations of hours of use per day and number of days per week. Distance exerts a greater influence on charges than does hours of use.

As mentioned previously, the rates and speed increase with schedule number. However, the difference in the total monthly charges is of little consequence. Therefore, speed has a relatively important effect on total charges.

Total monthly rates consist of station equipment rentals, circuit charges and transmission charges. In the first month installation charges also must be paid but these are inconsequential, except at very low mileages and utilizations. Station equipment rentals, on the other hand, can constitute a significant percentage of the total monthly charge. This is particularly true for local service, because there is no usage charge. Because mileage charges are low, the largest portion of the total charge at all utilizations is for station equipment. For inter-city service, station equipment rentals are only important at very short transmission distances. Transmission charges, on the other hand, are very prominent in inter-city service for all but very low mileages.

In local service there is a downward trend in charges per bit mile over distance. The trend becomes more pronounced as usage increases, indicating that economies of scale continue to occur as mileage and usage increase. The greatest economies of scale for local service result from increasing distance rather than greater use of the facility.

Inter-city service rates are based on distance and time. Charges per bit mile drop sharply as distances increase to 350 miles, becoming almost constant beyond 2000 miles. Charges per bit mile drop steadily

as holding times increase. The indication is that economies of scale are realized at relatively short distances but that they are continually available with increased usage.

The speed of Schedule 3 – 75 bps – is 50% faster than Schedule 1. However, changes in rates from Schedule 1 to Schedule 3 show only a 25% increase. In terms of charges per bit mile, therefore, Schedule 3 should be a more economical service for any given distance and usage. Obviously, speed is an important user consideration with respect to Schedules 1, 2, 3 and 3A.

See Tables 25 to 32 and Graphs 35 to 42.

## F. PRIVATE MEDIUM SPEED SERVICE

### 1. Dataline III

This service is a higher speed version of Dataline II, operating at speeds up to 2000 bps. This analysis assumes that the user has one access line in a system having from one to 30 stations. Total monthly charges under these circumstances can range from $750 to more than $23,000 in a system with 25 stations and maximum distance.

Charges increase with distance gradually with few stations in the system. In a system with a greater number of stations, the increase in charges is more pronounced at short distances. Incremental increases are smaller as distances increase. It is apparent that both distance and the number of stations have an equally significant influence on total charges.

As in most services, installation charges are insignificant; fixed charges, including station equipment and access line, are also less significant for this service, although at very low mileage with few stations this charge can account for more than one-half the first month's charges. On the other hand, transmission charges increase considerably as distance and the number of stations increase. In almost all situations, except short mileage and/or few stations, these two factors dominate the total monthly charges. Hours of use has no effect on total charges, since the facilities are dedicated.

Charges per mile per station decrease steadily as distance increases. Charges per mile per station drop quite rapidly with few stations but level off very quickly to become almost constant as more stations are introduced. This trend is almost identical at all mileages except that the unit charges become much less as distances increase. A user transmitting over longer distances can realize greater economies of scale than can a user with a greater number of stations in the network.

See Tables 33 and 34 and Graphs 43 to 46

### 2. Schedules 4, 4A, 4B and 4C

The important difference among these services is their speed, since the rate structures are almost identical. Since the relationships

and trends for each service are so similar, an analysis of one holds true for all. However, Schedule 4 and Schedule 4C are compared to evaluate the effect of speed on rates.

The rates are based on distance and the number of channels, although the latter simply multiplies the rate schedule by the number of channels. We have assumed for this purpose that only one channel is involved. A major rate break occurs between local and inter-city service and these are treated separately. It was assumed that in both cases these were basic services with no options. Because this is a dedicated service, the number of hours of use is of no consequence to total charges. However, in the analysis it is assumed that greater utilization leads to the rental of more costly station equipment, hence the increase in total charges at higher utilizations. This, together with the greater influence of distance, accounts for a range of charges from $94 for local service to almost $5,000 for inter-city at high mileages and maximum station rentals.

The critical factors in transmission charges for these services are distance and the number of channels. Assuming that only one channel is being used, only mileage influences the charges. For local service the influence of distance is small and almost linear because of the significant effect of station equipment rentals. The situation is similar for inter-city service except that charges increase rapidly at low mileages, becoming linear only beyond about 1400 miles. The influence of channels is obvious. Transmission charges increase in direct proportion to the number of channels employed, but trends and relationships are the same as with one channel.

Installation charges of from $50 to over $600 depend on the station equipment rented. This can be a rather substantial sum in the case of local services, representing about one-third of total charges for the first month. However, over a year it is relatively insignificant for either local or inter-city service. For short distance inter-city service, almost all of the monthly charge is consumed by station equipment rental, but this drops to less than 30% of the billing at the longest distances. Consequently, transmission charges are insignificant for local service but become more important where longer distances are involved in inter-city service.

Although the rates for these services are not based on holding time, it is useful to express the charges in basic units that include measureable data volumes. Charges per bit mile show similar trends for both local and inter-city services. In both cases they decline as distances

increase, more rapidly at short distances, less so as distances increase. The decline in charges per bit mile is also more rapid with distance when more expensive terminal equipment is involved. Economies of scale are realized as distances increase; substantial economies also occur as utilization goes up since the charges are fixed and increased utilization lowers the charge in terms of units of use.

Although the same trends and relationships hold true for all of the Schedules in absolute terms, the charges per bit mile are quite different because the transmission speeds are different. For example, Schedule 4 has a speed of 600 bps whereas Schedule 4C is 2400 bps. For a given high volume throughput, the higher speed is more economical.

See Tables 35 to 42 and Graphs 47 to 58.

## 3. Channel Deriving Arrangements

A Schedule 4 data channel may be subdivided when used for Computer Access or Teleprinter services. The rates are the same as those for Schedule 4 with the addition of certain extras associated with the derivation of additional channels. In total the charges for the two services are similar and in terms of trends and relationships they are so nearly identical that the Computer Access service will be used to represent both.

The range of total monthly charges reflects a low of about $400 to more than $25,000. The increase is a function of the number of derived channels and the transmission distance. The total charges for any number of channels behave much the same, increasing very sharply with distances up to 200 miles, levelling off above 1700 miles to a virtual ceiling charge at greater distances. Usage is not a factor in rate determination. The increase in total charges due to distance is greater than increases due to the derivation of more channels. Therefore, the most influential factor in charges for Computer Access services is distance.

The rate components for this service are installation charges, station equipment rentals, channel charges and transmission charges. Installation charges, as for other services are inconsequential. Terminal rentals, beyond the very lowest mileages, also are a minor element of total charges. Channel charges at $60 per channel also are a rather small proportion of the total charge, except at very low mileages where they can account for up to half of the monthly bill.

Transmission charges, on the other hand, increase substantially with increasing distances and climb in direct proportion to the number of derived channels. Therefore, as a percentage of the total charges, distance is more important when few channels are involved but becomes less important as the number of channels increase.

Charges per mile per channel show a downward trend as mileage increases, being greater at very low mileages and almost linear beyond 200 miles. Economies of scale are realized for transmission over greater distances. Similar economies do not occur as more channels are derived since the number of channels has no effect on the charge per mile per channel. When these charges are studied relative to the hours of use and expressed in terms of charges per bit mile per channel the trend over time is similar to that over distance. Charges drop quickly at low utilizations and decline more gradually as usage increases. Economies of scale are realized both with higher volumes of traffic and with transmission over greater distances.

See Tables 43 to 46 and Graphs 59 to 64.

## G. PRIVATE HIGH SPEED SERVICES

### 1. Telpak A, B, C and S

These are the only private, high speed services available in Canada at this time. The differences between the four services are the number of voice channels provided, hence their effective speeds and their rates. Because the rate structures are the same, the charges for each service are similar in terms of trends and relationships, so that only Telpak A will be discussed here. However, it is of interest to compare two services to note the effect of different speeds on rates. This has been done by comparing Telpak A and Telpak S.

The rates quoted for Telpak cover only transmission from exchange to exchange; a surcharge must be added for lines from the local exchange office to the user's terminal. This surcharge has not been considered in the study. A variety of factors influence the basic rate per volume of data for Telpak services. These are distance, usage, speed and the choice between simplex and duplex. Distance and usage are continuous within certain limits, whereas speed has four dimensions for each service. The possible combinations of these factors are so numerous that we have selected certain specific relationships for analysis. It is assumed that for Telpak A, each voice grade circuit has one piece of station equipment associated with it and for Telpak S one piece of equipment for each ten circuits.

Total monthly charges for Telpak A can range from about $400 to over $100,000 and for Telpak S charges can reach $300,000 or more, depending on station equipment. Since this is a dedicated private line service, usage is not a factor in determining charges. The only important determinant of total charges is mileage. Since rates are set per mile with no reduction as distance increases, the total charges increase with mileage. Charges increase rapidly at low mileages and taper off slightly at longer distances. Both simplex and duplex services show the same trend.

Installation charges for both simplex and duplex services vary from approximately $50 to $100 per channel. This means installation of 12 stations for Telpak A could cost from $600 to $1200. At short distances these charges in the first month could be equal to or greater than the total station and transmission charges. Spread over a number of months they become rather insignificant. However, at longer distances of transmission, installation charges become

much less significant. Station equipment rentals of from $120 to $480 per month for twelve stations are an important component of total charges only at low mileages. However, if voice grade circuits are subdivided into a number of data channels with associated station equipment, the charges for station equipment can rise substantially and represent a much greater share of the total. Transmission charges at all but very low mileages account for the vast majority of total charges. At very low mileage, transmission charges can be about half total charges, and are paramount at the longer distances.

Charges for a system operating with a given speed and distance are the same, but the charge per bit mile drops as utilization goes up. The drop is greatest at low utilizations, levelling off somewhat as utilization increases. The same trend is apparent for all services. Because the charge per mile is constant, the charges per bit mile are identical at all distances. At a given utilization the charges per bit mile drop as speed of transmission increases, the drop being inversely proportional to the speeds.

When comparing charges relating to two different systems, Telpak A and Telpak S, it is found that the latter has an effective speed ten times greater than Telpak A, but that the charges per bit mile are about one-third those of Telpax A and not one-tenth.

See Tables 47 to 52 and Graphs 65 to 67.

## TELEX AND DATA TELEX

### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| Mileage Intervals | One Hour | | | 22 Hours | | | 176 Hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/$10^6$ Bits | | Total Charges | $/Mile/$10^6$ Bits | | Total Charges | $/Mile/$10^6$ Bits | |
| | | Telex | Data Telex | | Telex | Data Telex | | Telex | Data Telex |
| 0- 25 | $46 | $12.77 | $3.55 | $ 332 | $4.19 | $1.16 | $1447 | $2.28 | $.63 |
| 25- 75 | 49 | 5.44 | 1.51 | 398 | 2.01 | .56 | 1975 | 1.25 | .35 |
| 75- 150 | 52 | 2.61 | .73 | 464 | 1.07 | .30 | 2503 | .72 | .20 |
| 150- 225 | 55 | 1.61 | .45 | 530 | .70 | .20 | 3031 | .50 | .14 |
| 225- 300 | 58 | 1.22 | .34 | 596 | .58 | .16 | 3559 | .43 | .12 |
| 300- 500 | 63 | .89 | .25 | 695 | .44 | .12 | 4351 | .34 | .095 |
| 500- 800 | 67 | .56 | .15 | 800 | .31 | .086 | 5148 | .25 | .069 |
| 800-1100 | 72 | .42 | .12 | 895 | .24 | .065 | 5949 | .20 | .054 |
| 1100-1400 | 76 | .34 | .09 | 992 | .20 | .055 | 6727 | .17 | .047 |
| 1400-2000 | 85 | .28 | .08 | 1190 | .18 | .049 | 8311 | .15 | .043 |
| 2000 + | 94 | .19 | .05 | 1386 | .13 | .035 | 9876 | .12 | .032 |

TABLE 1

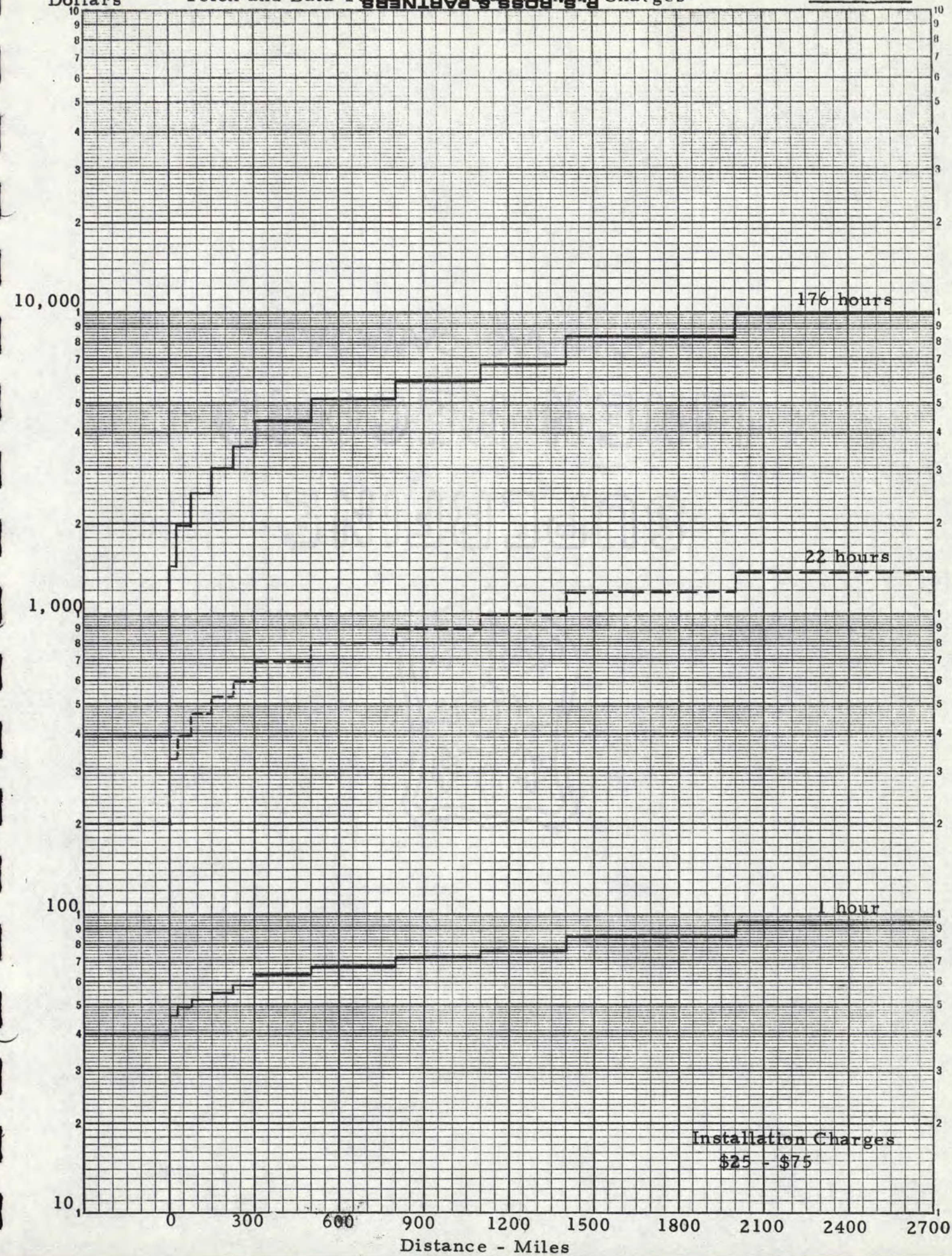
## TELEX AND DATA TELEX

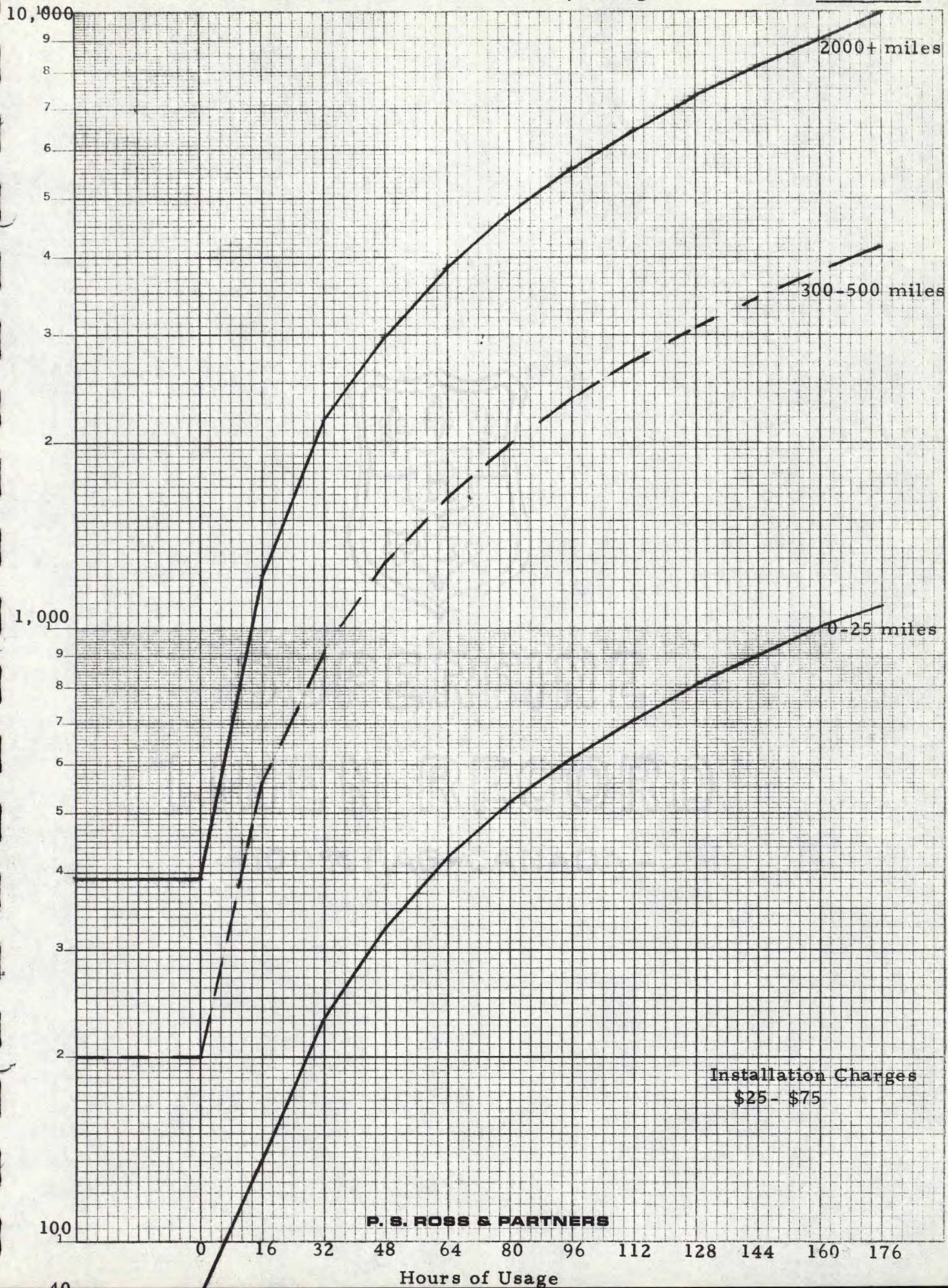
### MONTHLY CHARGES INCLUDING STATION RENTAL AND TRANSMISSION CHARGES

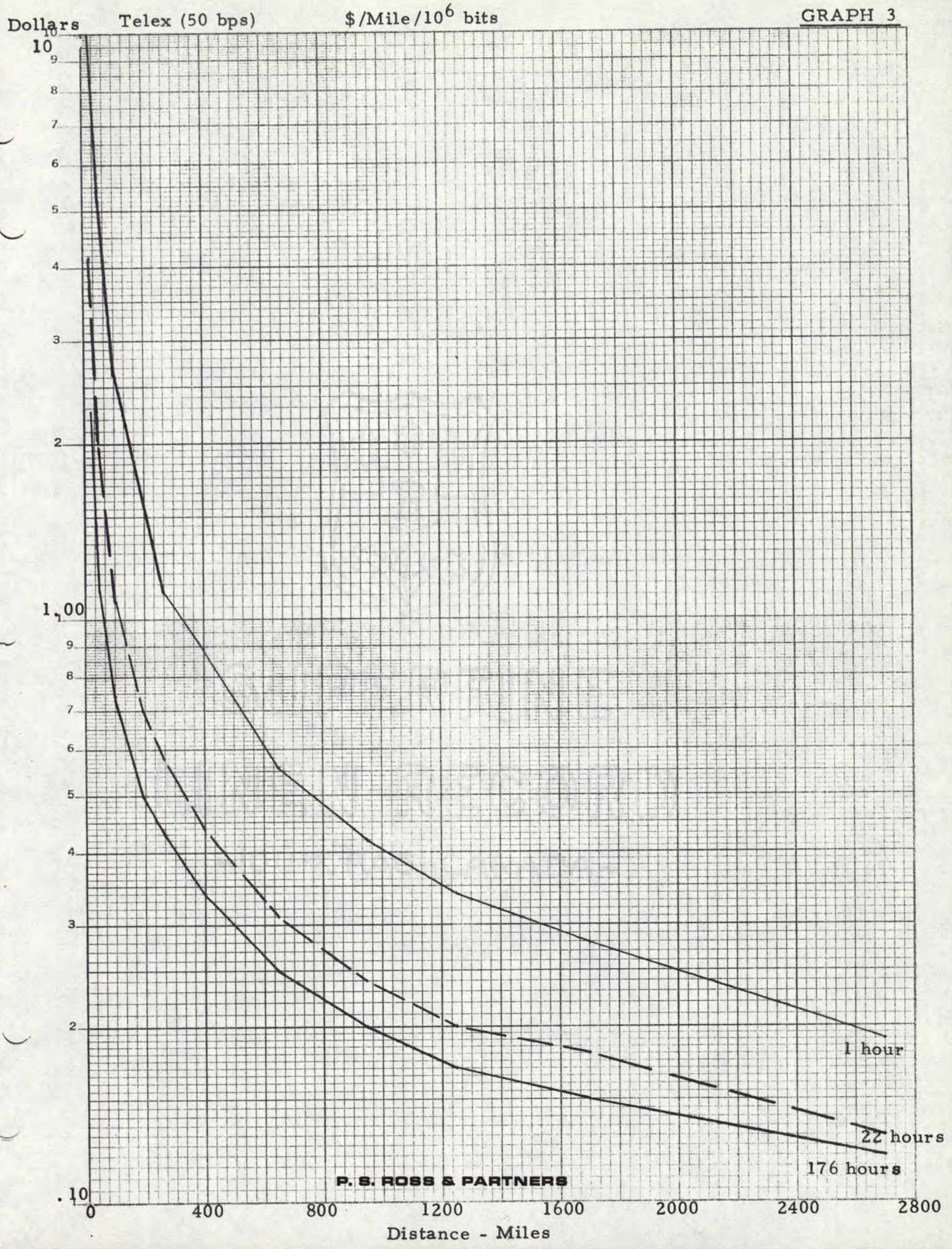
| Time in Hours | 0-25 Miles | | | 300-500 Miles | | | 2000+ Miles | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Charge | $/10^6 Bits/Mile | | Total Charge | $/10^6 Bits/Mile | | Total Charge | $/10^6/Bits Mile | |
| | | Telex | Data Telex | | Telex | Data Telex | | Telex | Data Telex |
| 1 | $ 46 | $12.77 | $3.54 | $ 206 | $2.89 | $.80 | $ 397 | $.89 | $.24 |
| 16 | 136 | 2.36 | .66 | 560 | .49 | .14 | 1255 | .17 | .048 |
| 32 | 232 | 2.01 | .55 | 920 | .40 | .11 | 2119 | .15 | .041 |
| 48 | 329 | 1.90 | .53 | 1280 | .37 | .10 | 2983 | .14 | .038 |
| 64 | 425 | 1.84 | .51 | 1640 | .36 | .10 | 3847 | .13 | .037 |
| 80 | 521 | 1.81 | .50 | 2000 | .35 | .096 | 4711 | .13 | .036 |
| 96 | 617 | 1.78 | .50 | 2360 | .34 | .095 | 5575 | .13 | .036 |
| 112 | 713 | 1.77 | .49 | 2720 | .32 | .090 | 6439 | .13 | .036 |
| 128 | 810 | 1.76 | .49 | 3080 | .33 | .093 | 7303 | .13 | .035 |
| 144 | 906 | 1.75 | .49 | 3440 | .33 | .092 | 8167 | .13 | .035 |
| 160 | 1002 | 1.74 | .48 | 3800 | .33 | .091 | 9031 | .13 | .035 |
| 176 | 1098 | 1.73 | .48 | 4160 | .32 | .089 | 9895 | .12 | .035 |



TABLE 2


Dollars
Telex and Data Telex Total Monthly Charges
GRAPH 1
P. S. ROSS & PARTNERS
10,000
1,000
100
10
176 hours
22 hours
1 hour
Installation Charges
$25 - $75
0
300
600
900
1200
1500
1800
2100
2400
2700
Distance - Miles


Dollars
Telex and Data Telex
Total Monthly Charges
GRAPH 2
10,000
9
8
7
6
5
4
3
2
1,000
9
8
7
6
5
4
3
2
100
2000+ miles
300-500 miles
0-25 miles
Installation Charges
$25- $75
P. S. ROSS & PARTNERS
0
16
32
48
64
80
96
112
128
144
160
176
Hours of Usage


Dollars
Telex (50 bps)
$/Mile/10^6 bits
GRAPH 3
10
9
8
7
6
5
4
3
2
1.00
9
8
7
6
5
4
3
2
.10
0
400
800
1200
1600
2000
2400
2800
Distance - Miles
1 hour
22 hours
176 hours
P. S. ROSS & PARTNERS

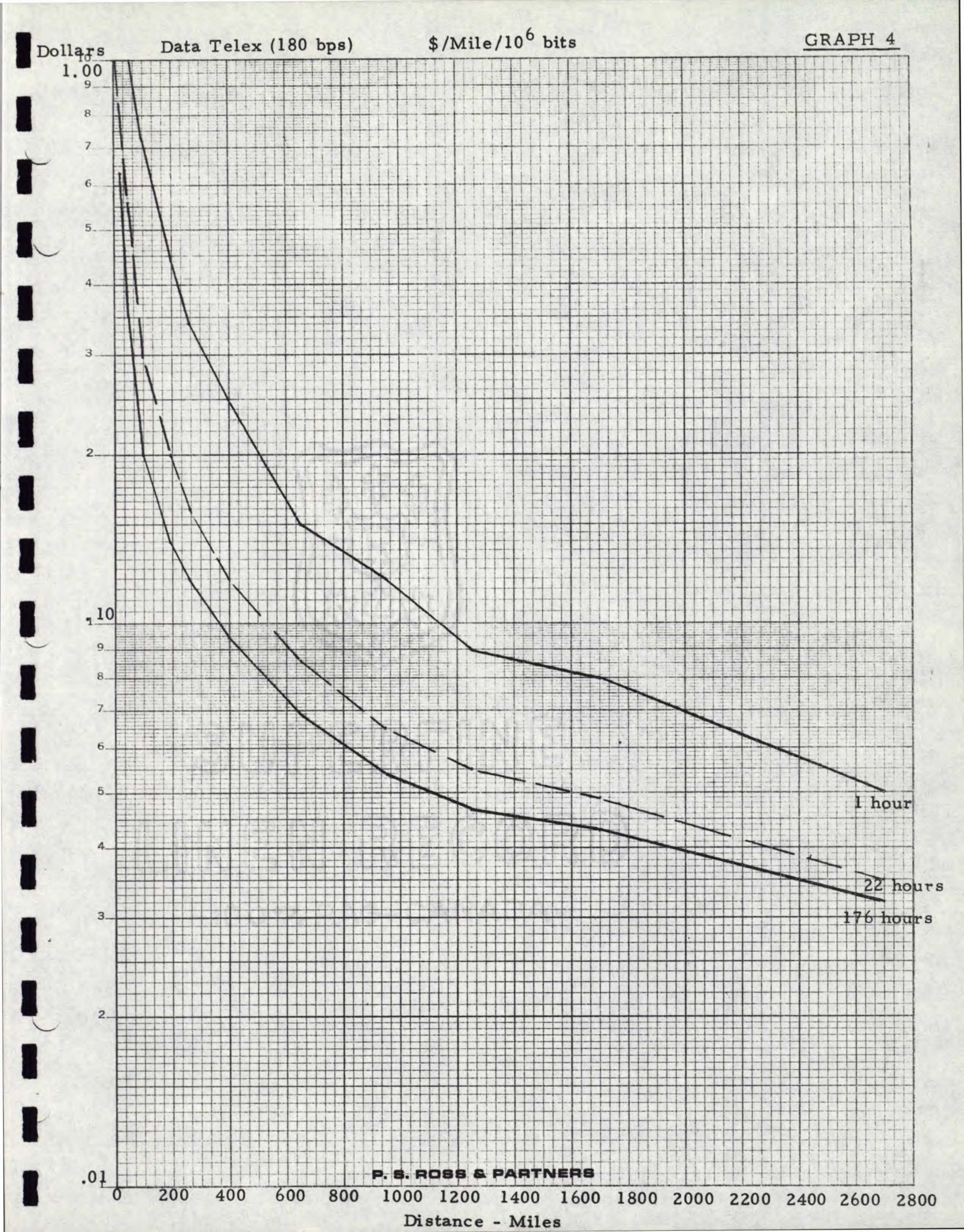

Dollars
Data Telex (180 bps)
$/Mile/10^6 bits
GRAPH 4
1.00
.10
.01
1 hour
22 hours
176 hours
P. S. ROSS & PARTNERS
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Distance - Miles

TABLE 3

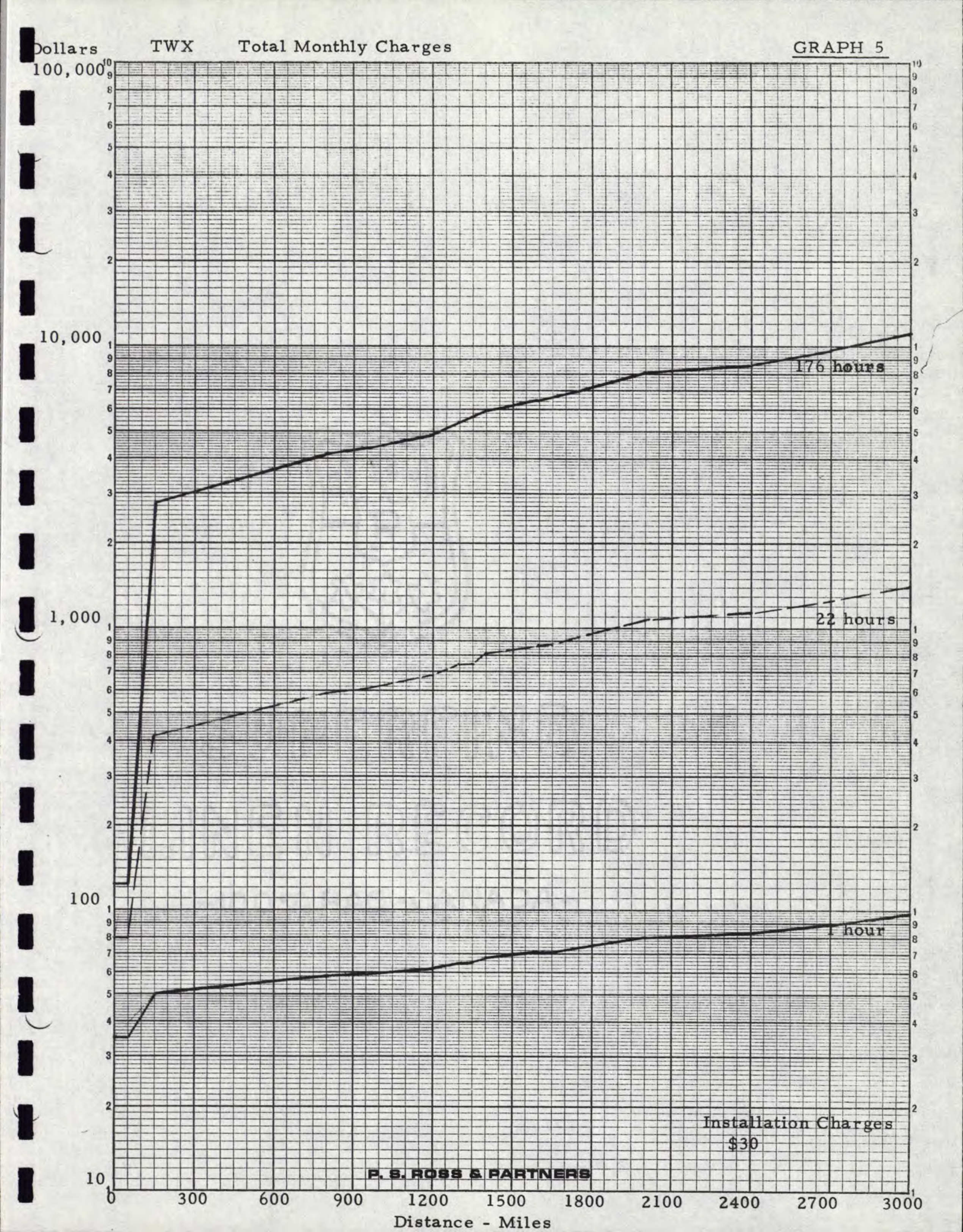
TWX

MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

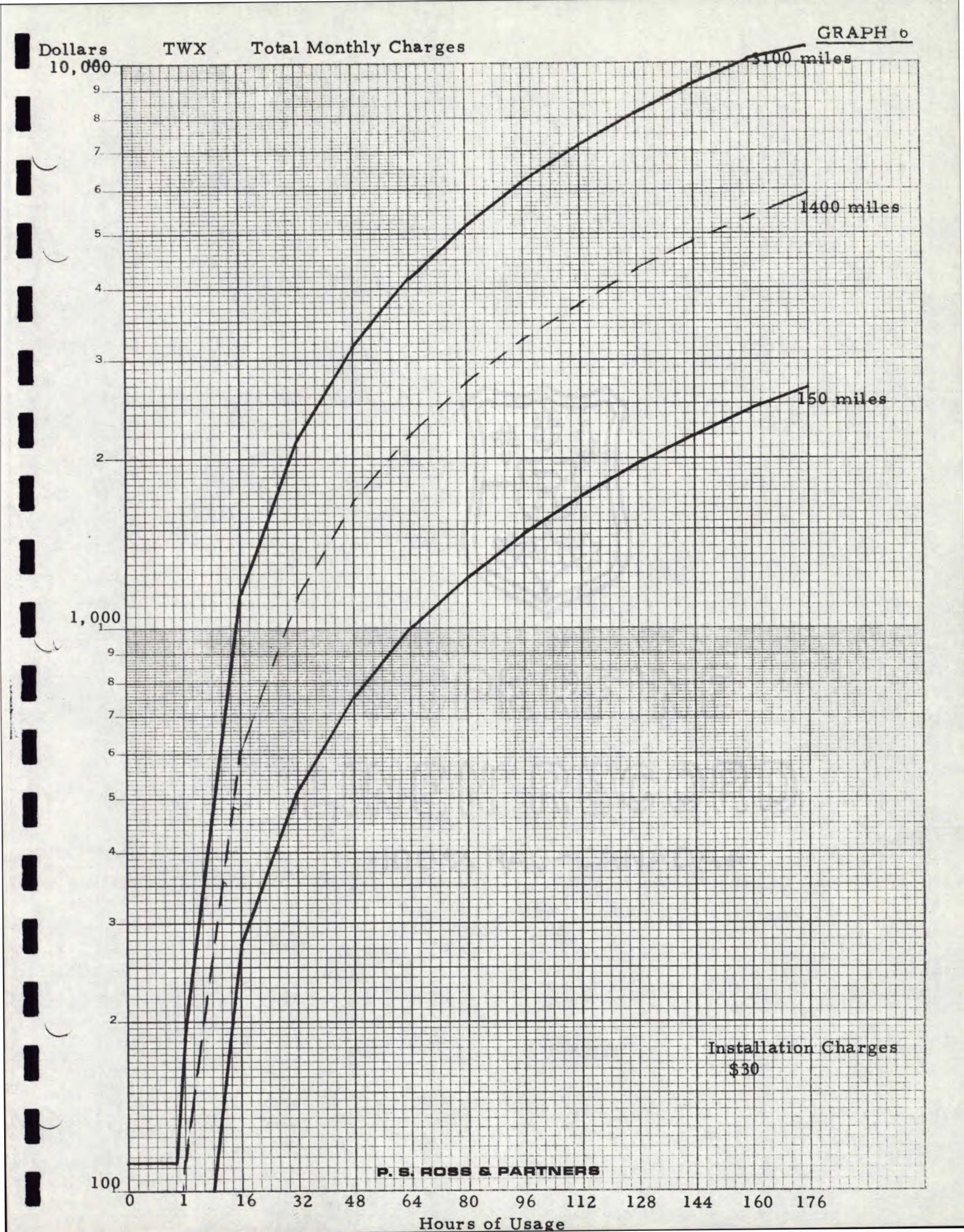
| | | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|---|
| Telephone Areas | Representative Mileages | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits |
| 709 to | | | | | | | |
| 709 | 150 | $ 50 | $.83 | $ 410 | $.31 | $ 2764 | $.26 |
| 902 | 800 | 58 | .18 | 582 | .084 | 4137 | .074 |
| 506 | 950 | 59 | .16 | 608 | .073 | 4348 | .066 |
| 418 | 1200 | 62 | .13 | 674 | .064 | 4876 | .058 |
| 514 | 1300 | 65 | .13 | 740 | .065 | 5404 | .060 |
| 819 | 1350 | 65 | .12 | 740 | .063 | 5404 | .057 |
| 613 | 1400 | 68 | .12 | 806 | .067 | 5932 | .061 |
| 416 | 1600 | 71 | .11 | 872 | .063 | 6460 | .058 |
| 705 | 1650 | 71 | .11 | 872 | .061 | 6460 | .056 |
| 519 | 1750 | 74 | .11 | 938 | .062 | 6988 | .057 |
| 807 | 2000 | 80 | .10 | 1070 | .062 | 8044 | .058 |
| 204 | 2400 | 83 | .09 | 1136 | .054 | 8572 | .051 |
| 306 | 2700 | 89 | .08 | 1268 | .054 | 9628 | .051 |
| 403 | 3100 | 98 | .08 | 1466 | .054 | 11212 | .052 |
| 604 | 3500 | 107 | .08 | 1664 | .055 | 12796 | .053 |

TABLE 4

| | 150 Miles | | 800 Miles | | 3100 Miles | |
|---|---|---|---|---|---|---|
| Time in Hours | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile |
| 1 | $ 50 | $.84 | $ 103 | $.32 | $ 187 | $.15 |
| 16 | 275 | .29 | 440 | .087 | 1132 | .058 |
| 32 | 515 | .27 | 800 | .079 | 2140 | .054 |
| 48 | 755 | .26 | 1160 | .076 | 3148 | .053 |
| 64 | 995 | .26 | 1520 | .075 | 4156 | .053 |
| 80 | 1235 | .26 | 1880 | .074 | 5164 | .053 |
| 96 | 1475 | .26 | 2240 | .074 | 6172 | .052 |
| 112 | 1715 | .26 | 2600 | .073 | 7180 | .052 |
| 128 | 1955 | .26 | 2960 | .073 | 8188 | .052 |
| 144 | 2195 | .26 | 3320 | .073 | 9196 | .052 |
| 160 | 2435 | .26 | 3680 | .072 | 10204 | .052 |
| 176 | 2675 | .26 | 4040 | .072 | 11212 | .052 |


Dollars
TWX Total Monthly Charges
GRAPH 5
100,000
10,000
1,000
100
10
176 hours
22 hours
1 hour
Installation Charges
$30
P. S. ROSS & PARTNERS
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
Distance - Miles

GRAPH 6


Dollars
TWX
Total Monthly Charges
10,000
9
8
7
6
5
4
3
2
1,000
9
8
7
6
5
4
3
2
100
3100 miles
1400 miles
150 miles
Installation Charges
$30
P. S. ROSS & PARTNERS
0
1
16
32
48
64
80
96
112
128
144
160
176
Hours of Usage

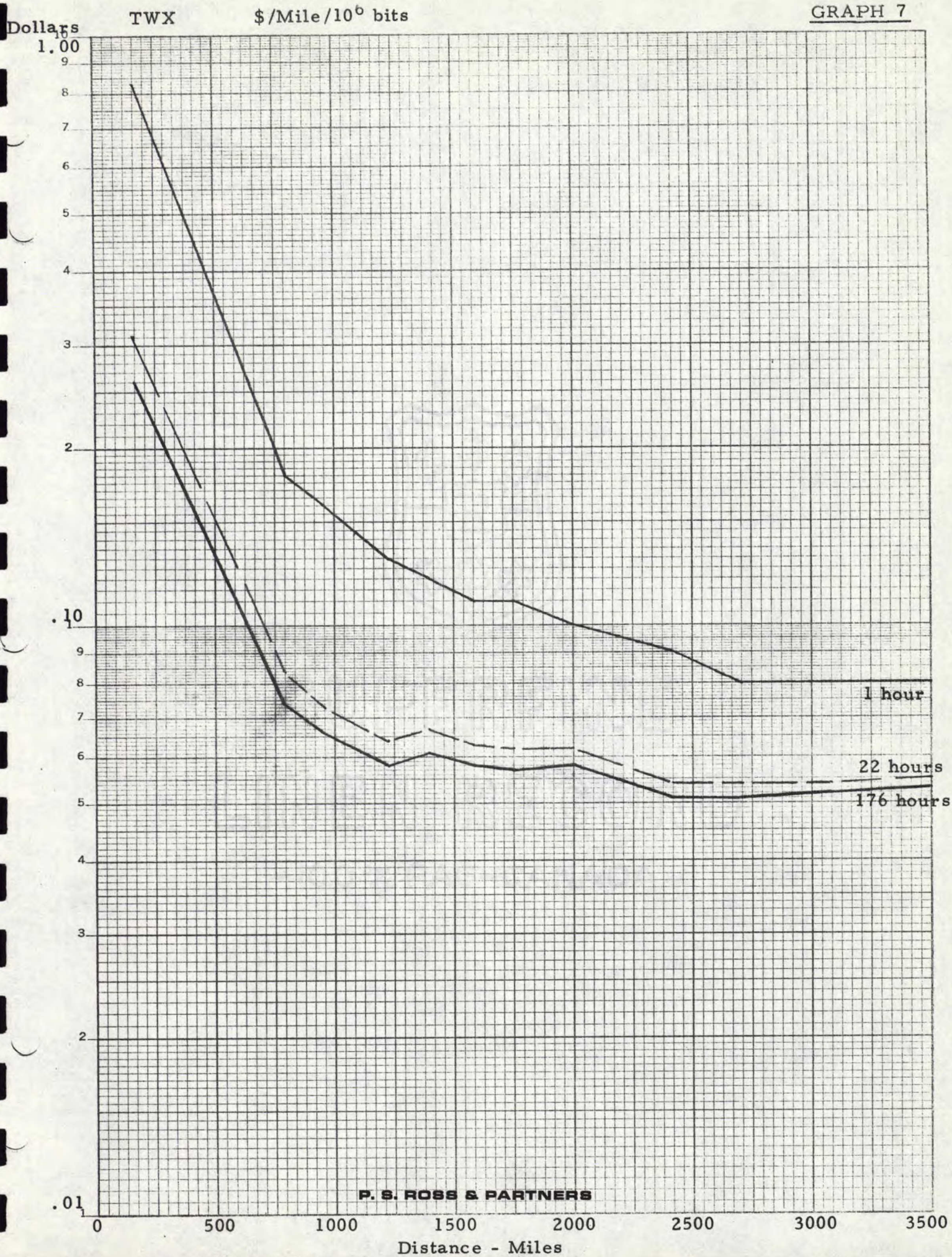

TWX
$/Mile/10^6 bits
GRAPH 7
Dollars
1.00
.10
.01
1 hour
22 hours
176 hours
P. S. ROSS & PARTNERS
0
500
1000
1500
2000
2500
3000
3500
Distance - Miles

TABLE 5

## DATACOM

### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

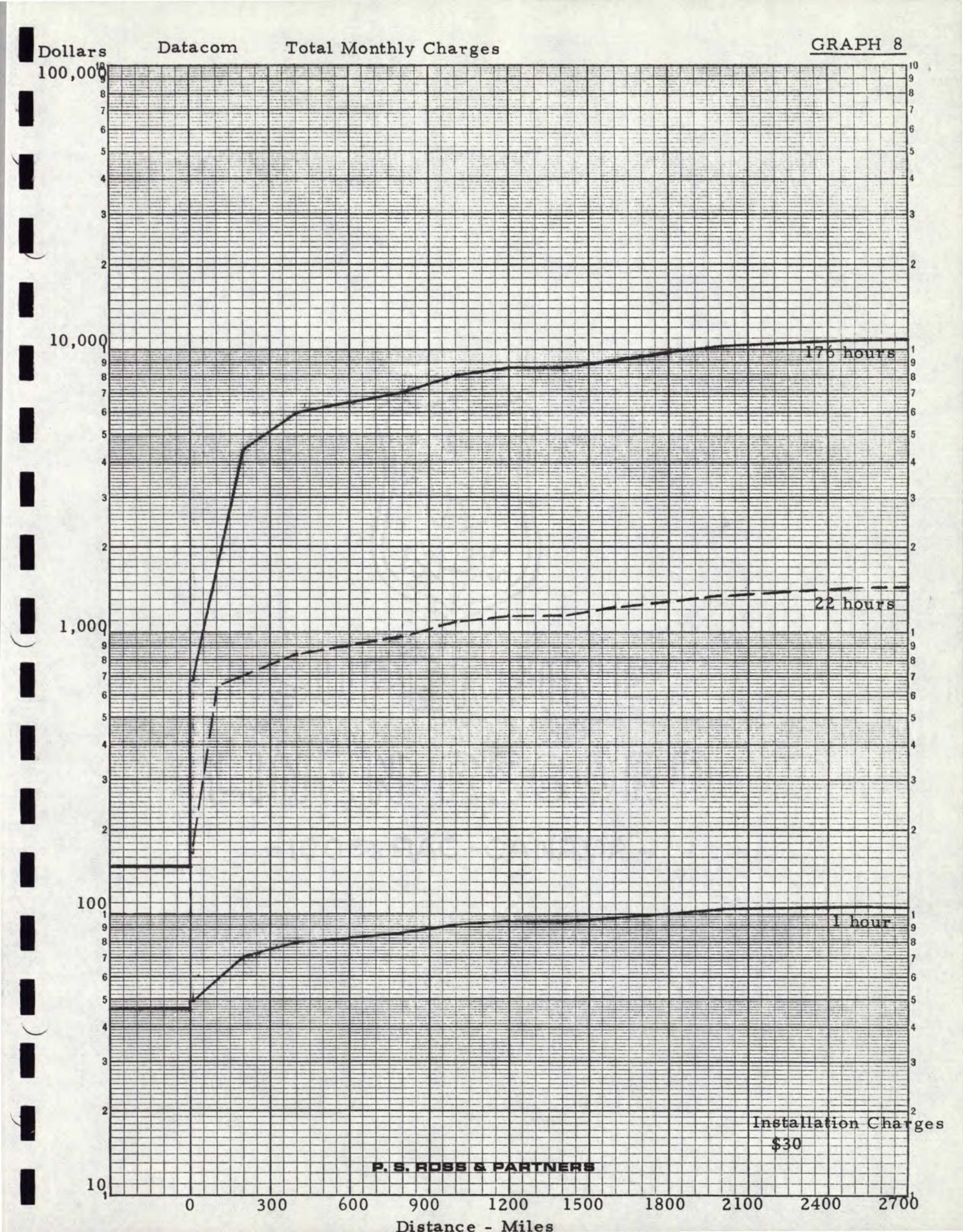
| Representative Mileages | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| | Total Charge | $/Mile/$10^6$ Bits | Total Charge | $/Mile/$10^6$ Bits | Total Charge | $/Mile/$10^6$ Bits |
| Local | $ 46 | $23.23 | $100 | $2.30 | $ 148 | $.42 |
| 10 | 49 | 12.37 | 166 | 1.91 | 676 | .97 |
| 200 | 70 | .88 | 628 | .36 | 4372 | .32 |
| 400 | 79 | .51 | 826 | .24 | 5956 | .21 |
| 600 | 82 | .35 | 892 | .17 | 6484 | .16 |
| 800 | 85 | .28 | 958 | .14 | 7012 | .13 |
| 1000 | 91 | .23 | 1090 | .13 | 8068 | .12 |
| 1200 | 94 | .20 | 1156 | .11 | 8596 | .10 |
| 1400 | 94 | .17 | 1156 | .095 | 8596 | .088 |
| 1600 | 97 | .15 | 1222 | .087 | 9124 | .082 |
| 1800 | 100 | .14 | 1288 | .083 | 9652 | .077 |
| 2000 | 103 | .13 | 1354 | .078 | 10180 | .073 |
| 2500 | 106 | .11 | 1420 | .065 | 10708 | .061 |
| 3000 | 106 | .09 | 1420 | .054 | 10708 | .051 |

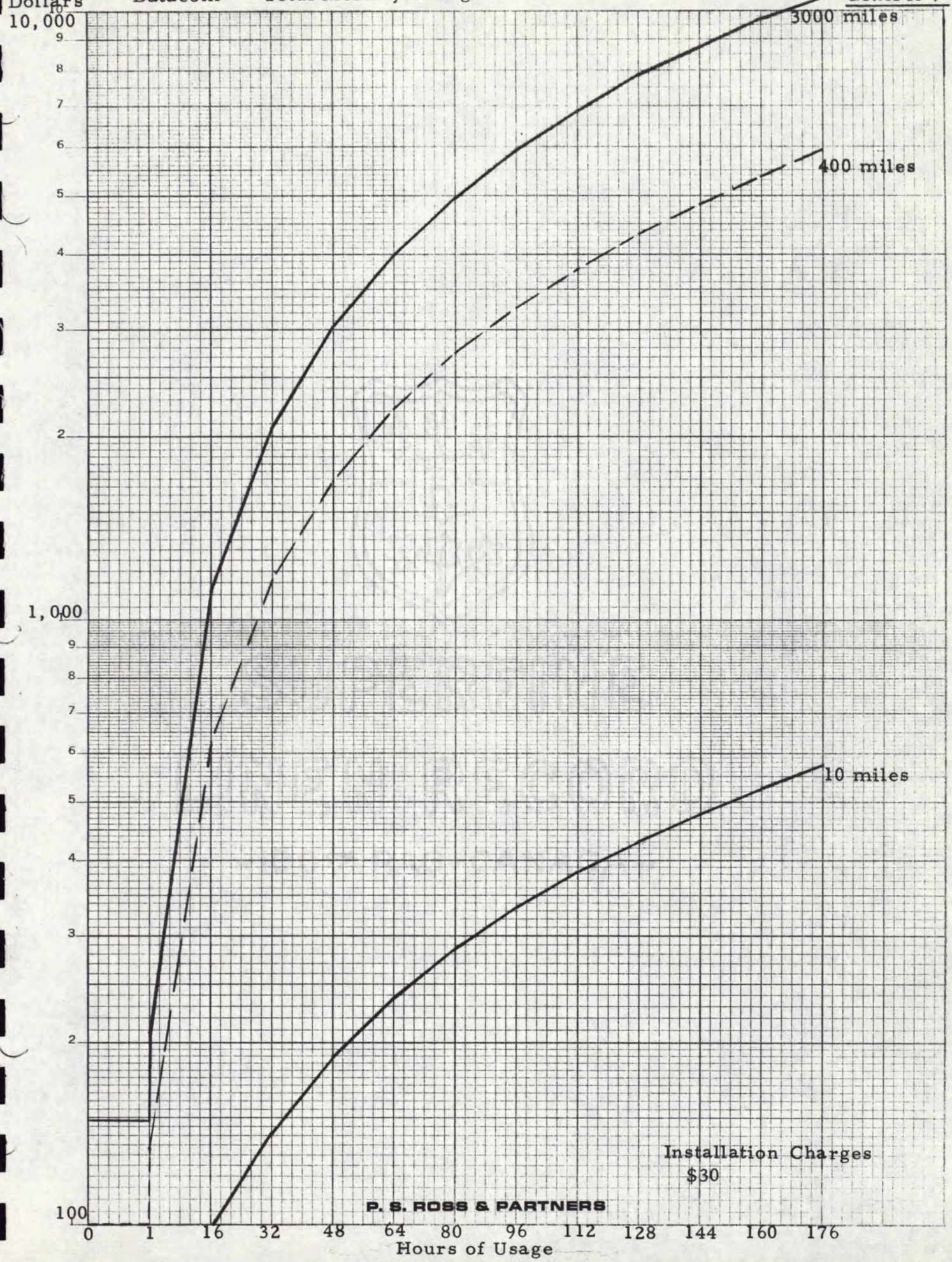
TABLE 6

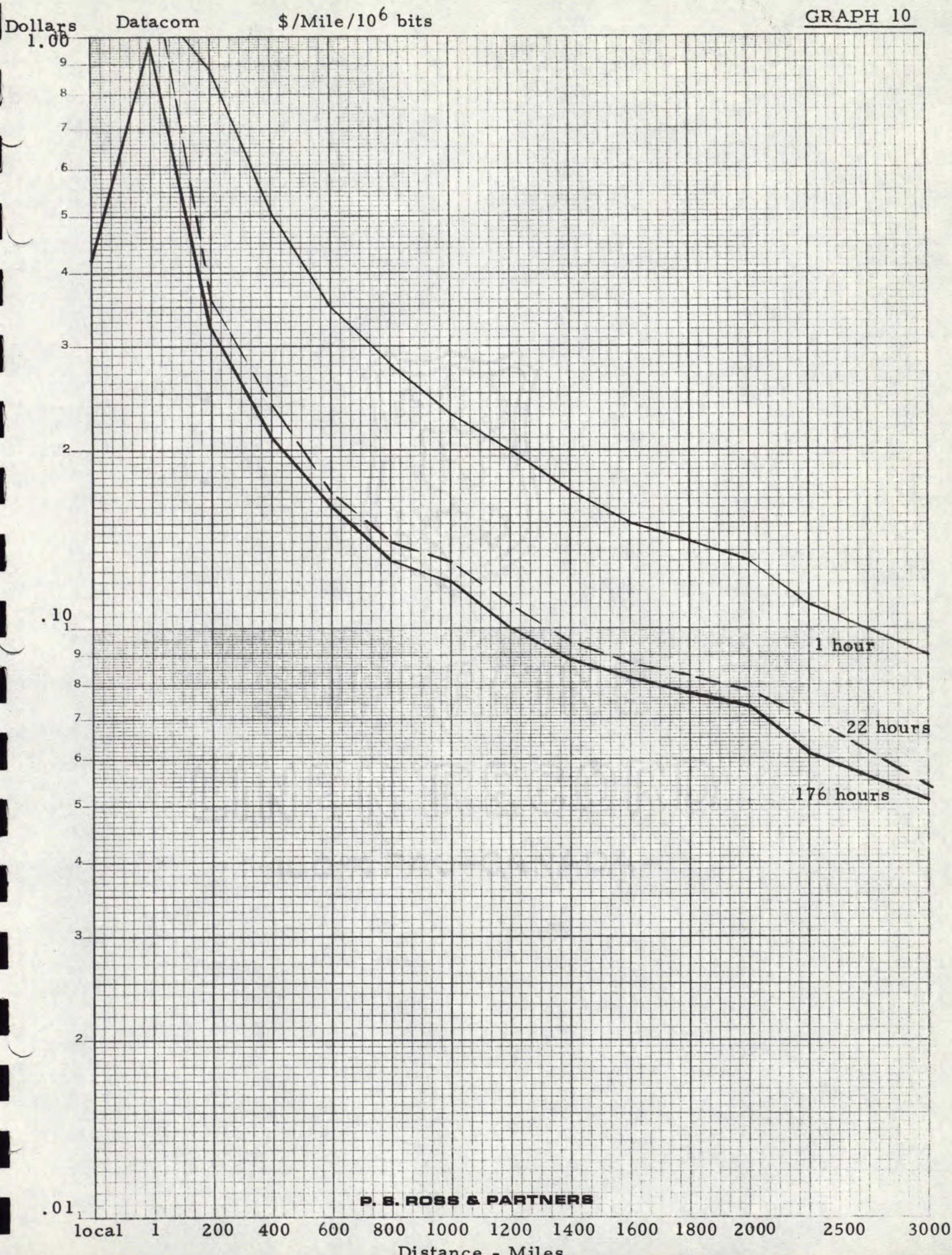
## DATACOM

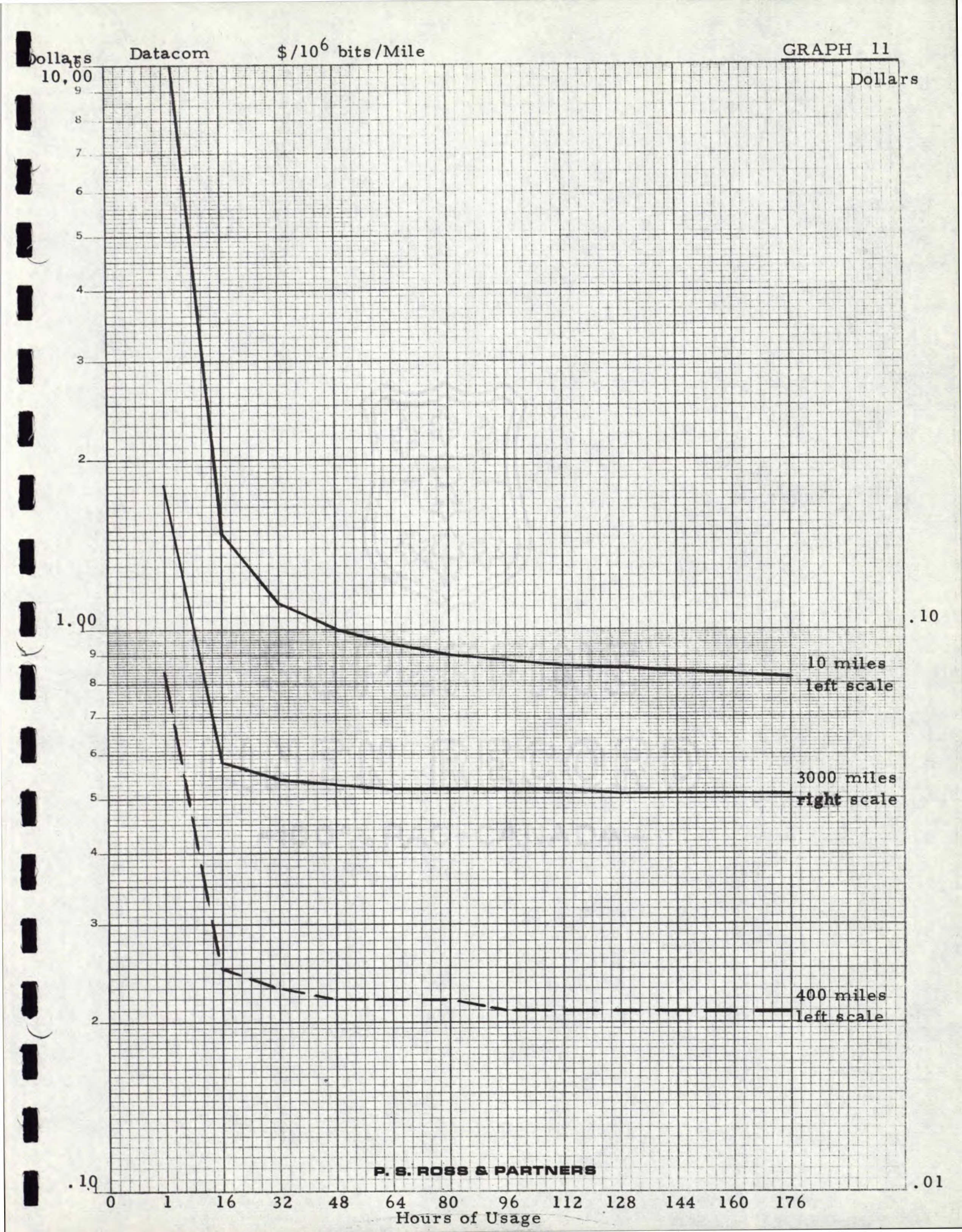
### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| Time in Hours | 10 Miles | | 400 Miles | | 3000 Miles | |
|---|---|---|---|---|---|---|
| | Total Charge | $/10$^6$ Bits/ Mile | Total Charge | $/10$^6$ Bits/ Mile | Total Charge | $/10$^6$ Bits/ Mile |
| 1 | $ 49 | $12.30 | $133 | .84 | $ 208 | $.18 |
| 16 | 94 | 1.48 | 628 | .25 | 1108 | .058 |
| 32 | 142 | 1.12 | 1156 | .23 | 2068 | .054 |
| 48 | 190 | 1.00 | 1684 | .22 | 3028 | .053 |
| 64 | 238 | .94 | 2212 | .22 | 3988 | .052 |
| 80 | 286 | .90 | 2740 | .22 | 4948 | .052 |
| 96 | 334 | .88 | 3268 | .21 | 5908 | .052 |
| 112 | 382 | .86 | 3796 | .21 | 6868 | .052 |
| 128 | 430 | .85 | 4324 | .21 | 7828 | .051 |
| 144 | 478 | .84 | 4852 | .21 | 8788 | .051 |
| 160 | 526 | .83 | 5380 | .21 | 9748 | .051 |
| 176 | 574 | .82 | 5908 | .21 | 10708 | .051 |


Dollars
Datacom
Total Monthly Charges
GRAPH 8
100,000
10,000
1,000
100
10
176 hours
22 hours
1 hour
Installation Charges
$30
P. S. ROSS & PARTNERS
0
300
600
900
1200
1500
1800
2100
2400
2700
Distance - Miles


Dollars
Datacom
Total Monthly Charges
GRAPH 9
10,000
1,000
100
3000 miles
400 miles
10 miles
Installation Charges
$30
P. S. ROSS & PARTNERS
0
1
16
32
48
64
80
96
112
128
144
160
176
Hours of Usage


Dollars
Datacom
$/Mile/10^6 bits
GRAPH 10
1.00
9
8
7
6
5
4
3
2
.10
1
9
8
7
6
5
4
3
2
.01
1 hour
22 hours
176 hours
P. B. ROSS & PARTNERS
local
1
200
400
600
800
1000
1200
1400
1600
1800
2000
2500
3000
Distance - Miles


Dollars
Datacom
$/10^6 bits/Mile
GRAPH 11
Dollars
10,00
1.00
.10
.01
10 miles
left scale
3000 miles
right scale
400 miles
left scale
P. S. ROSS & PARTNERS
0
1
16
32
48
64
80
96
112
128
144
160
176
Hours of Usage

DATAPHONE

MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| Representative Mileages | One Hour | | | 22 Hours | | | 176 Hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Charge | $/Mile/$10^6$ Bits | | Total Charge | $/Mile/$10^6$ Bits | | Total Charge | $/Mile/$10^6$ Bits | |
| | | 600 bps | 2000 bps | | 600 bps | 2000 bps | | 600 bps | 2000 bps |
| Local (5) | $27 | $2.50 | $.75 | $ 82 | $.34 | $.10 | $ 136 | $.072 | $.021 |
| 10 | 30 | 1.40 | .42 | 148 | .31 | .093 | 664 | .17 | .052 |
| 200 | 51 | .12 | .035 | 610 | .064 | .0019 | 4360 | .057 | .0017 |
| 400 | 60 | .069 | .021 | 808 | .042 | .0013 | 5944 | .039 | .0012 |
| 600 | 63 | .048 | .015 | 874 | .031 | .00092 | 6472 | .028 | .00085 |
| 800 | 66 | .038 | .011 | 940 | .025 | .00074 | 7000 | .023 | .00069 |
| 1000 | 72 | .033 | .010 | 1072 | .023 | .00067 | 8056 | .021 | .00064 |
| 1200 | 75 | .029 | .0087 | 1138 | .020 | .00059 | 8584 | .019 | .00056 |
| 1400 | 75 | .025 | .0074 | 1138 | .017 | .00051 | 8584 | .016 | .00048 |
| 1600 | 78 | .023 | .0068 | 1204 | .016 | .00047 | 9112 | .015 | .00045 |
| 1800 | 81 | .021 | .0063 | 1270 | .015 | .00045 | 9640 | .014 | .00042 |
| 2000 | 84 | .019 | .0058 | 1336 | .014 | .00042 | 10168 | .013 | .00040 |
| 2500 | 87 | .016 | .0048 | 1402 | .012 | .00035 | 10696 | .011 | .00034 |
| 3000 | 87 | .013 | .0040 | 1402 | .0098 | .00030 | 10696 | .0094 | .00028 |

TABLE 7

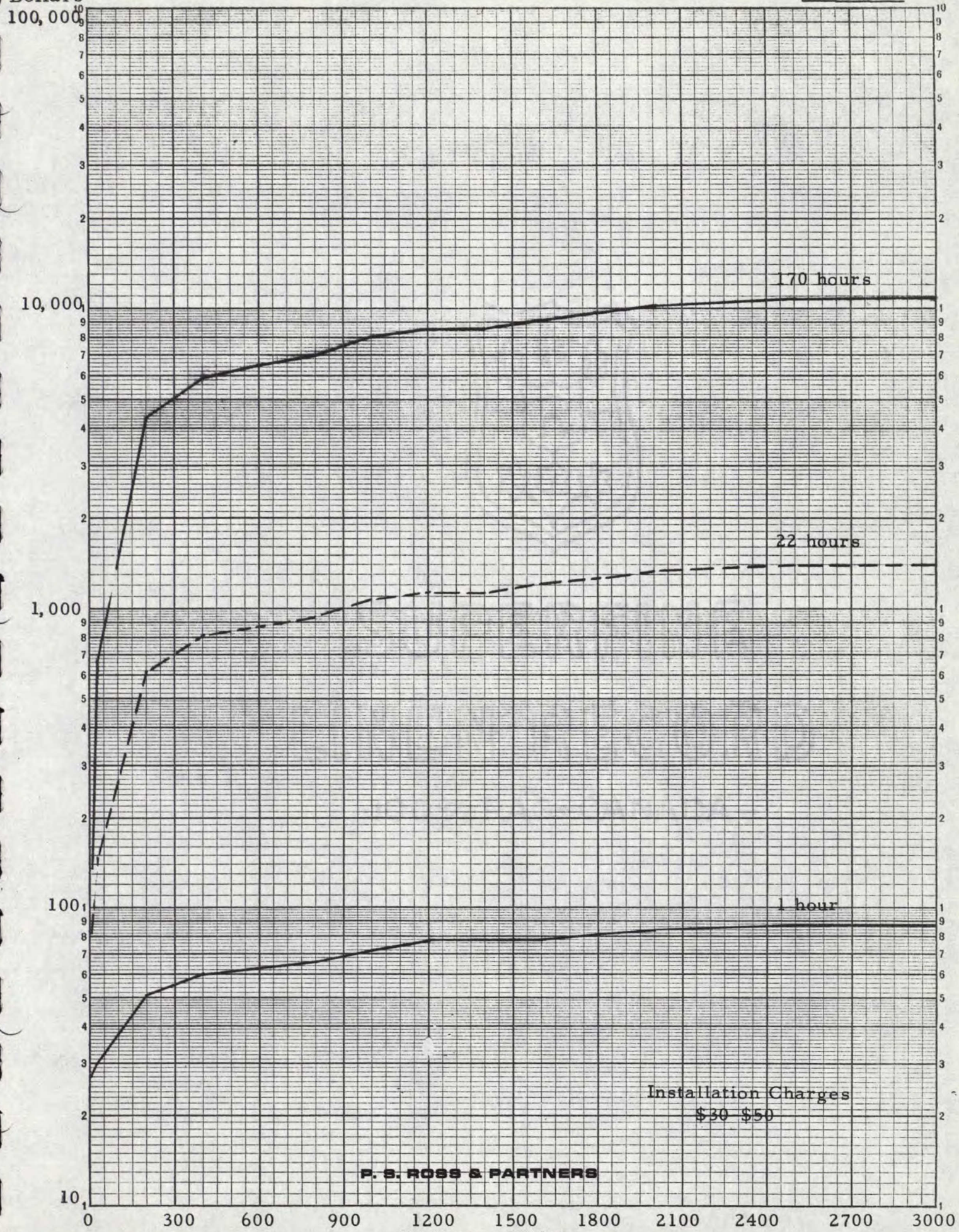
## DATAPHONE

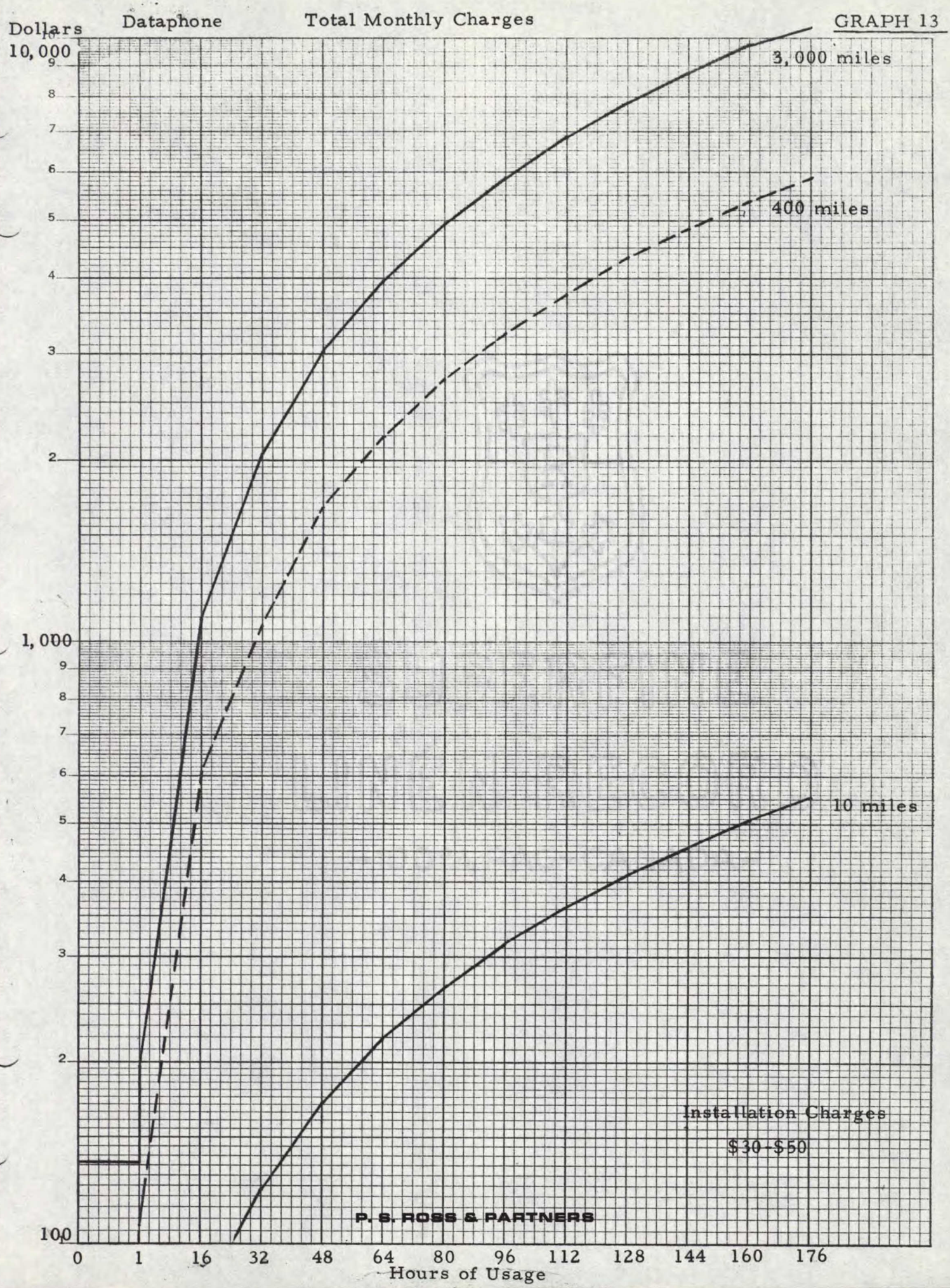
### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

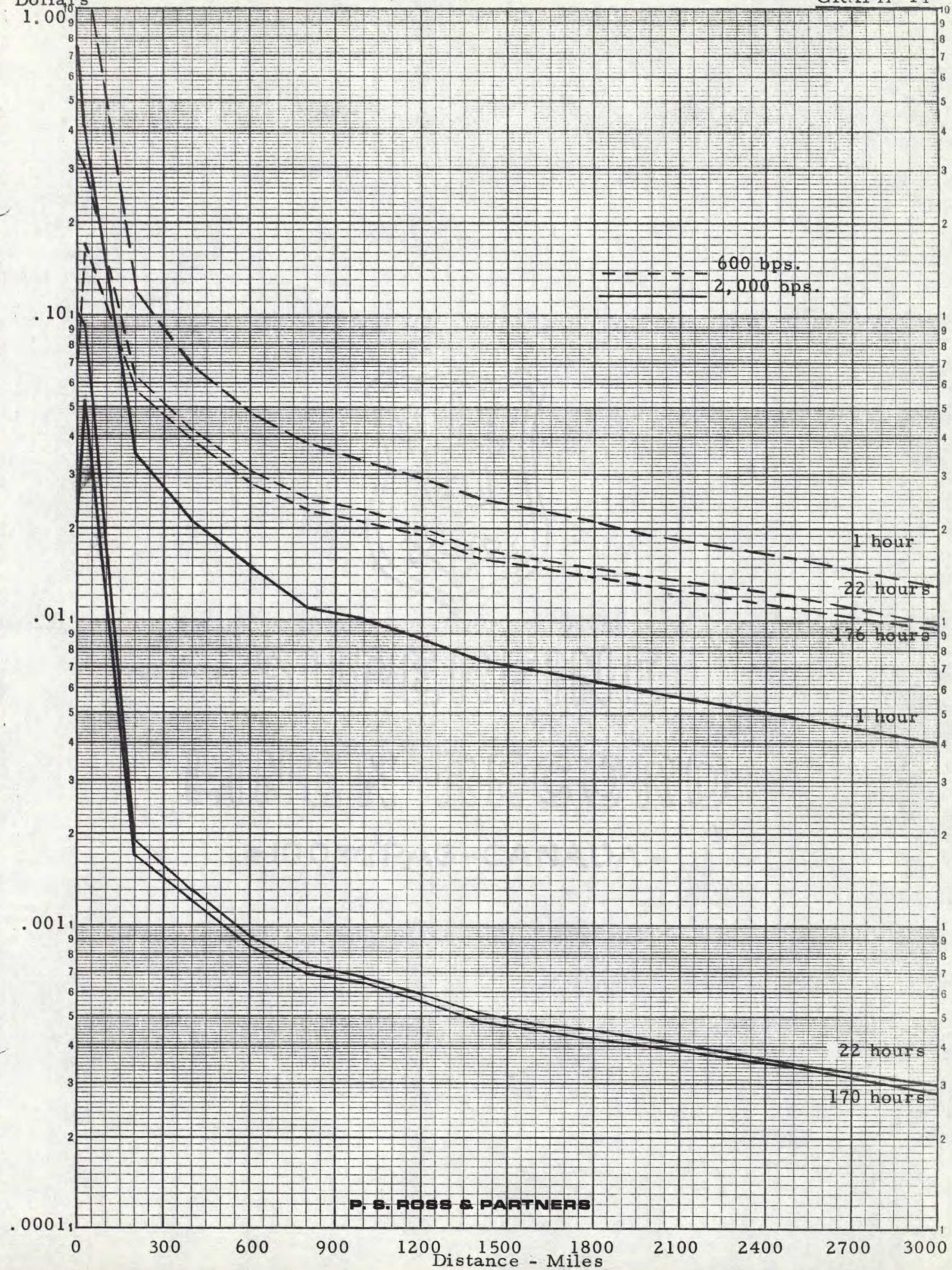
| Time in Hours | 10 Miles | | | 400 Miles | | | 3000 Miles | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Charge | $/10^6 Bits/Mile | | Total Charge | $/10^6 Bits/Mile | | Total Charge | $/10^6 Bits/Mile | |
| | | 600 bps | 2000 bps | | 600 bps | 2000 bps | | 600 bps | 2000 bps |
| 1 | $ 30 | $1.40 | $.42 | $ 115 | $.13 | $.04 | $ 196 | $.03 | $.0091 |
| 16 | 75 | .22 | .065 | 610 | .044 | .0013 | 1096 | .0011 | .00032 |
| 32 | 123 | .18 | .053 | 1138 | .041 | .0012 | 2056 | .00099 | .00030 |
| 48 | 171 | .16 | .049 | 1666 | .040 | .0012 | 3016 | .00097 | .00029 |
| 64 | 219 | .16 | .048 | 2194 | .040 | .0012 | 3976 | .00096 | .00029 |
| 80 | 267 | .15 | .046 | 2722 | .039 | .0012 | 4936 | .00095 | .00029 |
| 96 | 315 | .15 | .046 | 3250 | .039 | .0012 | 5896 | .00095 | .00028 |
| 112 | 363 | .15 | .045 | 3778 | .039 | .0012 | 6856 | .00094 | .00028 |
| 128 | 411 | .15 | .044 | 4306 | .039 | .0012 | 7816 | .00094 | .00028 |
| 144 | 459 | .15 | .044 | 4834 | .039 | .0012 | 8776 | .00094 | .00028 |
| 160 | 507 | .15 | .044 | 5362 | .039 | .0012 | 9736 | .00094 | .00028 |
| 176 | 555 | .15 | .044 | 5890 | .039 | .0012 | 10696 | .00094 | .00028 |

TABLE 8

Dataphone Total Monthly Charges GRAPH 12




Dataphone
Total Monthly Charges
GRAPH 13
Dollars
10,000
9
8
7
6
5
4
3
2
1,000
9
8
7
6
5
4
3
2
100
3,000 miles
400 miles
10 miles
Installation Charges
$30-$50
P. S. ROSS & PARTNERS
0
1
16
32
48
64
80
96
112
128
144
160
176
Hours of Usage


Dataphone
$/Mile/10^6 Bits
GRAPH 14
Dollars
1.00
.10
.01
.001
.0001
600 bps.
2,000 bps.
1 hour
22 hours
176 hours
1 hour
22 hours
170 hours
P. S. ROSS & PARTNERS
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
Distance - Miles

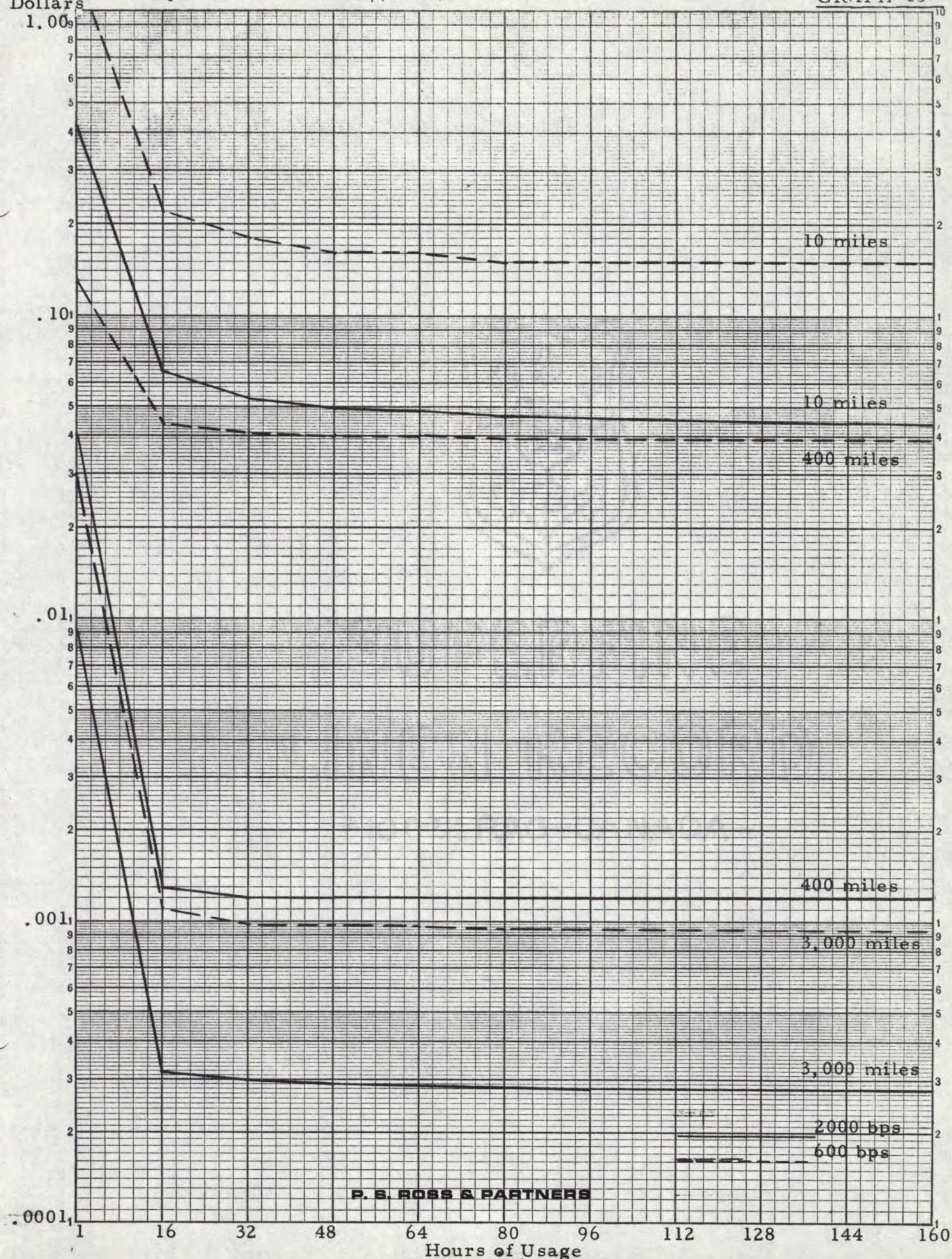

Dataphone
$/Mile/10^6 Bits
GRAPH 15
Dollars
1.00
.10
.01
.001
.0001
10 miles
10 miles
400 miles
400 miles
3,000 miles
3,000 miles
2000 bps
600 bps
P. S. ROSS & PARTNERS
1
16
32
48
64
80
96
112
128
144
160
Hours of Usage

TABLE 9

## BROADBAND

## MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES FOR SPEEDS OF 1800, 2000 AND 2400 BPS

### Total Charges at Various Station Rentals

| Mileage Intervals | One Hour | 22 Hours | 176 Hours |
|---|---|---|---|
| 0 - 350 | $146 | $ 382 | $1426 |
| 350 - 700 | 149 | 448 | 1954 |
| 700 - 1050 | 152 | 514 | 2482 |
| 1050 - 1400 | 158 | 646 | 3538 |
| 1400 - 1750 | 164 | 778 | 4594 |
| 1750 - 2100 | 170 | 910 | 5650 |
| 2100 - 2500 | 176 | 1042 | 6706 |
| 2500 + | 182 | 1174 | 7762 |

TABLE 10

### $/Mile/$10^6$ Bits at Fixed Station Rental

| Mileage Intervals | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| | 1800 bps | 2400 bps | 1800 bps | 2400 bps | 1800 bps | 2400 bps |
| 0 - 350 | $.13 | $.096 | $.011 | $.0082 | $.006 | $.0045 |
| 350 - 700 | .04 | .034 | .0045 | .0034 | .0029 | .0022 |
| 700 - 1050 | .026 | .020 | .0032 | .0024 | .0023 | .0017 |
| 1050 - 1400 | .02 | .015 | .0031 | .0023 | .0024 | .0018 |
| 1400 - 1750 | .015 | .012 | .0029 | .0022 | .0024 | .0018 |
| 1750 - 2100 | .014 | .010 | .0029 | .0022 | .0025 | .0019 |
| 2100 - 2500 | .012 | .0093 | .0029 | .0022 | .0025 | .0019 |
| 2500 + | .009 | .0069 | .0025 | .0018 | .0022 | .0017 |

## BROADBAND

## MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES FOR SPEEDS OF 1800, 2000 AND 2400 BPS

### Total Charges With Station Rentals

| Time in Hours | 175 Miles | 875 Miles | 3000 Miles |
|---|---|---|---|
| 1 | $ 146 | $ 262 | $ 371 |
| 16 | 236 | 442 | 1042 |
| 32 | 332 | 634 | 1714 |
| 48 | 428 | 826 | 2386 |
| 64 | 524 | 1018 | 3058 |
| 80 | 620 | 1210 | 3730 |
| 96 | 716 | 1402 | 4402 |
| 112 | 812 | 1594 | 5074 |
| 128 | 908 | 1786 | 5746 |
| 144 | 1004 | 1978 | 6418 |
| 160 | 1100 | 2170 | 7090 |
| 176 | 1196 | 2362 | 7762 |

TABLE 12

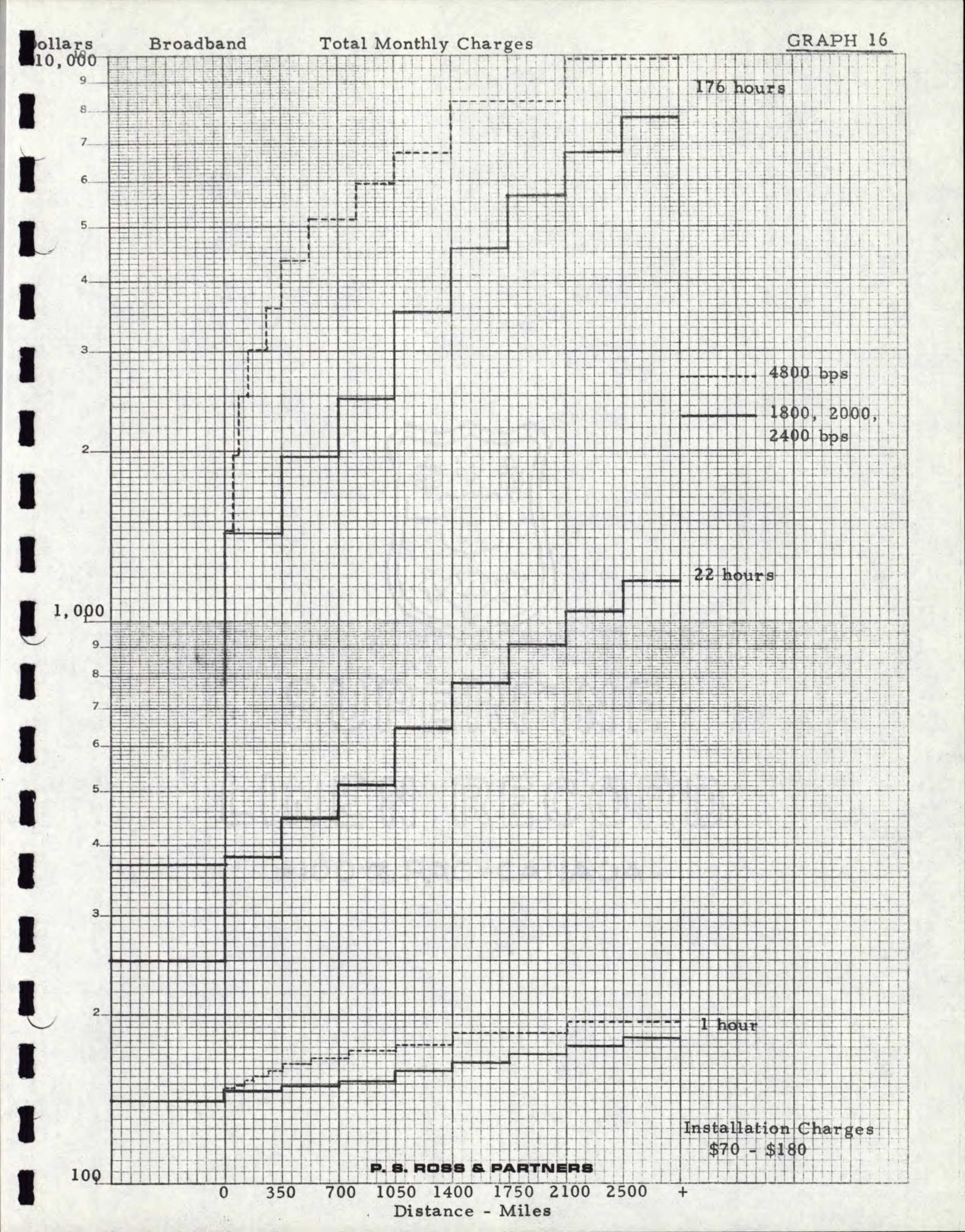
## BROADBAND

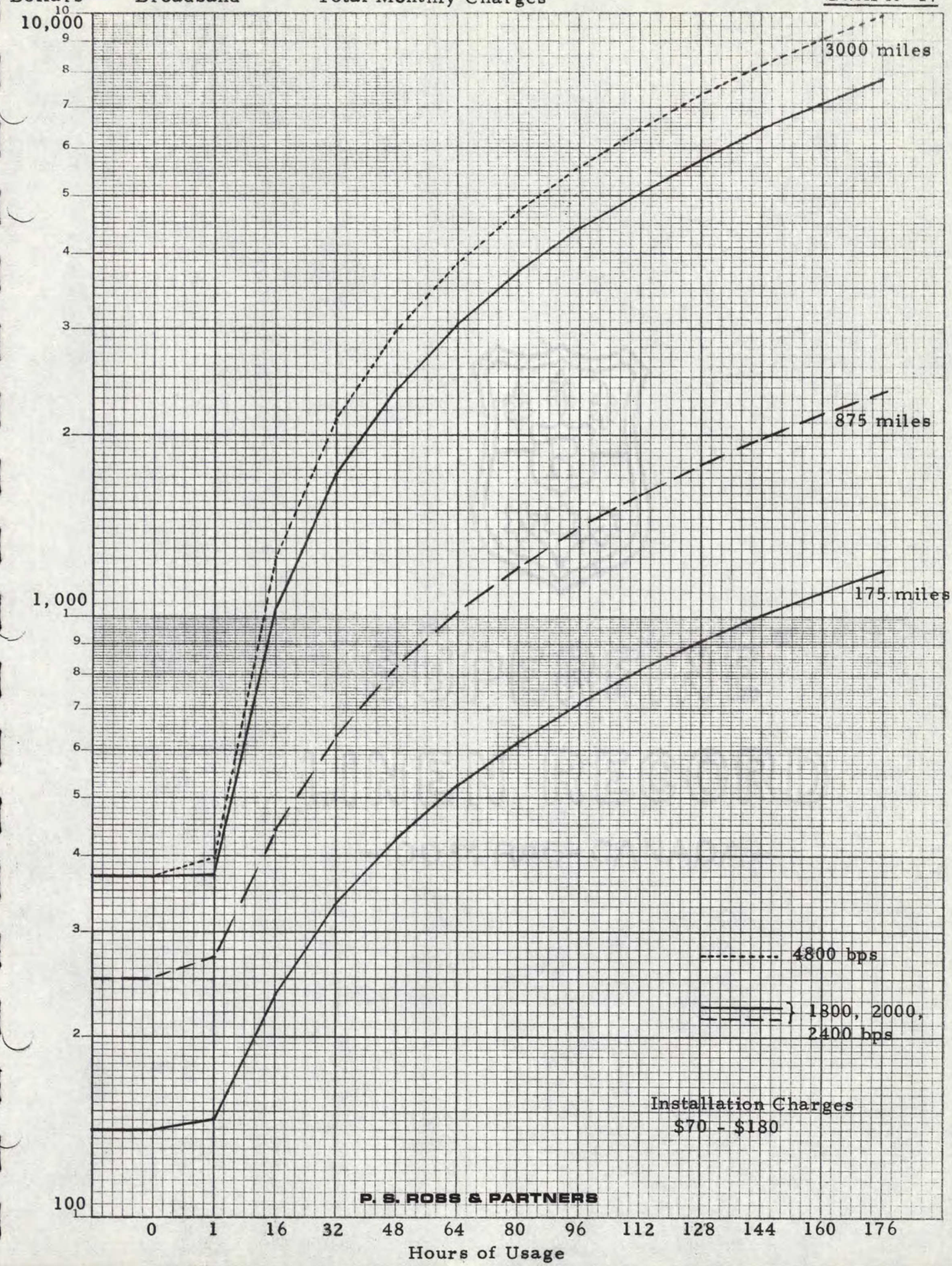
## MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES FOR 4800 BPS

| | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| Mileage Intervals | Total Charge | $/Mile/ $10^6$ Bits | Total Charge | $/Mile/ $10^6$ Bits | Total Charge | $/Mile/ $10^6$ Bits |
| 0 - 25 | $146 | $.42 | $382 | $.05 | $1447 | $.024 |
| 25 - 75 | 149 | .17 | 448 | .024 | 1975 | .013 |
| 75 - 150 | 152 | .08 | 514 | .013 | 2503 | .0075 |
| 150 - 225 | 155 | .047 | 580 | .0082 | 3031 | .0052 |
| 225 - 300 | 158 | .035 | 646 | .0065 | 3559 | .0045 |
| 300 - 500 | 163 | .024 | 745 | .0049 | 4351 | .0036 |
| 500 - 800 | 167 | .014 | 850 | .0035 | 5148 | .0026 |
| 800 - 1100 | 172 | .01 | 945 | .0026 | 5949 | .0021 |
| 1100 - 1400 | 176 | .0081 | 1045 | .0022 | 6727 | .0018 |
| 1400 - 2000 | 185 | .0064 | 1240 | .0019 | 8311 | .0016 |
| 2000 + | 194 | .0042 | 1436 | .0014 | 9876 | .0012 |

TABLE 13

| | 0 - 25 Miles | 300 - 500 Miles | 2000 + Miles |
|---|---|---|---|
| Time in Hours | Total Charge | Total Charge | Total Charge |
| 1 | $ 146 | $ 256 | $ 397 |
| 16 | 236 | 610 | 1255 |
| 32 | 332 | 970 | 2119 |
| 48 | 429 | 1330 | 2983 |
| 64 | 525 | 1690 | 3847 |
| 80 | 621 | 2050 | 4711 |
| 96 | 717 | 2410 | 5575 |
| 112 | 813 | 2770 | 6439 |
| 128 | 910 | 3130 | 7303 |
| 144 | 1006 | 3490 | 8167 |
| 160 | 1102 | 3850 | 9031 |
| 176 | 1198 | 4250 | 9895 |


ollars
10,000
9
8
7
6
5
4
3
2
1,000
9
8
7
6
5
4
3
2
100
Broadband
Total Monthly Charges
GRAPH 16
176 hours
4800 bps
1800, 2000,
2400 bps
22 hours
1 hour
Installation Charges
$70 - $180
P. S. ROSS & PARTNERS
0
350
700
1050
1400
1750
2100
2500
+
Distance - Miles


Dollars
Broadband
Total Monthly Charges
GRAPH 17
10,000
1,000
100
3000 miles
875 miles
175 miles
4800 bps
1800, 2000, 2400 bps
Installation Charges
$70 - $180
P. S. ROSS & PARTNERS
0
1
16
32
48
64
80
96
112
128
144
160
176
Hours of Usage

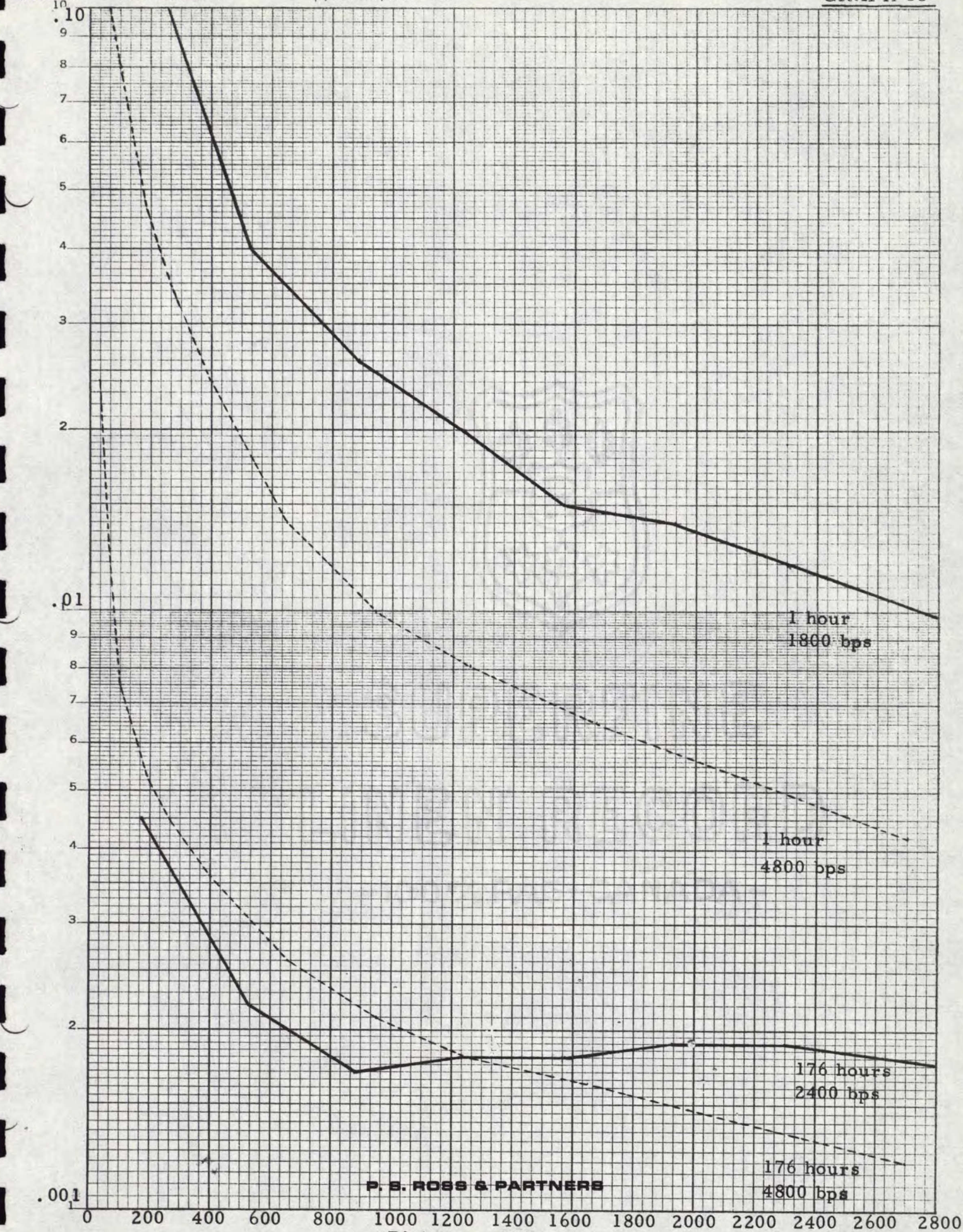

Dollars
Broadband
$/Mile/10^6 bits
GRAPH 18
.10
.01
.001
1 hour
1800 bps
1 hour
4800 bps
176 hours
2400 bps
176 hours
4800 bps
P. S. ROSS & PARTNERS
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800
Distance - Miles

TABLE 14

MULTICOM

TOTAL MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES FOR MEDIUM SPEED SERVICES

2400 BPS

| | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| Mileage Intervals | Total Charges | $/Mile/ $10^6$ Bits | Total Charges | $/Mile/ $10^6$ Bits | Total Charges | $/Mile/ $10^6$ Bits |
| 0 - 200 | $117 | $.14 | $306 | $.016 | $1293 | $.0085 |
| 200 - 425 | 117 | .045 | 306 | .0054 | 1293 | .0028 |
| 425 - 650 | 120 | .028 | 372 | .0039 | 1821 | .0024 |
| 650 - 1000 | 123 | .017 | 438 | .0029 | 2349 | .0019 |
| 1000 - 1400 | 129 | .013 | 570 | .0025 | 3405 | .0019 |
| 1400 - 1800 | 135 | .0097 | 702 | .0023 | 4461 | .0018 |
| 1800 - 2200 | 141 | .0082 | 834 | .0022 | 5517 | .0018 |
| 2200 + | 147 | .0061 | 966 | .0018 | 6573 | .0015 |

TABLE 15

4800 BPS

| | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| Representative Mileages | Total Charges | $/Mile/ $10^6$ Bits | Total Charges | $/Mile/ $10^6$ Bits | Total Charges | $/Mile/ $10^6$ Bits |
| 100 | $120 | $.069 | $372 | $.0098 | $1821 | $.006 |
| 300 | 126 | .024 | 504 | .0044 | 2877 | .0032 |
| 500 | 132 | .015 | 636 | .0033 | 3933 | .0026 |
| 800 | 138 | .0098 | 768 | .0025 | 4989 | .0021 |
| 1200 | 144 | .0069 | 900 | .0020 | 6045 | .0017 |
| 1600 | 150 | .0054 | 1032 | .0017 | 7101 | .0015 |
| 2000 | 156 | .0045 | 1164 | .0015 | 8157 | .0013 |
| 2800 | 162 | .0034 | 1296 | .0012 | 9213 | .0011 |

TABLE 16

MULTICOM

TOTAL MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES FOR HIGH SPEED SERVICES

19,200 BPS

| Representative Mileages | One Hour Total Charges | One Hour $/Mile/$10^6$ Bits | 22 Hours Total Charges | 22 Hours $/Mile/$10^6$ Bits | 176 Hours Total Charges | 176 Hours $/Mile/$10^6$ Bits |
|---|---|---|---|---|---|---|
| 100 | $730 | $.11 | $2942 | $.019 | $19120 | $.016 |
| 300 | 760 | .037 | 3602 | .0079 | 24400 | .0067 |
| 500 | 790 | .023 | 4262 | .0056 | 29680 | .0049 |
| 800 | 820 | .015 | 4922 | .0040 | 34960 | .0036 |
| 1200 | 850 | .010 | 5582 | .0031 | 40240 | .0028 |
| 1600 | 865 | .0078 | 5912 | .0024 | 42880 | .0022 |
| 2000 | 865 | .0062 | 5912 | .0019 | 42880 | .0018 |
| 2800 | 865 | .0045 | 5912 | .0014 | 42880 | .0013 |

TABLE 17

50,000 BPS

| Representative Mileages | One Hour Total Charges | One Hour $/Mile/$10^6$ Bits | 22 Hours Total Charges | 22 Hours $/Mile/$10^6$ Bits | 176 Hours Total Charges | 176 Hours $/Mile/$10^6$ Bits |
|---|---|---|---|---|---|---|
| 100 | $ 785 | $.044 | $ 5202 | $.013 | $37550 | $.012 |
| 300 | 845 | .016 | 6522 | .0055 | 48110 | .0051 |
| 500 | 905 | .010 | 7842 | .0040 | 58670 | .0037 |
| 800 | 965 | .0067 | 9162 | .0029 | 69230 | .0027 |
| 1200 | 1025 | .0047 | 10482 | .0022 | 79790 | .0021 |
| 1600 | 1055 | .0037 | 11142 | .0018 | 85070 | .0017 |
| 2000 | 1055 | .0029 | 11142 | .0014 | 85070 | .0013 |
| 2800 | 1055 | .0021 | 11142 | .0010 | 85070 | .0010 |

MULTICOM

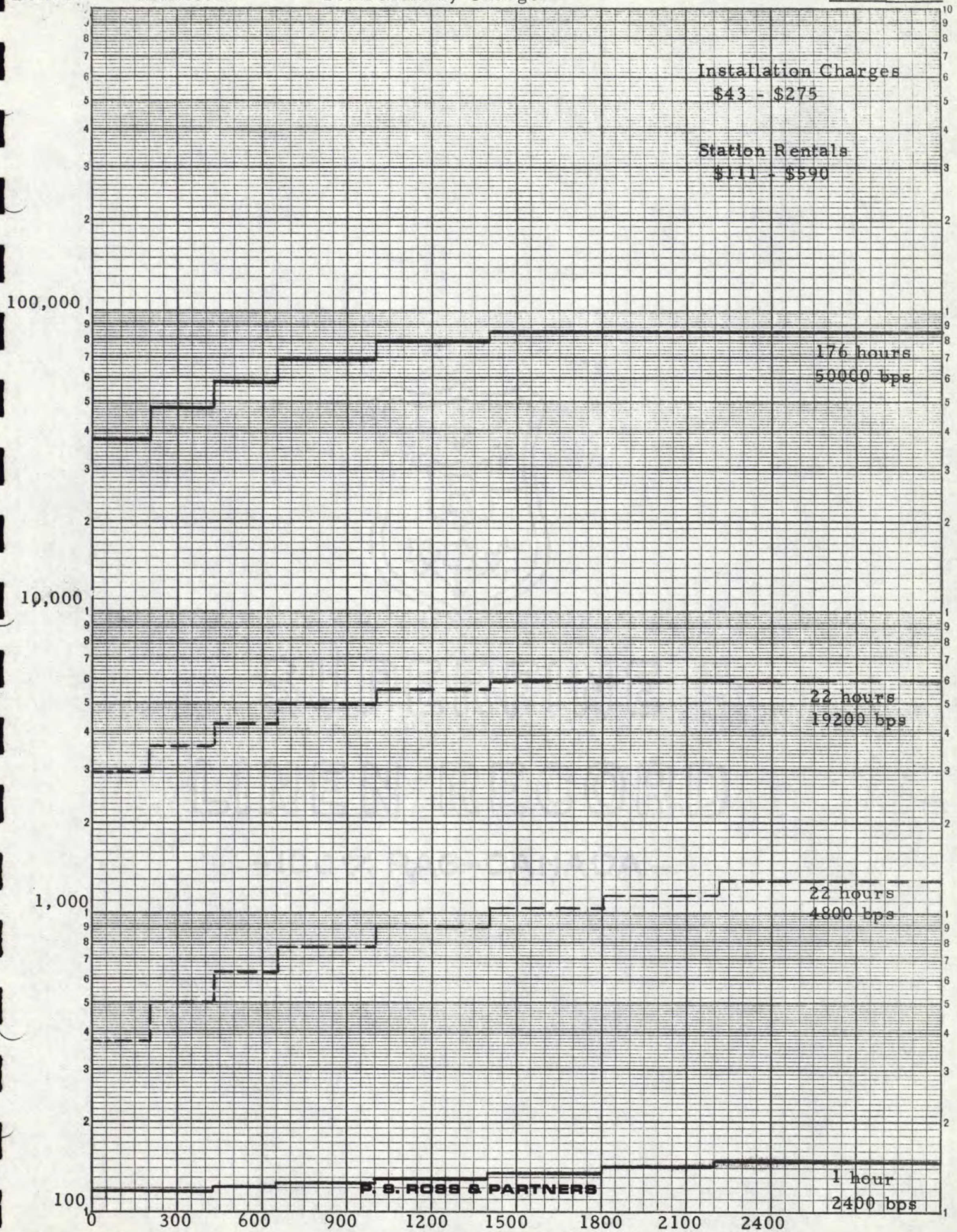
TOTAL MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| | 2400 BPS | | | | 50,000 BPS | | | |
|---|---|---|---|---|---|---|---|---|
| | 100 Miles | | 2800 Miles | | 100 Miles | | 2800 Miles | |
| Time in Hours | Total Charges | $/10^6 Bits/ Mile | Total Charges | $/10^6 Bits/ Mile | Total Charges | $/10^6 Bits/ Mile | Total Charges | $/10^6 Bits Mile |
| 1 | $ 117 | $.14 | $ 273 | $.011 | 785 | $.044 | 1070 | $.0021 |
| 16 | 207 | .015 | 813 | .0021 | 3935 | .014 | 8270 | .0010 |
| 32 | 303 | .011 | 1389 | .0018 | 7295 | .013 | 15950 | .00099 |
| 48 | 399 | .0096 | 1965 | .0017 | 10655 | .012 | 23630 | .00098 |
| 64 | 495 | .0089 | 2541 | .0016 | 14015 | .012 | 31310 | .00097 |
| 80 | 591 | .0085 | 3117 | .0016 | 17375 | .012 | 38990 | .00096 |
| 96 | 687 | .0082 | 3693 | .0016 | 20735 | .012 | 46670 | .00096 |
| 112 | 783 | .0080 | 4269 | .0016 | 24095 | .012 | 54350 | .00096 |
| 128 | 879 | .0079 | 4845 | .0016 | 27455 | .012 | 62030 | .00096 |
| 144 | 975 | .0078 | 5421 | .0016 | 30815 | .012 | 69710 | .00096 |
| 160 | 1071 | .0077 | 5997 | .0015 | 34175 | .012 | 77390 | .00096 |
| 176 | 1167 | .0076 | 6573 | .0015 | 37535 | .012 | 85070 | .00096 |

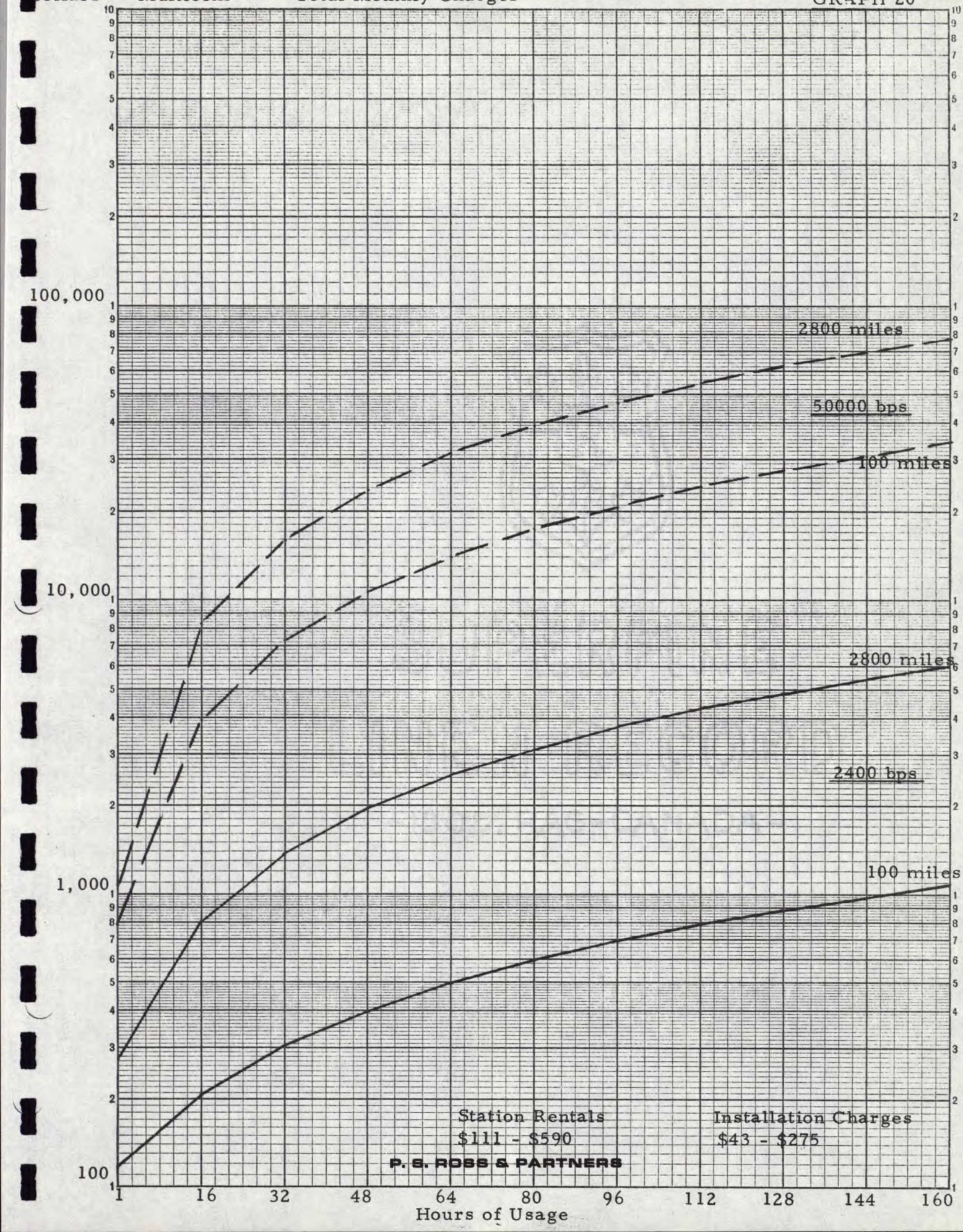


TABLE 18

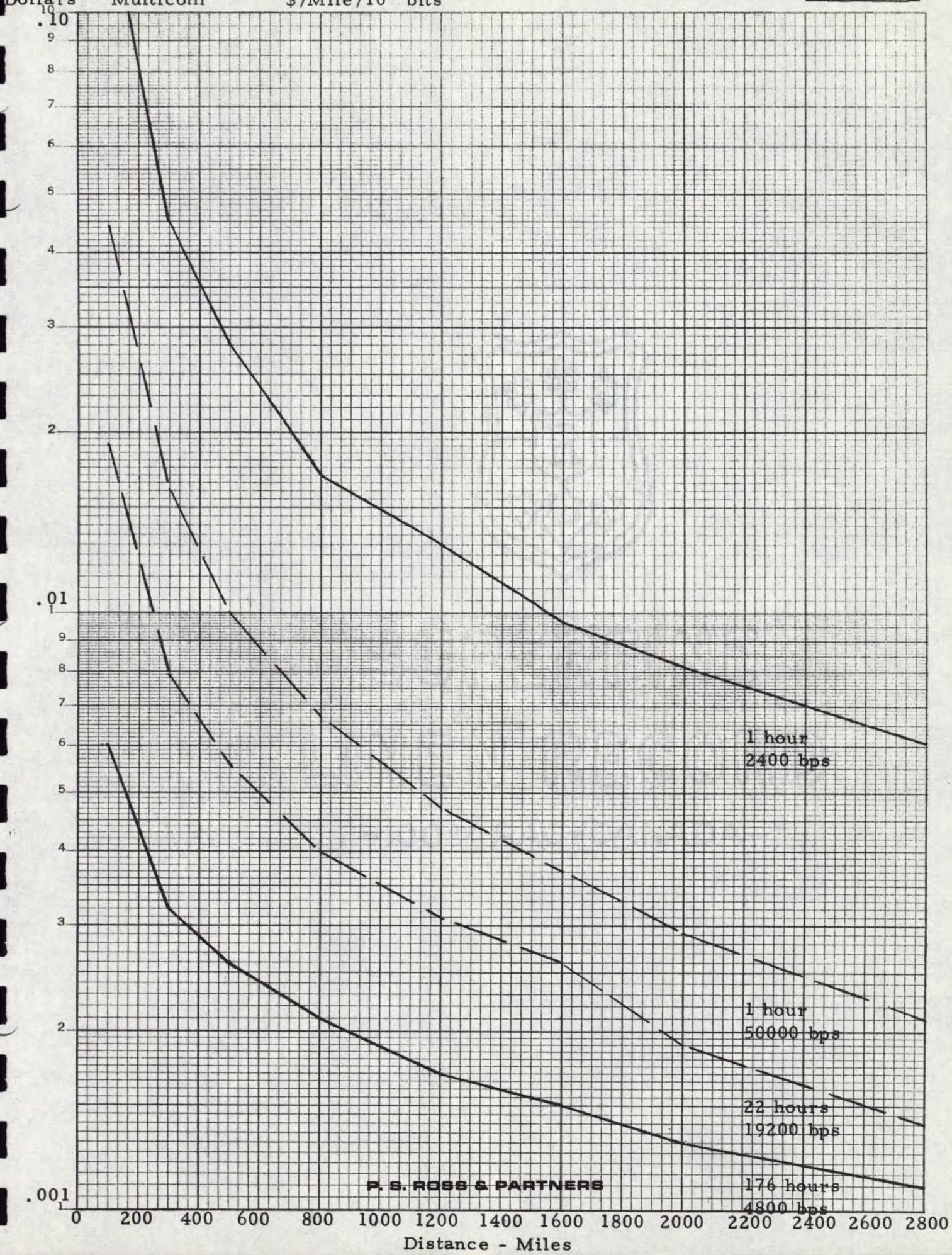
Dollars Multicom Total Monthly Charges GRAPH 19

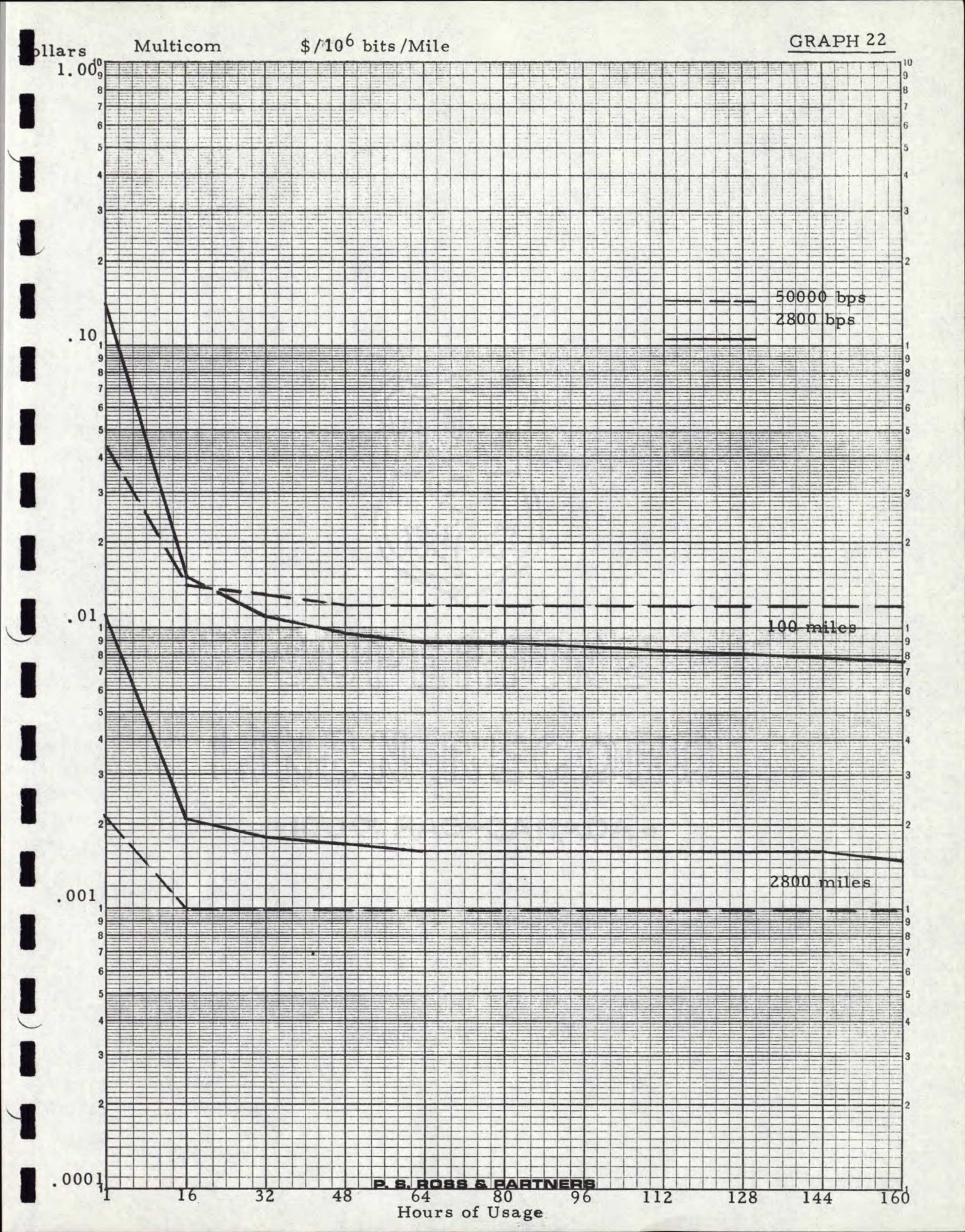


Dollars Multicom Total Monthly Charges GRAPH 20



GRAPH 21


Dollars
Multicom
$/Mile/10^6 bits
10
.10
9
8
7
6
5
4
3
2
.01
1
9
8
7
6
5
4
3
2
.001
1
1 hour
2400 bps
1 hour
50000 bps
22 hours
19200 bps
176 hours
4800 bps
P. S. ROSS & PARTNERS
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Distance - Miles


Dollars
Multicom
$/10^6 bits/Mile
GRAPH 22
1.00
.10
.01
.001
.0001
50000 bps
2800 bps
100 miles
2800 miles
1
16
32
48
64
80
96
112
128
144
160
Hours of Usage
P. S. ROSS & PARTNERS

## DATASPEED

### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| Representative Mileages | One Hour | | | 22 Hours | | | 176 Hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Charge | $/Mile/$10^6$ Bits | | Total Charge | $/Mile/$10^6$ Bits | | Total Charge | $/Mile/$10^6$ Bits | |
| | | 600 bps | 1200 bps | | 600 bps | 1200 bps | | 600 bps | 1200 bps |
| Local (5) | $ 91 | $8.70 | $4.20 | $ 235 | $.99 | $.49 | $ 379 | $.20 | $.10 |
| 10 | 94 | 4.50 | 2.20 | 301 | .63 | .32 | 907 | .24 | .12 |
| 200 | 115 | 2.70 | 1.30 | 763 | .08 | .04 | 4603 | .061 | .030 |
| 400 | 124 | 1.50 | .72 | 961 | .05 | .025 | 6187 | .041 | .020 |
| 600 | 127 | 1.00 | .49 | 1027 | .035 | .018 | 6715 | .029 | .015 |
| 800 | 130 | .77 | .38 | 1093 | .027 | .013 | 7243 | .024 | .012 |
| 1000 | 136 | .65 | .32 | 1225 | .026 | .013 | 8299 | .022 | .011 |
| 1200 | 139 | .55 | .27 | 1291 | .023 | .011 | 8827 | .019 | .010 |
| 1400 | 139 | .47 | .23 | 1291 | .019 | .0097 | 8827 | .017 | .0083 |
| 1600 | 142 | .42 | .21 | 1357 | .018 | .0089 | 9355 | .015 | .0077 |
| 1800 | 145 | .38 | .19 | 1423 | .017 | .0083 | 9883 | .014 | .0072 |
| 2000 | 148 | .35 | .17 | 1489 | .016 | .0078 | 10411 | .014 | .0068 |
| 2500 | 151 | .29 | .14 | 1555 | .013 | .0065 | 10939 | .012 | .0058 |
| 3000 | 151 | .24 | .12 | 1555 | .011 | .0055 | 10939 | .0096 | .0048 |

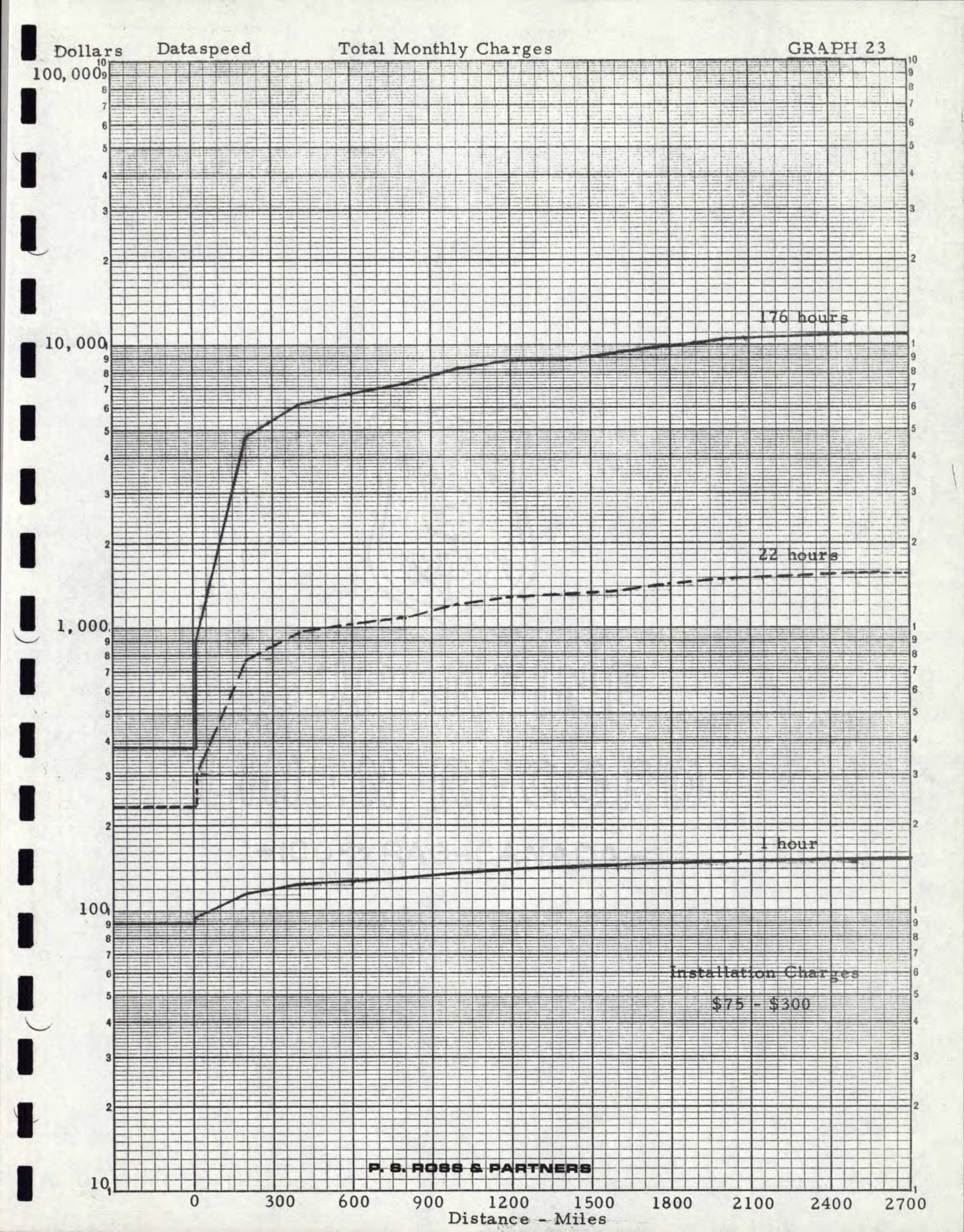
TABLE 19

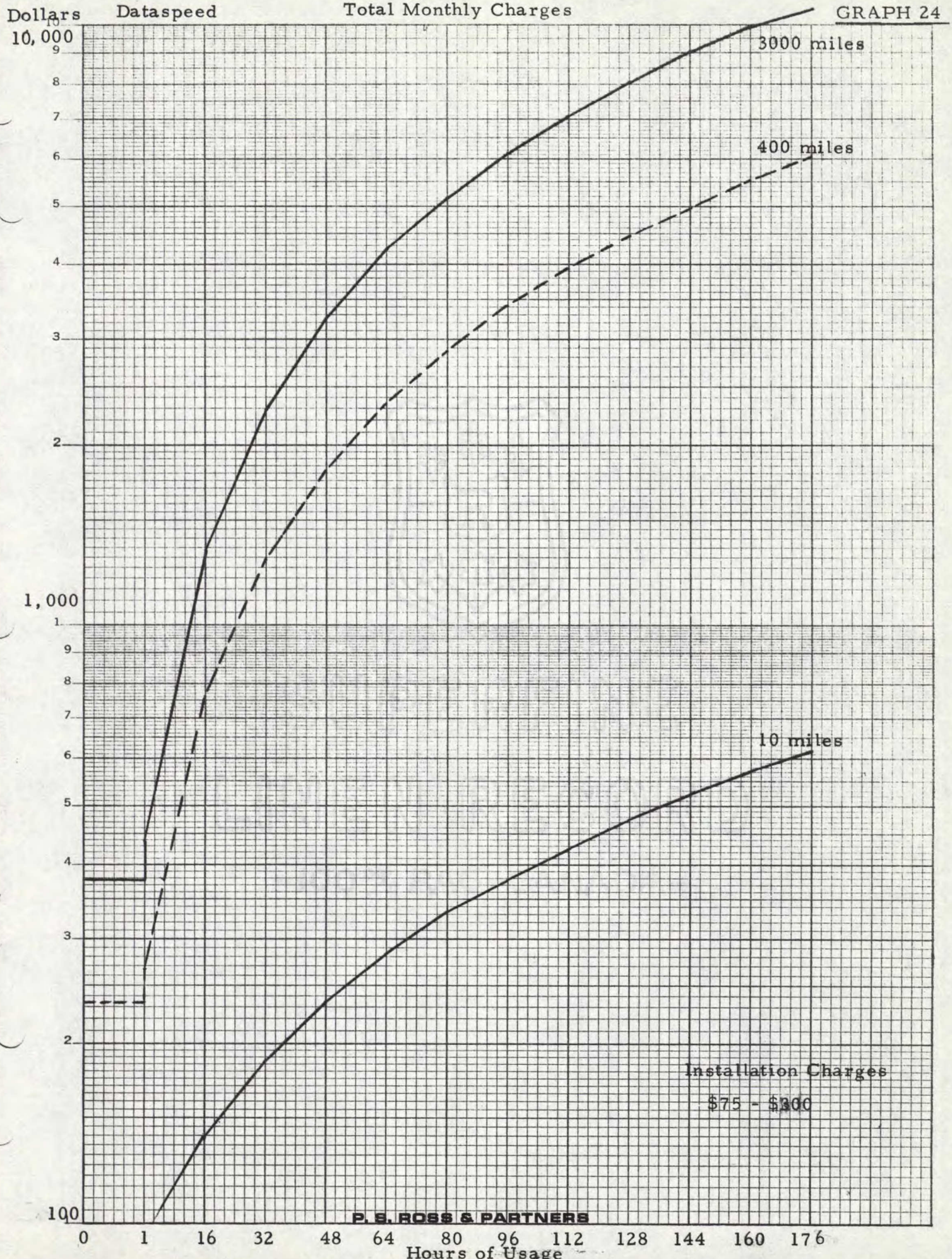
DATASPEED

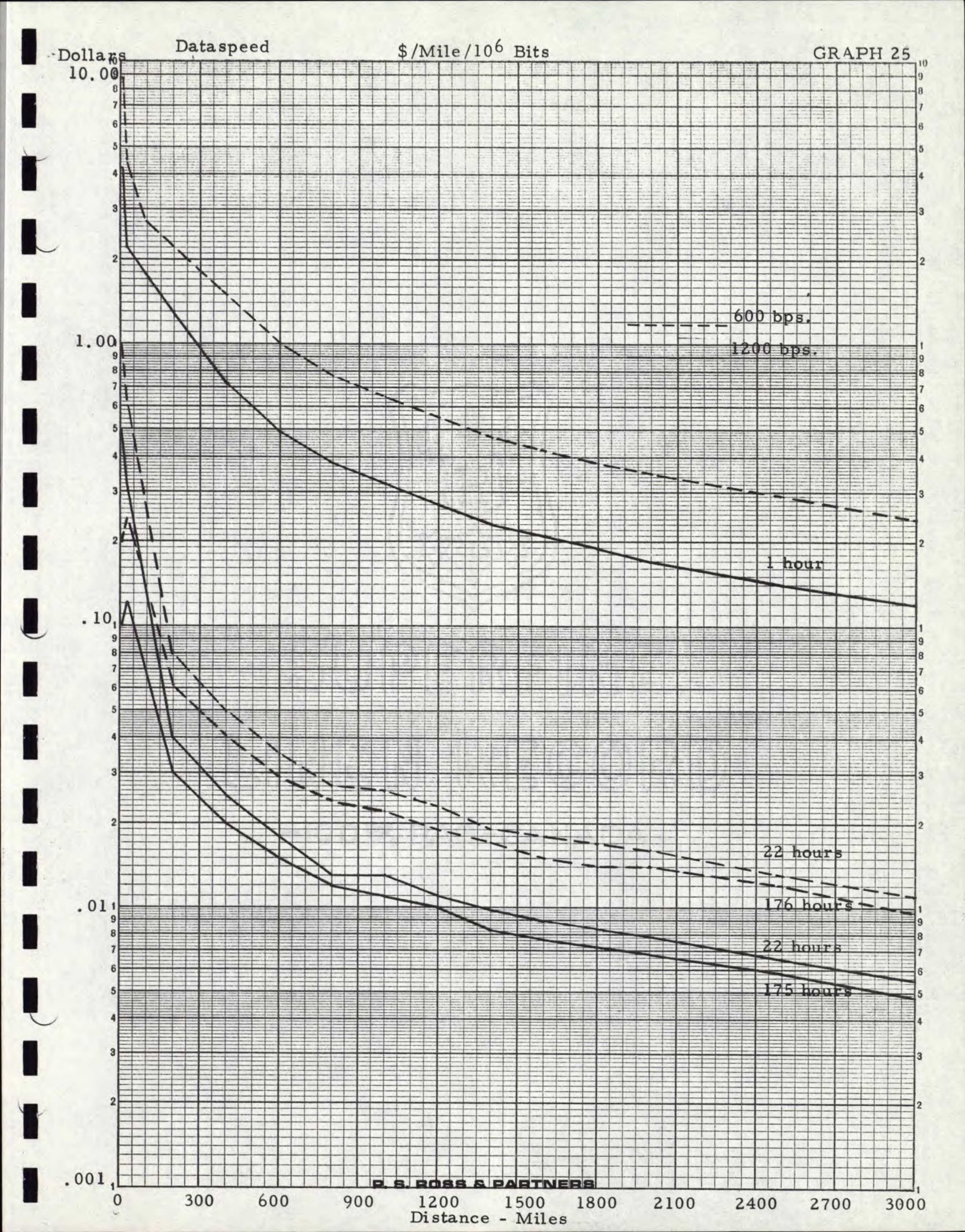
MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| Time in Hours | 10 Miles | | | 400 Miles | | | 3000 Miles | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Charge | $/10^6 Bits/Mile | | Total Charge | $/10^6 Bits/Mile | | Total Charge | $/10^6 Bits Mile | |
| | | 600 bps | 1200 bps | | 600 bps | 1200 bps | | 600 bps | 1200 bps |
| 1 | $ 94 | $4.35 | $2.18 | $ 268 | $.31 | $.16 | $ 439 | $.068 | $.034 |
| 16 | 139 | .40 | .20 | 763 | .055 | .028 | 1339 | .013 | .0065 |
| 32 | 187 | .27 | .14 | 1291 | .047 | .023 | 2299 | .011 | .0056 |
| 48 | 235 | .23 | .11 | 1819 | .044 | .022 | 3259 | .010 | .0053 |
| 64 | 283 | .21 | .10 | 2347 | .043 | .021 | 4219 | .010 | .0051 |
| 80 | 331 | .19 | .096 | 2875 | .042 | .021 | 5179 | .010 | .0050 |
| 96 | 379 | .18 | .091 | 3403 | .041 | .021 | 6139 | .010 | .0049 |
| 112 | 427 | .18 | .088 | 3931 | .041 | .020 | 7099 | .0098 | .0049 |
| 128 | 475 | .17 | .086 | 4459 | .040 | .020 | 8059 | .0097 | .0048 |
| 144 | 523 | .17 | .084 | 4987 | .040 | .020 | 9019 | .0097 | .0048 |
| 160 | 571 | .16 | .083 | 5515 | .040 | .020 | 9979 | .0096 | .0048 |
| 176 | 619 | .15 | .081 | 6043 | .040 | .020 | 10939 | .0096 | .0048 |

TABLE 20


Dollars
Dataspeed
Total Monthly Charges
GRAPH 23
100,000
10,000
1,000
100
176 hours
22 hours
1 hour
Installation Charges
$75 - $300
P. S. ROSS & PARTNERS
0
300
600
900
1200
1500
1800
2100
2400
2700
Distance - Miles


Dollars
Dataspeed
Total Monthly Charges
GRAPH 24
10,000
1,000
100
3000 miles
400 miles
10 miles
Installation Charges
$75 - $300
P. S. ROSS & PARTNERS
0
1
16
32
48
64
80
96
112
128
144
160
176
Hours of Usage


Dollars
Dataspeed
$/Mile/10^6 Bits
GRAPH 25
10.00
1.00
.10
.01
.001
600 bps.
1200 bps.
1 hour
22 hours
176 hours
22 hours
175 hours
P. S. ROSS & PARTNERS
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
Distance - Miles

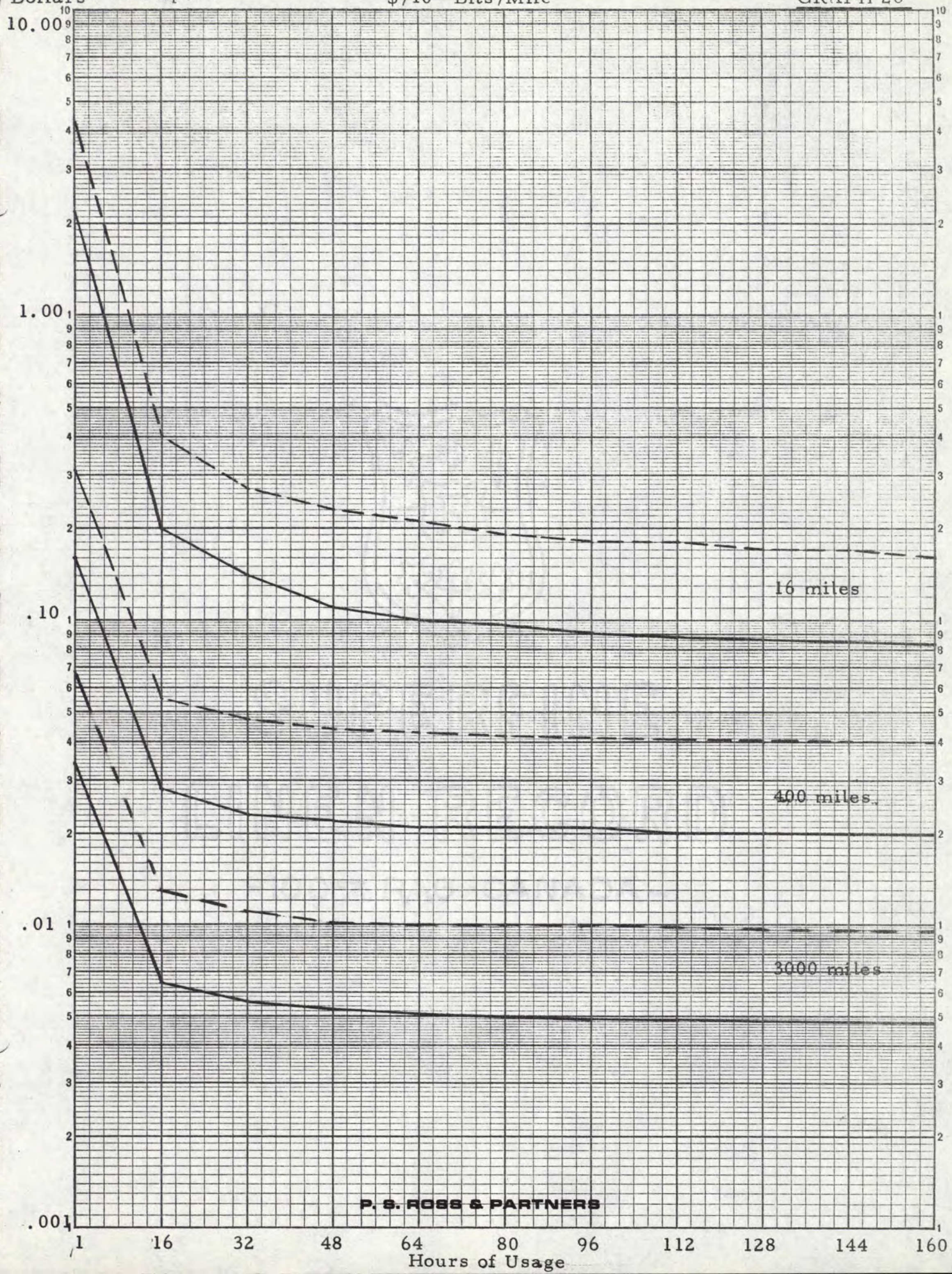

Dollars Dataspeed
$/10^6 Bits/Mile
GRAPH 26
10.00
1.00
.10
.01
.001
16 miles
400 miles
3000 miles
P. S. ROSS & PARTNERS
1
16
32
48
64
80
96
112
128
144
160
Hours of Usage

TABLE 21

## TELEX COMPUTER INQUIRY SERVICE

### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| Mileage Intervals | One Station | | 12 Stations | | 25 Stations | |
|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station |
| Local | $355 | $35.50 | $ 585 | $4.88 | $ 925 | $3.70 |
| 0- 50 | 380 | 15.20 | 835 | 2.78 | 1175 | 1.88 |
| 51- 125 | 390 | 4.33 | 945 | .87 | 1350 | .60 |
| 126- 225 | 415 | 2.37 | 1215 | .59 | 1750 | .40 |
| 226- 350 | 440 | 1.52 | 1485 | .43 | 2150 | .30 |
| 351- 550 | 475 | 1.08 | 1855 | .34 | 2650 | .24 |
| 551- 750 | 525 | .81 | 2405 | .31 | 3525 | .22 |
| 751- 950 | 575 | .68 | 2945 | .29 | 4325 | .20 |
| 951-1150 | 625 | .59 | 3485 | .28 | 5125 | .20 |
| 1151-1350 | 675 | .54 | 4025 | .27 | 5925 | .19 |
| 1351-1550 | 725 | .50 | 4565 | .26 | 6725 | .19 |
| 1551-1950 | 800 | .49 | 5375 | .26 | 7925 | .18 |
| 1951-2350 | 875 | .41 | 6185 | .24 | 9125 | .17 |
| 2351 + | 975 | .34 | 7265 | .21 | 10725 | .15 |

## TELEX COMPUTER INQUIRY SERVICE

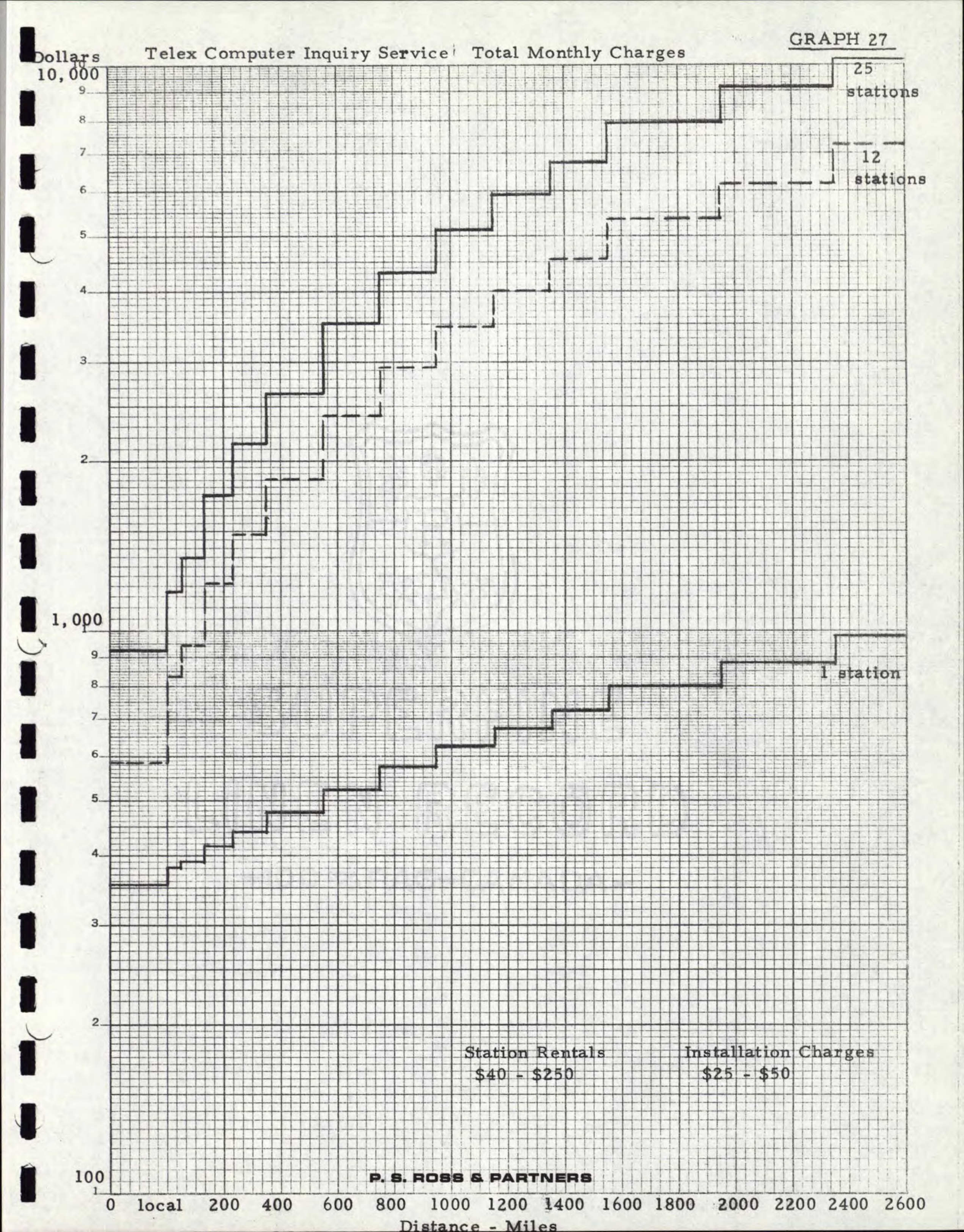
### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

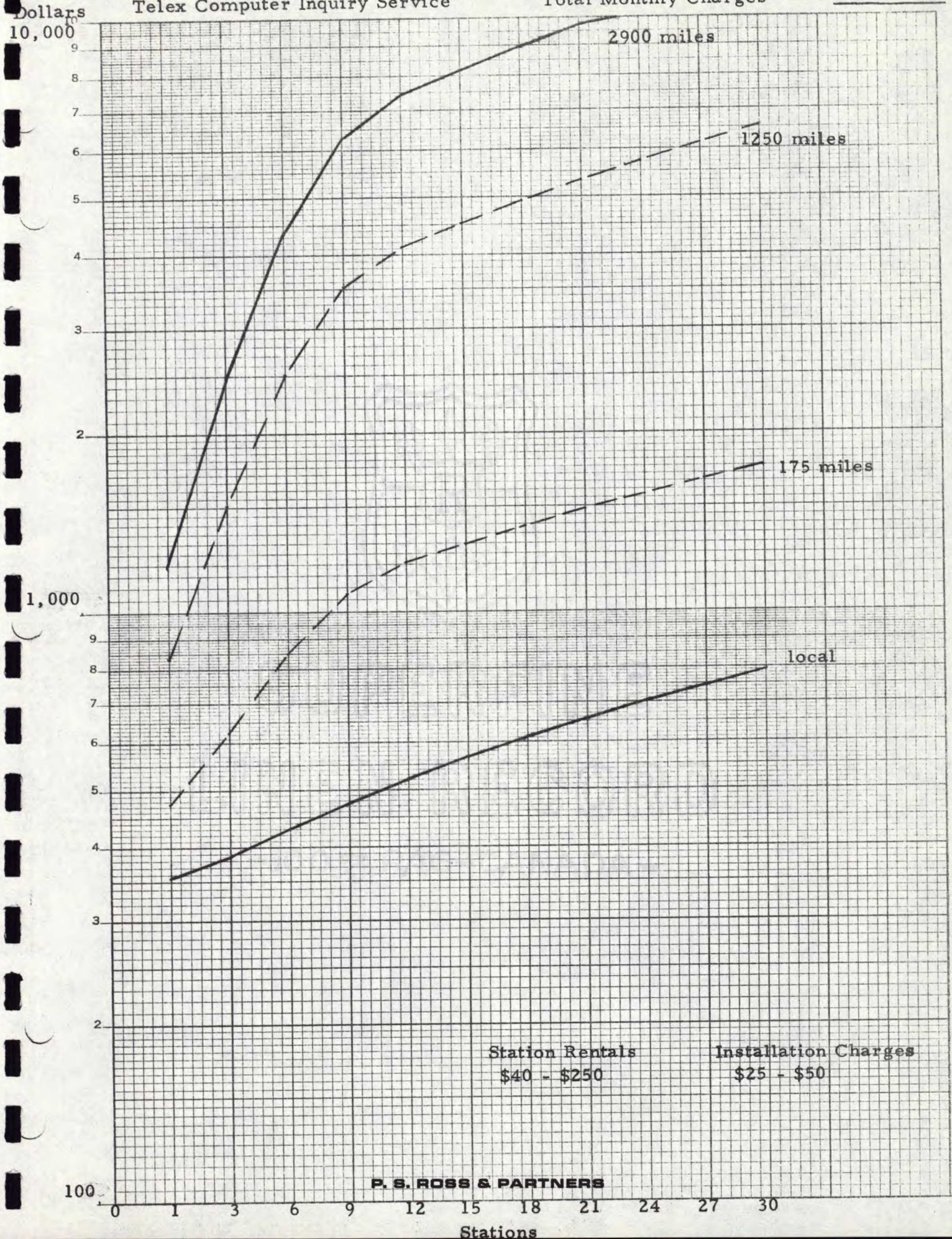
| | Local (10 Miles) | | 175 Miles | | 1250 Miles | | 2900 Miles | |
|---|---|---|---|---|---|---|---|---|
| Number of Stations | Total Charges | $/Station/ Mile | Total Charges | $/Station/ Mile | Total Charges | $/Station/ Mile | Total Charges | $/Station/ Mile |
| 1 | $355 | $35.50 | $475 | $2.70 | $ 835 | $.67 | $ 1185 | $.41 |
| 3 | 385 | 12.80 | 625 | 1.19 | 1505 | .40 | 2455 | .28 |
| 6 | 430 | 7.20 | 850 | .81 | 2510 | .33 | 4360 | .25 |
| 9 | 475 | 5.30 | 1075 | .68 | 3515 | .31 | 6265 | .24 |
| 12 | 520 | 4.30 | 1210 | .58 | 4120 | .28 | 7410 | .21 |
| 15 | 565 | 3.80 | 1300 | .50 | 4525 | .24 | 8175 | .19 |
| 18 | 610 | 3.40 | 1390 | .44 | 4930 | .22 | 8940 | .17 |
| 21 | 655 | 3.10 | 1480 | .40 | 5335 | .20 | 9705 | .16 |
| 24 | 700 | 2.90 | 1570 | .37 | 5740 | .19 | 10470 | .15 |
| 27 | 745 | 2.80 | 1660 | .35 | 6145 | .18 | 11235 | .14 |
| 30 | 790 | 2.60 | 1750 | .33 | 6550 | .17 | 12000 | .14 |



TABLE 22

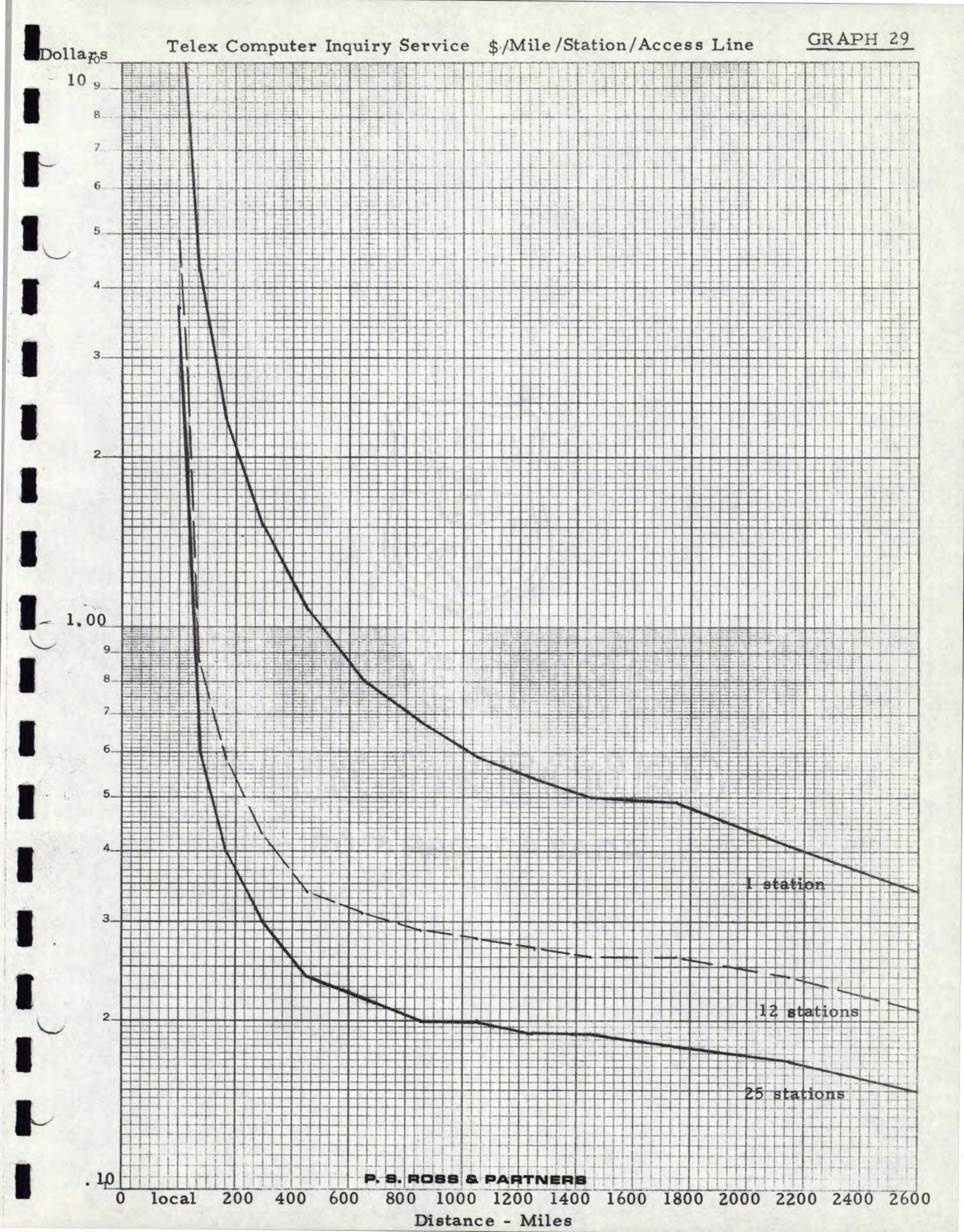
GRAPH 27


Telex Computer Inquiry Service Total Monthly Charges
Dollars
10,000
1,000
100
25 stations
12 stations
1 station
Station Rentals
$40 - $250
Installation Charges
$25 - $50
P. S. ROSS & PARTNERS
0 local 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600
Distance - Miles


Telex Computer Inquiry Service
Total Monthly Charges
GRAPH 28
Dollars
10,000
9
8
7
6
5
4
3
2
1,000
9
8
7
6
5
4
3
2
100
2900 miles
1250 miles
175 miles
local
Station Rentals
$40 - $250
Installation Charges
$25 - $50
P. S. ROSS & PARTNERS
0
1
3
6
9
12
15
18
21
24
27
30
Stations

Telex Computer Inquiry Service $/Mile/Station/Access Line

GRAPH 29



GRAPH 30

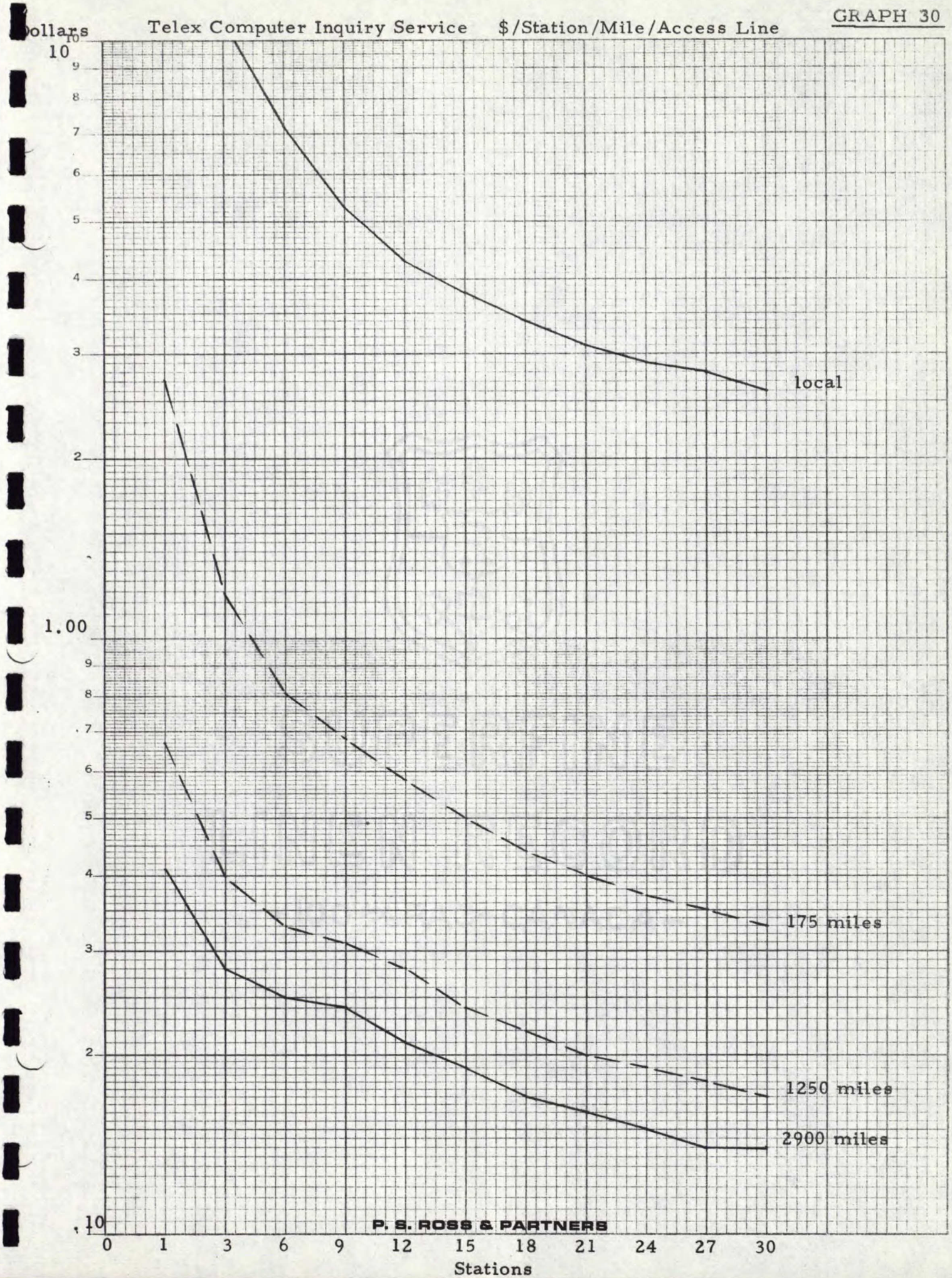

Dollars
Telex Computer Inquiry Service $/Station/Mile/Access Line
10
9
8
7
6
5
4
3
2
1.00
9
8
7
6
5
4
3
2
.10
local
175 miles
1250 miles
2900 miles
P. S. ROSS & PARTNERS
0
1
3
6
9
12
15
18
21
24
27
30
Stations

TABLE 23

## DATALINE II

### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| Mileage Intervals | One Station | | 10 Stations | | 25 Stations | |
|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station |
| 0- 50 | $390 | $15.60 | $ 800 | $ 3.20 | $ 1075 | $ 1.72 |
| 51- 126 | 400 | 4.44 | 900 | 1.00 | 1250 | .56 |
| 126- 225 | 425 | 2.43 | 1150 | .66 | 1650 | .38 |
| 226- 350 | 450 | 1.55 | 1400 | .48 | 2050 | .28 |
| 351- 550 | 485 | 1.08 | 1750 | .39 | 2550 | .23 |
| 551- 750 | 535 | .82 | 2250 | .35 | 3325 | .20 |
| 751- 950 | 585 | .69 | 2750 | .32 | 4225 | .20 |
| 951-1150 | 635 | .60 | 3250 | .31 | 5025 | .19 |
| 1151-1350 | 685 | .55 | 3750 | .30 | 5825 | .19 |
| 1351-1550 | 735 | .51 | 4250 | .29 | 6625 | .18 |
| 1551-1950 | 810 | .46 | 5000 | .29 | 7825 | .18 |
| 1951-2350 | 885 | .41 | 5750 | .27 | 9025 | .17 |
| 2351 + | 985 | .34 | 6750 | .23 | 10625 | .15 |

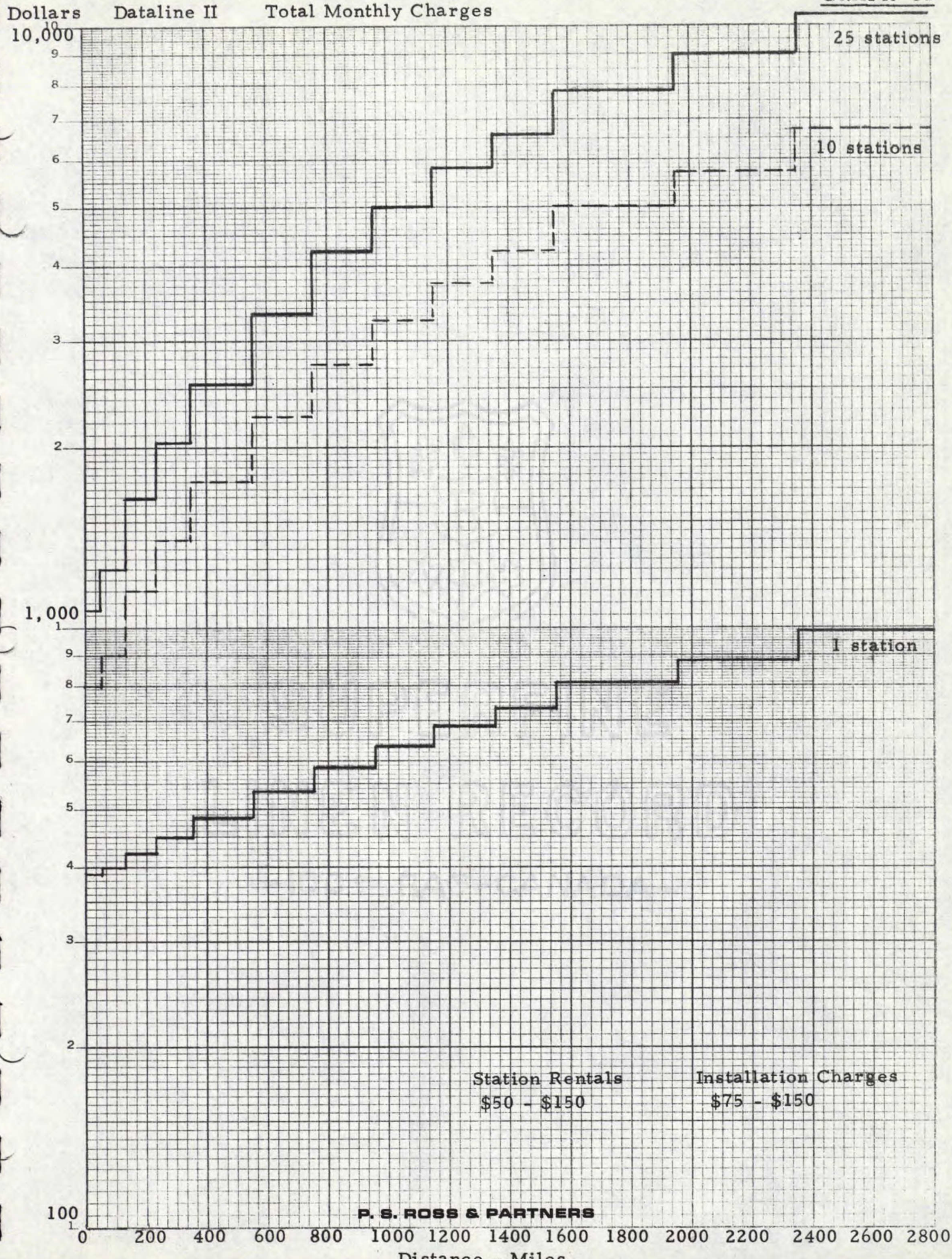
## DATALINE II

### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

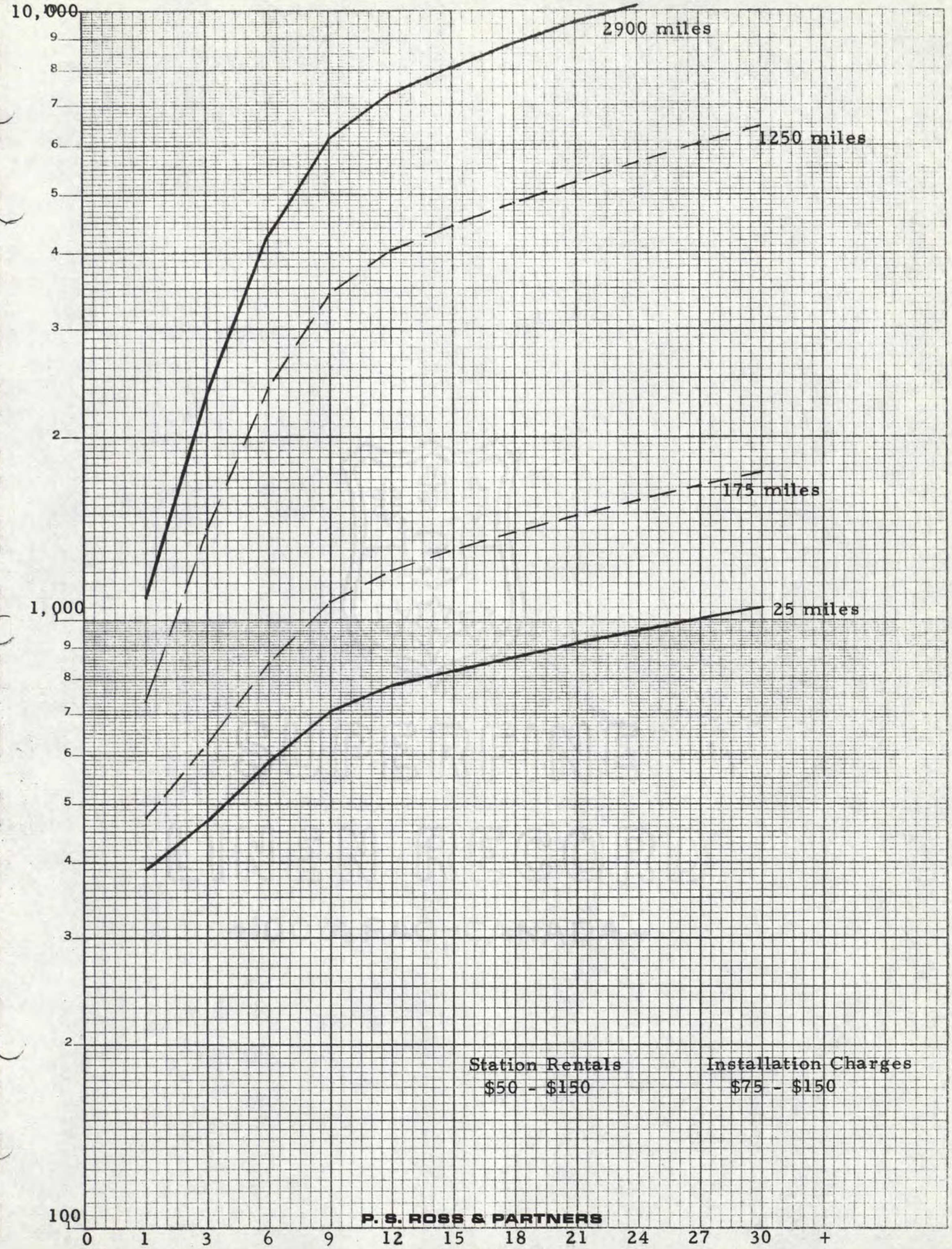
| | 25 Miles | | 175 Miles | | 1200 Miles | | 2900 Miles | |
|---|---|---|---|---|---|---|---|---|
| Number of Stations | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station |
| 1 | $ 390 | $15.60 | $ 475 | $2.71 | $ 735 | $.59 | $ 1085 | $.37 |
| 3 | 470 | 6.28 | 625 | 1.19 | 1405 | .37 | 2355 | .27 |
| 6 | 590 | 3.92 | 850 | .81 | 2410 | .32 | 4260 | .24 |
| 9 | 710 | 3.16 | 1075 | .68 | 3415 | .30 | 6165 | .24 |
| 12 | 780 | 2.60 | 1210 | .58 | 4020 | .27 | 7310 | .21 |
| 15 | 825 | 2.20 | 1300 | .50 | 4425 | .24 | 8075 | .19 |
| 18 | 870 | 1.92 | 1390 | .44 | 4830 | .21 | 8840 | .17 |
| 21 | 915 | 1.76 | 1480 | .41 | 5235 | .20 | 9605 | .16 |
| 24 | 960 | 1.60 | 1570 | .37 | 5640 | .19 | 10370 | .15 |
| 27 | 1005 | 1.48 | 1660 | .35 | 6045 | .18 | 11135 | .14 |
| 30 | 1050 | 1.40 | 1750 | .33 | 6450 | .17 | 11900 | .14 |

TABLE 24

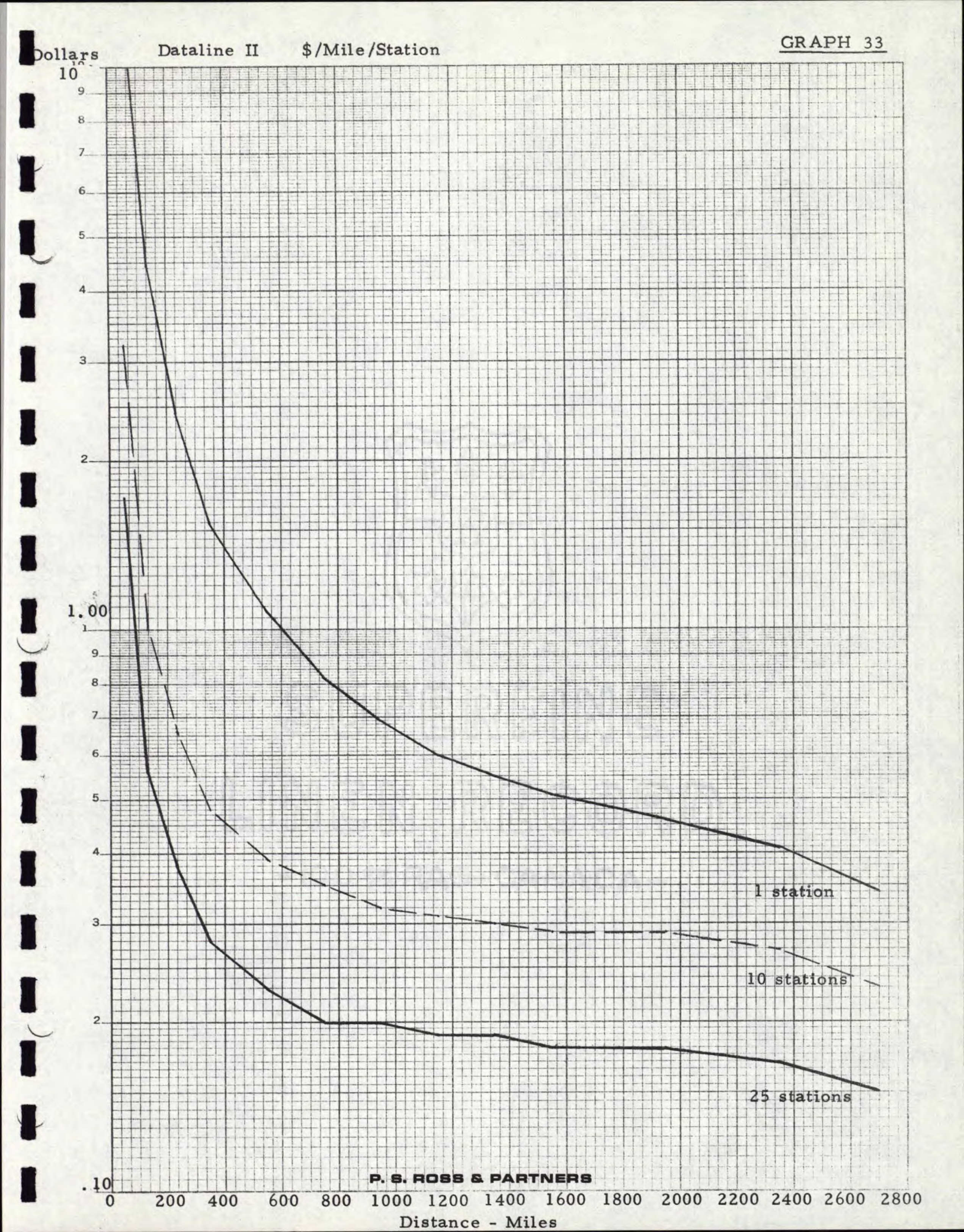
GRAPH 31


Dollars
Dataline II
Total Monthly Charges
10,000
1,000
100
25 stations
10 stations
1 station
Station Rentals
$50 - $150
Installation Charges
$75 - $150
P. S. ROSS & PARTNERS
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Distance - Miles

Dollars Dataline II Total Monthly Charges GRAPH 32



GRAPH 33


Dollars
Dataline II $/Mile/Station
10
9
8
7
6
5
4
3
2
1.00
1
9
8
7
6
5
4
3
2
.10
1 station
10 stations
25 stations
P. S. ROSS & PARTNERS
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800
Distance - Miles

GRAPH 34

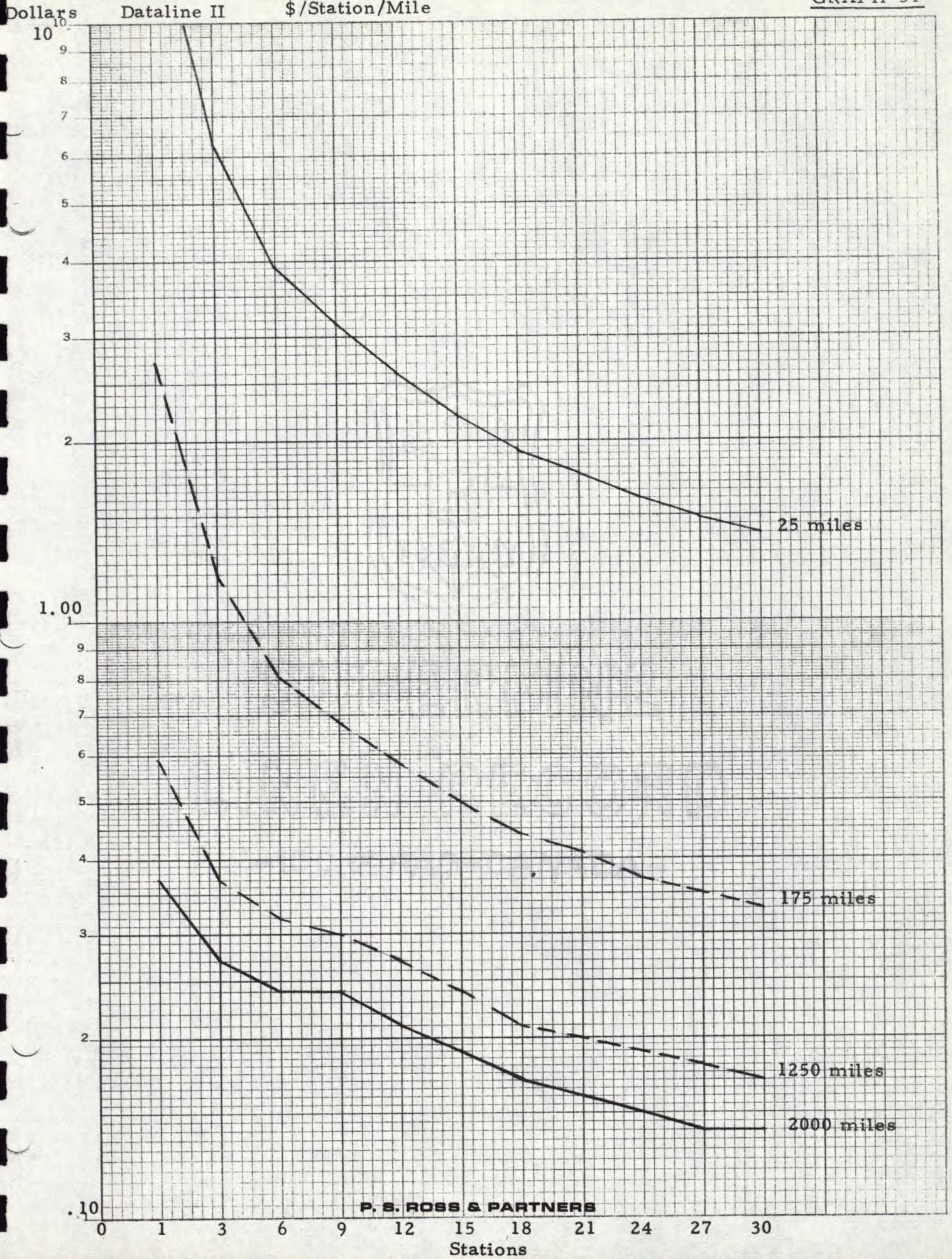

Dollars
Dataline II
$/Station/Mile
10
1.00
.10
25 miles
175 miles
1250 miles
2000 miles
P. S. ROSS & PARTNERS
0
1
3
6
9
12
15
18
21
24
27
30
Stations

TABLE 25

## SCHEDULE 1 - LOCAL

## MONTHLY CHARGES INCLUDING STATION RENTALS, CIRCUIT CHARGES AND TRANSMISSION CHARGES

Two Points Different Property

| Representative Mileages | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits |
| 1 | $ 44.50 | $247 | $558 | $141 | $1143 | $36.00 |
| 5 | 56.50 | 63 | 570 | 28.79 | 1155 | 7.29 |
| 10 | 71.50 | 40 | 585 | 14.77 | 1170 | 3.69 |
| 15 | 86.50 | 32 | 600 | 10.10 | 1185 | 2.49 |
| 20 | 101.50 | 28 | 615 | 7.77 | 1200 | 1.89 |
| 25 | 116.50 | 26 | 630 | 6.36 | 1215 | 1.55 |
| 30 | 131.50 | 24 | 645 | 5.43 | 1230 | 1.29 |

TABLE 26

| Time in Hours | One Mile | | 15 Miles | | 30 Miles | |
|---|---|---|---|---|---|---|
| | Total Charges | $/$10^6$ Bits/ Mile | Total Charges | $/$10^6$ Bits/ Mile | Total Charges | $/$10^6$ Bits/ Mile |
| 1 | $44.50 | $247 | $600 | $222 | $1230 | $228 |
| 16 | 44.50 | 15.45 | 600 | 13.89 | 1230 | 14.23 |
| 32 | 44.50 | 7.73 | 600 | 6.94 | 1230 | 7.13 |
| 48 | 44.50 | 5.15 | 600 | 4.63 | 1230 | 4.73 |
| 64 | 44.50 | 3.86 | 600 | 3.47 | 1230 | 3.57 |
| 80 | 44.50 | 3.09 | 600 | 2.78 | 1230 | 2.83 |
| 96 | 44.50 | 2.58 | 600 | 2.31 | 1230 | 2.37 |
| 112 | 44.50 | 2.21 | 600 | 1.98 | 1230 | 2.03 |
| 128 | 44.50 | 1.93 | 600 | 1.74 | 1230 | 1.77 |
| 144 | 44.50 | 1.72 | 600 | 1.54 | 1230 | 1.57 |
| 160 | 44.50 | 1.55 | 600 | 1.39 | 1230 | 1.43 |
| 176 | 44.50 | 1.40 | 600 | 1.26 | 1230 | 1.30 |

TABLE 27

## SCHEDULE 1 - INTER-CITY

## MONTHLY CHARGES INCLUDING STATION RENTALS, CIRCUIT CHARGES AND TRANSMISSION CHARGES

| Representative Mileages | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits |
| 10 | 52 | $28.87 | $ 607 | $15.33 | $1163 | $3.67 |
| 350 | 287 | 4.55 | 1056 | .76 | 1799 | .16 |
| 700 | 528 | 4.17 | 1518 | .55 | 2453 | .11 |
| 1000 | 735 | 4.11 | 1914 | .48 | 3014 | .095 |
| 1400 | 1011 | 4.00 | 2442 | .44 | 3762 | .085 |
| 1700 | 1218 | 4.00 | 2838 | .42 | 4323 | .081 |
| 2000 | 1425 | 3.94 | 3234 | .41 | 4884 | .077 |
| 2400 | 1701 | 3.94 | 3762 | .40 | 5632 | .074 |
| 2700 | 1908 | 3.94 | 4158 | .39 | 6193 | .072 |
| 3000 | 2115 | 3.94 | 4554 | .38 | 6754 | .071 |
| 3400 | 2391 | 3.94 | 5082 | .38 | 7502 | .070 |

TABLE 28

| Time in Hours | 350 Miles | | 1700 Miles | | 3000 Miles | |
|---|---|---|---|---|---|---|
| | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile |
| 1 | $287 | $4.55 | $1728 | $5.65 | $3214 | $5.95 |
| 16 | 287 | .28 | 1728 | .35 | 3214 | .37 |
| 32 | 287 | .14 | 1728 | .18 | 3214 | .19 |
| 48 | 287 | .095 | 1728 | .12 | 3214 | .12 |
| 64 | 287 | .071 | 1728 | .089 | 3214 | .093 |
| 80 | 507 | .10 | 2800 | .11 | 5104 | .12 |
| 96 | 507 | .084 | 2800 | .095 | 5104 | .098 |
| 112 | 507 | .072 | 2800 | .082 | 5104 | .084 |
| 128 | 507 | .063 | 2800 | .072 | 5104 | .074 |
| 144 | 507 | .056 | 2800 | .064 | 5104 | .066 |
| 160 | 507 | .050 | 2800 | .057 | 5104 | .059 |
| 176 | 700 | .063 | 3734 | .069 | 6754 | .071 |

TABLE 29

## SCHEDULE 3 - LOCAL

## MONTHLY CHARGES INCLUDING STATION RENTALS, CIRCUIT CHARGES AND TRANSMISSION CHARGES

Two Points Different Property

| Representative Mileages | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits |
| 1 | $ 45.76 | $169 | $556 | $93.60 | $1144 | $24.07 |
| 5 | 60.80 | 45.04 | 571 | 19.23 | 1159 | 4.88 |
| 10 | 79.60 | 29.48 | 596 | 10.03 | 1184 | 2.49 |
| 15 | 98.40 | 24.30 | 608 | 6.82 | 1196 | 1.68 |
| 20 | 117.20 | 21.70 | 627 | 5.28 | 1215 | 1.28 |
| 25 | 136.00 | 20.15 | 646 | 4.35 | 1234 | 1.04 |
| 30 | 154.80 | 19.11 | 665 | 3.73 | 1253 | .88 |

TABLE 30

| Time in Hours | One Mile | | 15 Miles | | 30 Miles | |
|---|---|---|---|---|---|---|
| | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile |
| 1 | $46 | $170 | $608 | $150 | $1253 | $155 |
| 16 | 46 | 10.65 | 608 | 9.38 | 1253 | 9.67 |
| 32 | 46 | 5.32 | 608 | 4.69 | 1253 | 4.83 |
| 48 | 46 | 3.55 | 608 | 3.13 | 1253 | 3.22 |
| 64 | 46 | 2.66 | 608 | 2.35 | 1253 | 2.42 |
| 80 | 46 | 2.13 | 608 | 1.88 | 1253 | 1.93 |
| 96 | 46 | 1.77 | 608 | 1.56 | 1253 | 1.61 |
| 112 | 46 | 1.52 | 608 | 1.34 | 1253 | 1.38 |
| 128 | 46 | 1.33 | 608 | 1.17 | 1253 | 1.21 |
| 144 | 46 | 1.18 | 608 | 1.04 | 1253 | 1.07 |
| 160 | 46 | 1.06 | 608 | .94 | 1253 | .97 |
| 176 | 46 | .97 | 608 | .85 | 1253 | .88 |

TABLE 31

## SCHEDULE 3 - INTER-CITY

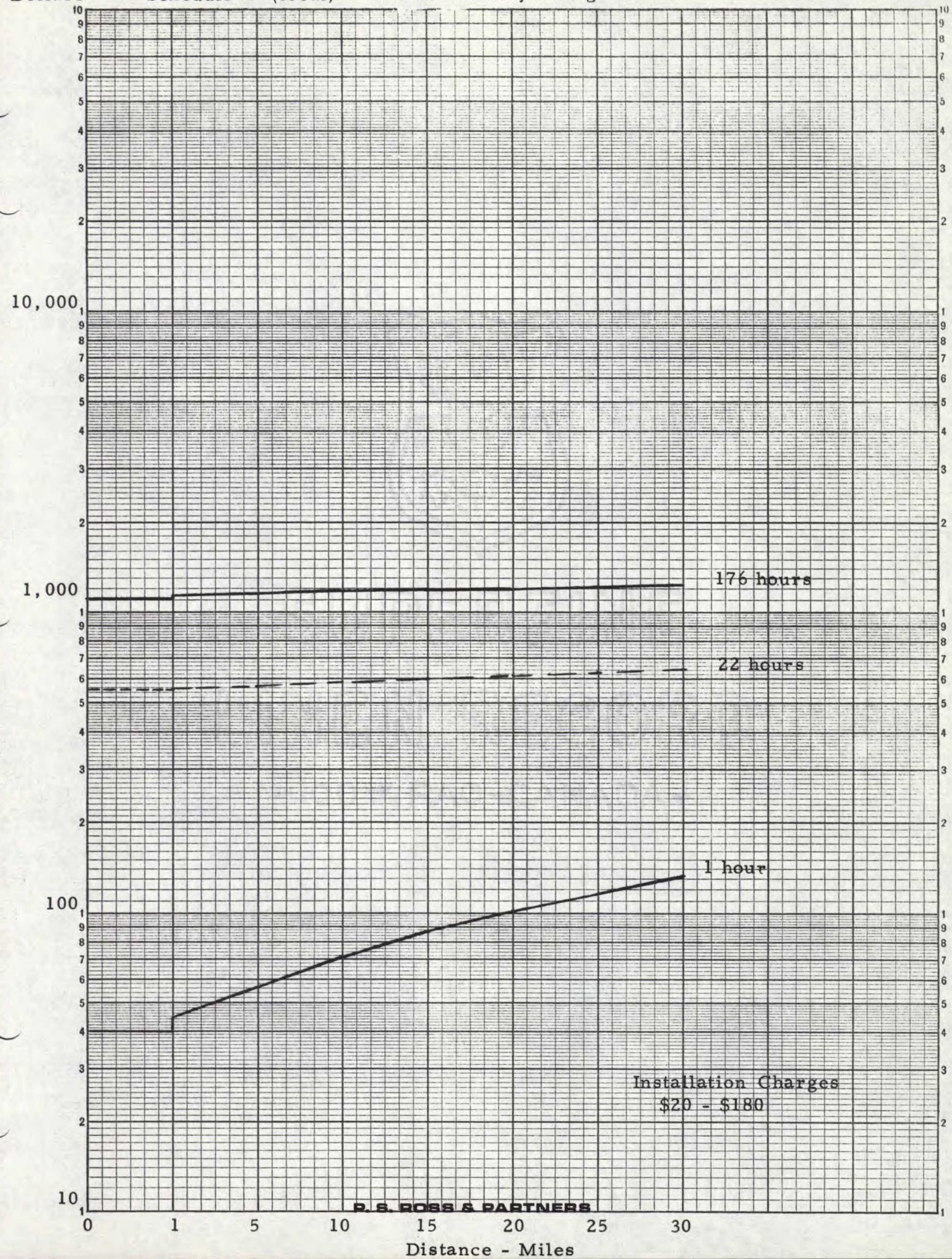
## MONTHLY CHARGES INCLUDING STATION RENTALS, CIRCUIT CHARGES AND TRANSMISSION CHARGES

| Representative Mileages | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits |
| 10 | $ 55 | $20.40 | 616 | $11.75 | $1165 | $2.45 |
| 350 | 347 | 3.65 | 1177 | .57 | 1961 | 1.18 |
| 700 | 648 | 3.45 | 1755 | .42 | 2780 | .83 |
| 1000 | 906 | 3.35 | 2250 | .38 | 3482 | .73 |
| 1400 | 1250 | 3.30 | 2910 | .35 | 4418 | .66 |
| 1700 | 1508 | 3.29 | 3405 | .34 | 5120 | .64 |
| 2000 | 1766 | 3.27 | 3900 | .33 | 5822 | .61 |
| 2400 | 2110 | 3.25 | 4560 | .32 | 6758 | .59 |
| 2700 | 2368 | 3.25 | 5055 | .32 | 7460 | .58 |
| 3000 | 2626 | 3.24 | 5550 | .31 | 8162 | .57 |
| 3400 | 2970 | 3.24 | 6210 | .31 | 9098 | .56 |

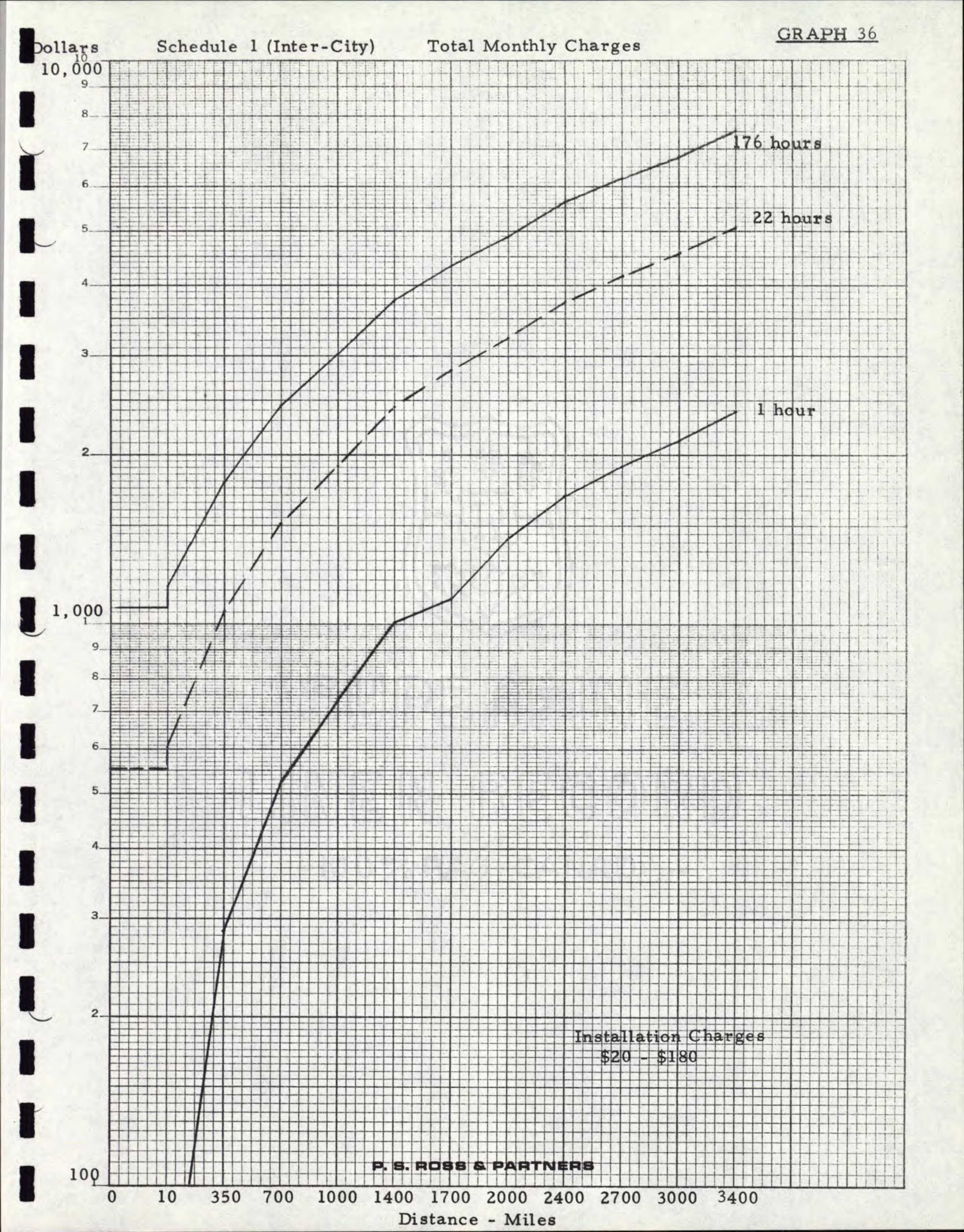
TABLE 32

| Time in Hours | 350 Miles | | 1700 Miles | | 3000 Miles | |
|---|---|---|---|---|---|---|
| | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile |
| 1 | $347 | $3.68 | $2062 | $4.50 | $3722 | $4.60 |
| 16 | 347 | .23 | 2062 | .28 | 3722 | .29 |
| 32 | 347 | .11 | 2062 | .14 | 3722 | .14 |
| 48 | 347 | .077 | 2062 | .094 | 3722 | .096 |
| 64 | 347 | .057 | 2062 | .070 | 3722 | .072 |
| 80 | 624 | .083 | 3405 | .093 | 6092 | .094 |
| 96 | 624 | .069 | 3405 | .077 | 6092 | .078 |
| 112 | 624 | .059 | 3405 | .066 | 6092 | .067 |
| 128 | 624 | .052 | 3405 | .058 | 6092 | .059 |
| 144 | 624 | .046 | 3405 | .052 | 6092 | .052 |
| 160 | 624 | .041 | 3405 | .046 | 6092 | .047 |
| 176 | 865 | .052 | 4578 | .057 | 8162 | .057 |

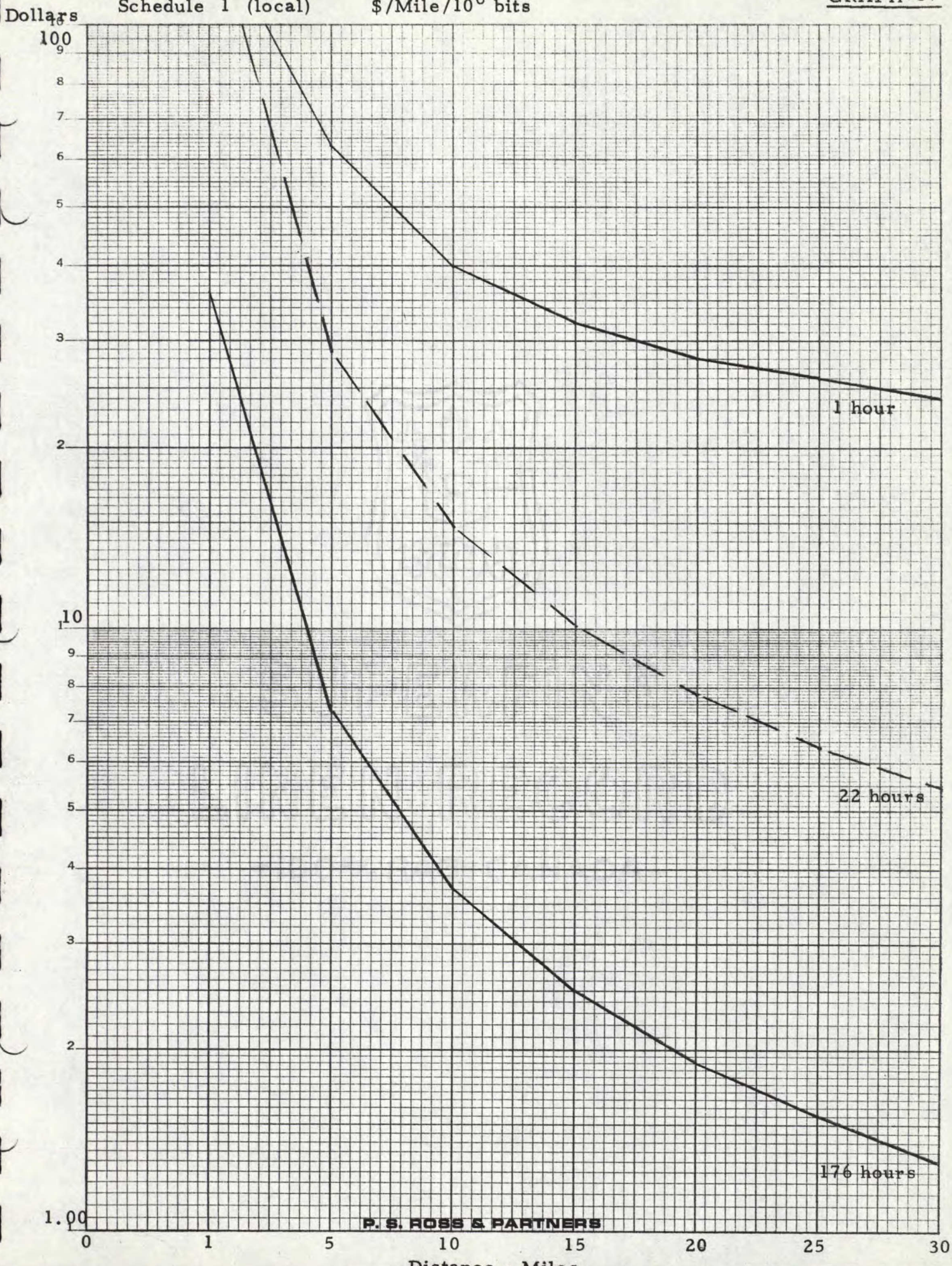
GRAPH 35


Dollars
Schedule 1 (local)
Total Monthly Charges
10,000
1,000
100
10
176 hours
22 hours
1 hour
Installation Charges
$20 - $180
P. S. ROSS & PARTNERS
0
1
5
10
15
20
25
30
Distance - Miles

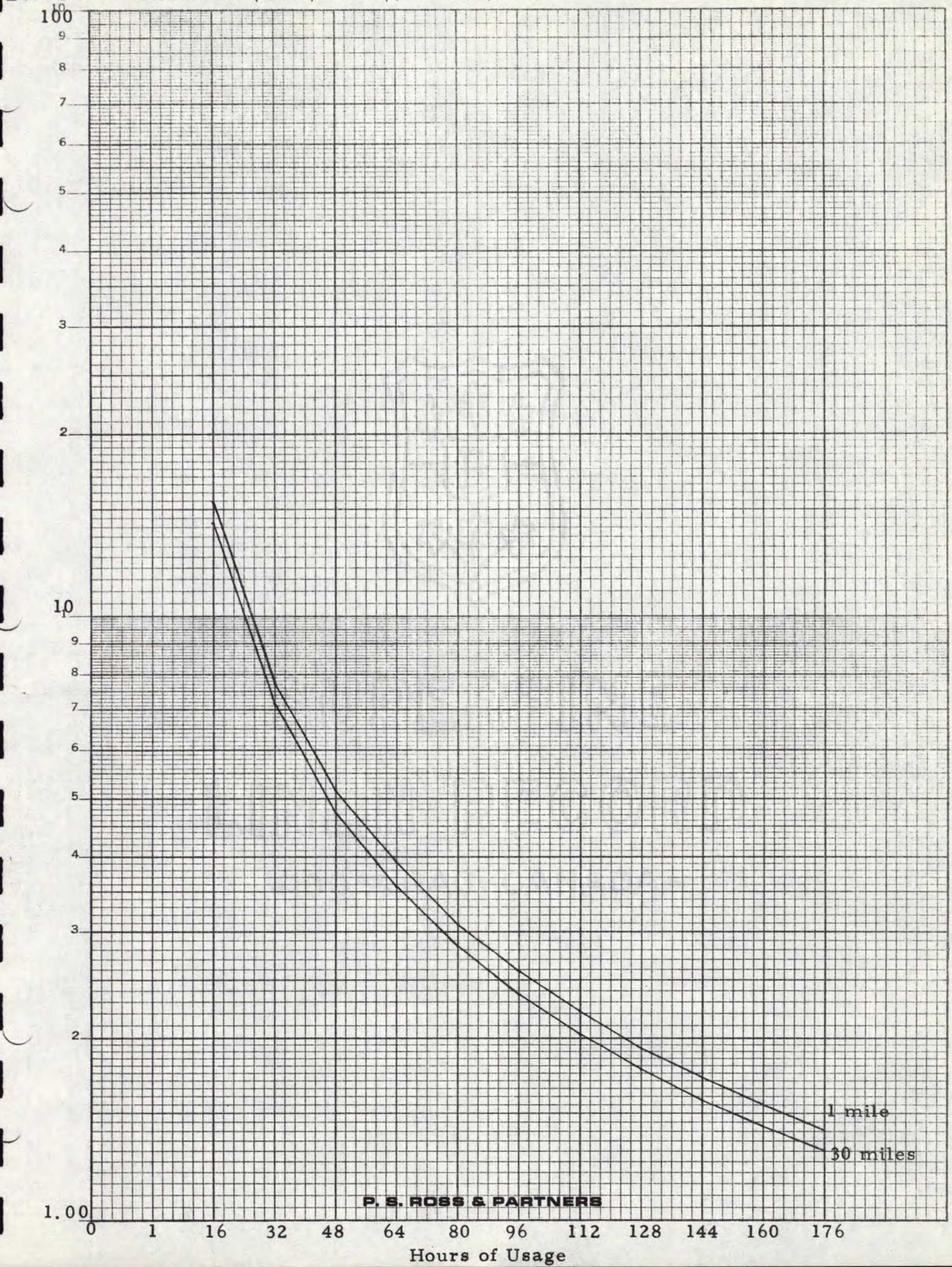
GRAPH 36


Dollars
Schedule 1 (Inter-City)
Total Monthly Charges
10,000
1,000
100
176 hours
22 hours
1 hour
Installation Charges
$20 - $180
P. S. ROSS & PARTNERS
0
10
350
700
1000
1400
1700
2000
2400
2700
3000
3400
Distance - Miles

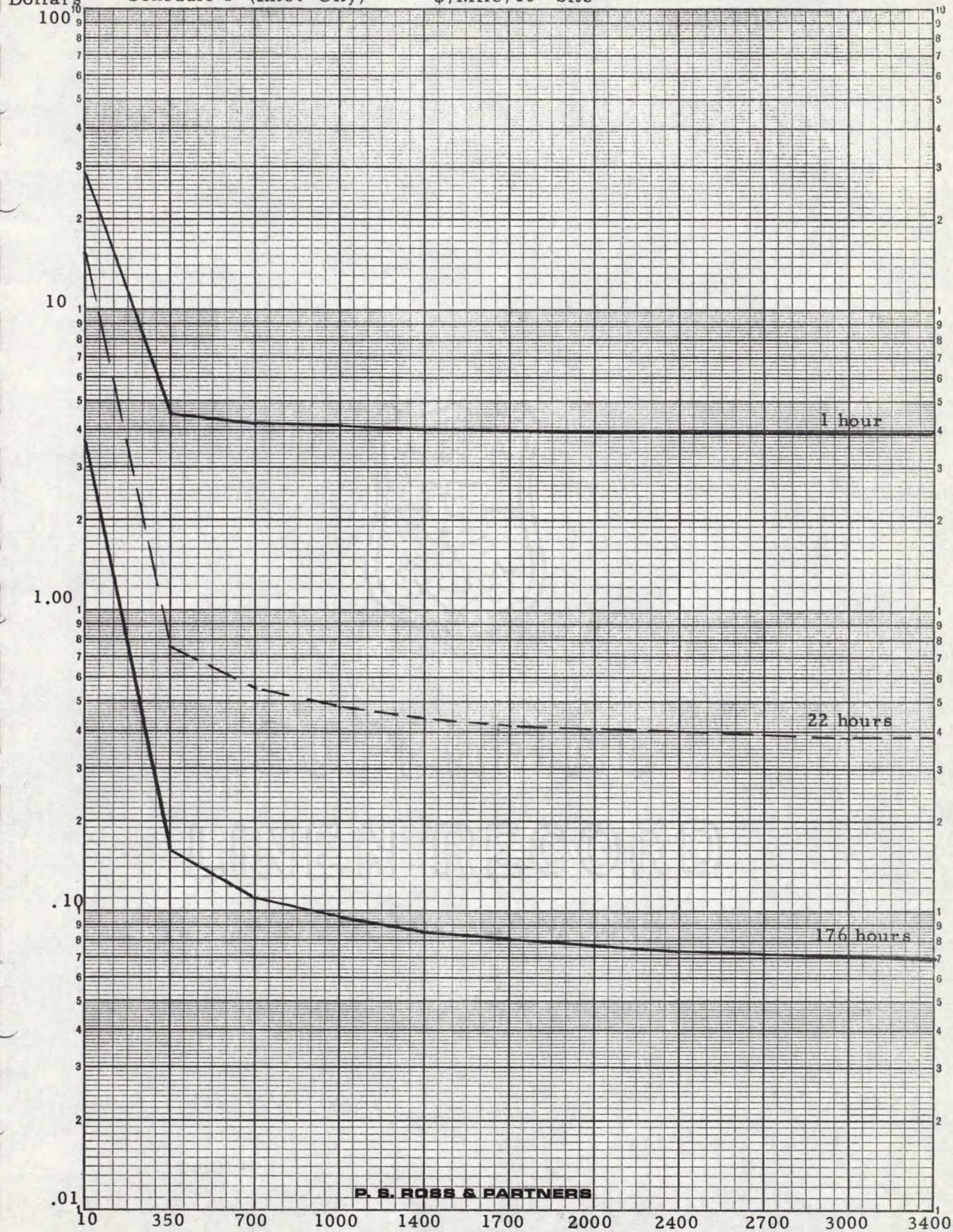
GRAPH 37


Schedule 1 (local)
$/Mile/10^6 bits
Dollars
100
10
1.00
1 hour
22 hours
176 hours
P. S. ROSS & PARTNERS
0
1
5
10
15
20
25
30
Distance - Miles

GRAPH 38


Dollars
Schedule 1 (local)
$/10^6 bits/Mile
100
10
1.00
0
1
16
32
48
64
80
96
112
128
144
160
176
Hours of Usage
1 mile
30 miles
P. S. ROSS & PARTNERS

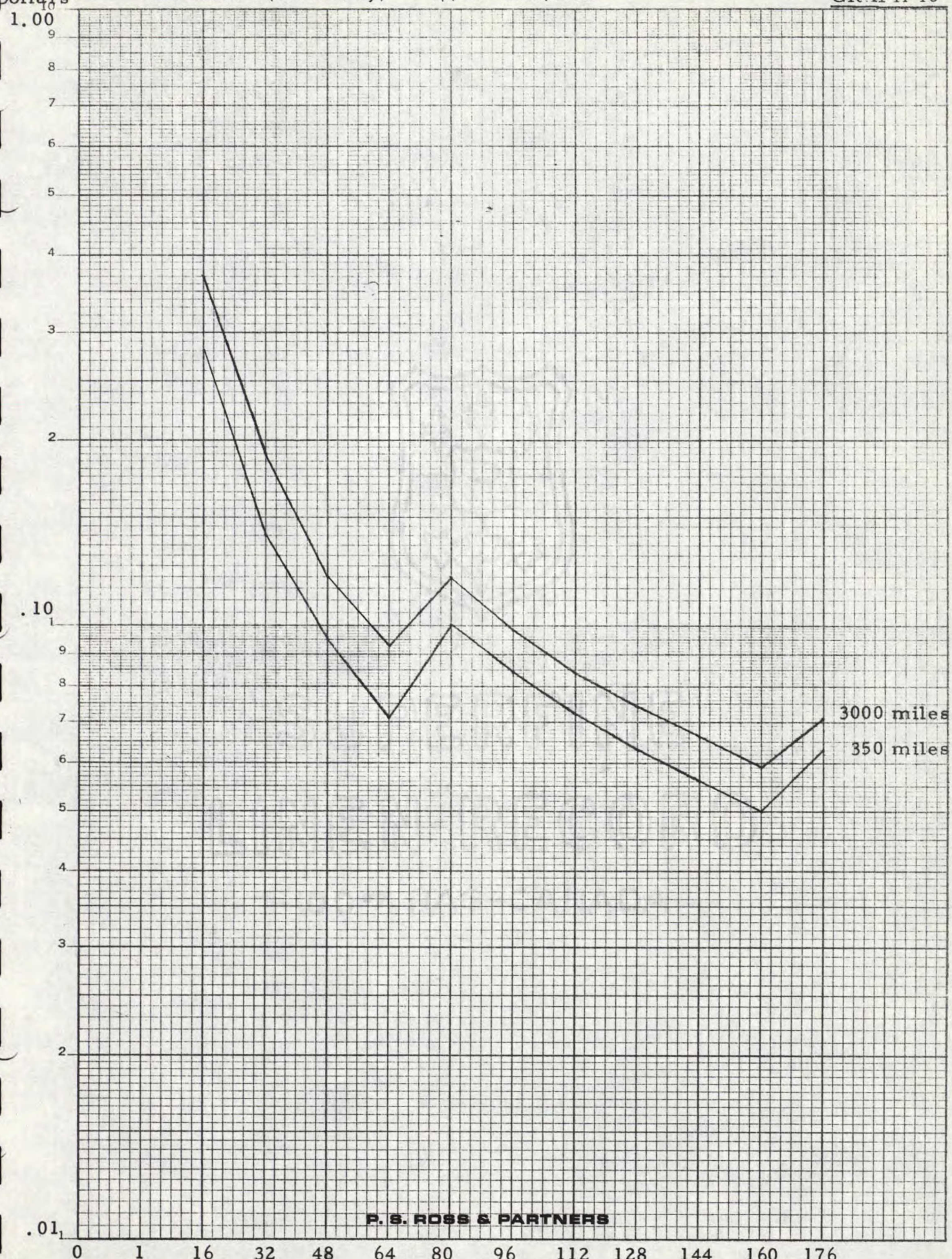
GRAPH 39

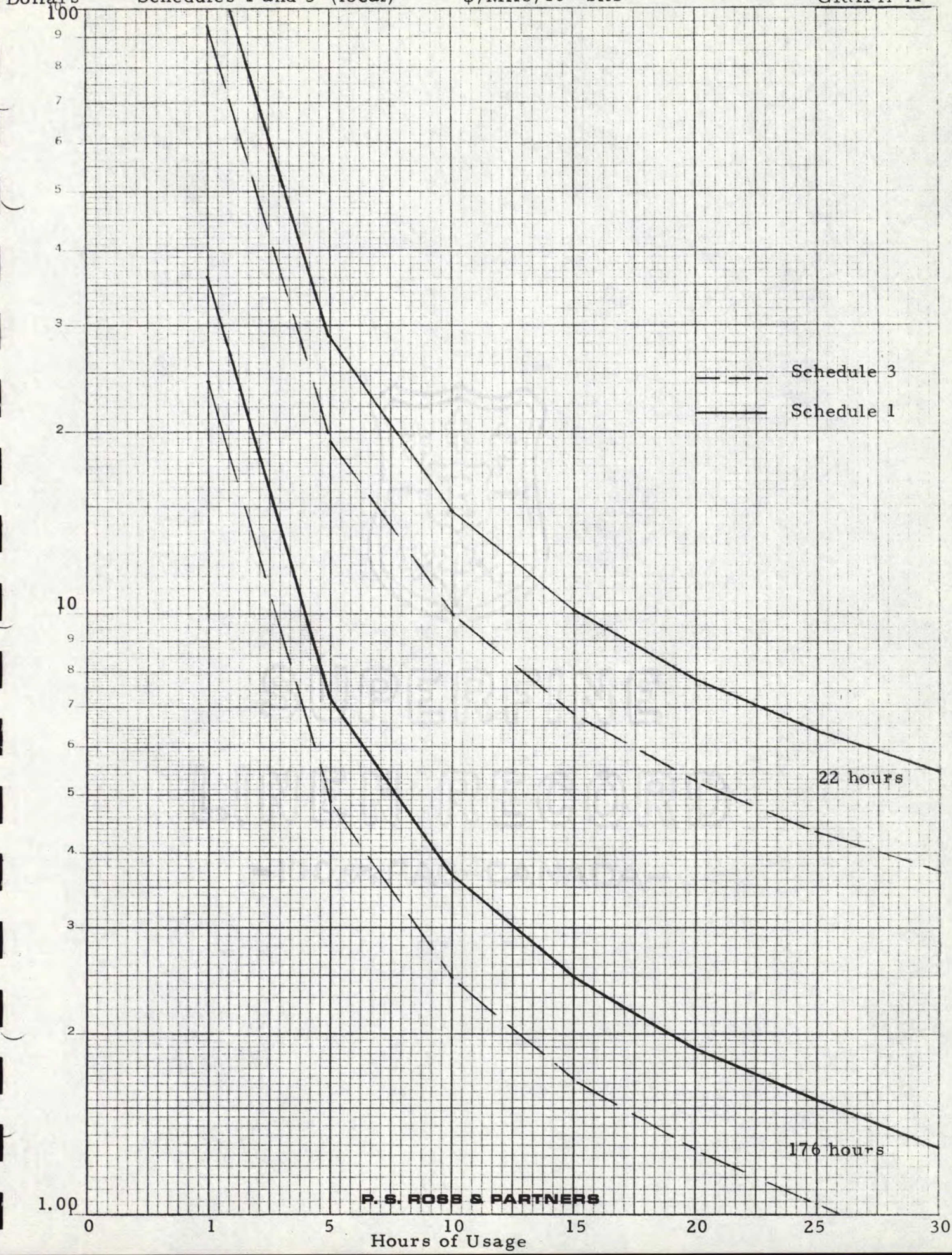

Dollars
Schedule 1 (Inter-City)
$/Mile/10^6 bits
100
10
1.00
.10
.01
1 hour
22 hours
176 hours
P. S. ROSS & PARTNERS
10
350
700
1000
1400
1700
2000
2400
2700
3000
3400
Distance - Miles

Dollars

Schedule 1 (Inter-City) $/10^6$ bits/Mile

GRAPH 40




Dollars
Schedules 1 and 3 (local)
$/Mile/10^6 bits
GRAPH 41
100
9
8
7
6
5
4
3
2
10
9
8
7
6
5
4
3
2
1.00
Schedule 3
Schedule 1
22 hours
176 hours
P. S. ROSS & PARTNERS
0
1
5
10
15
20
25
30
Hours of Usage

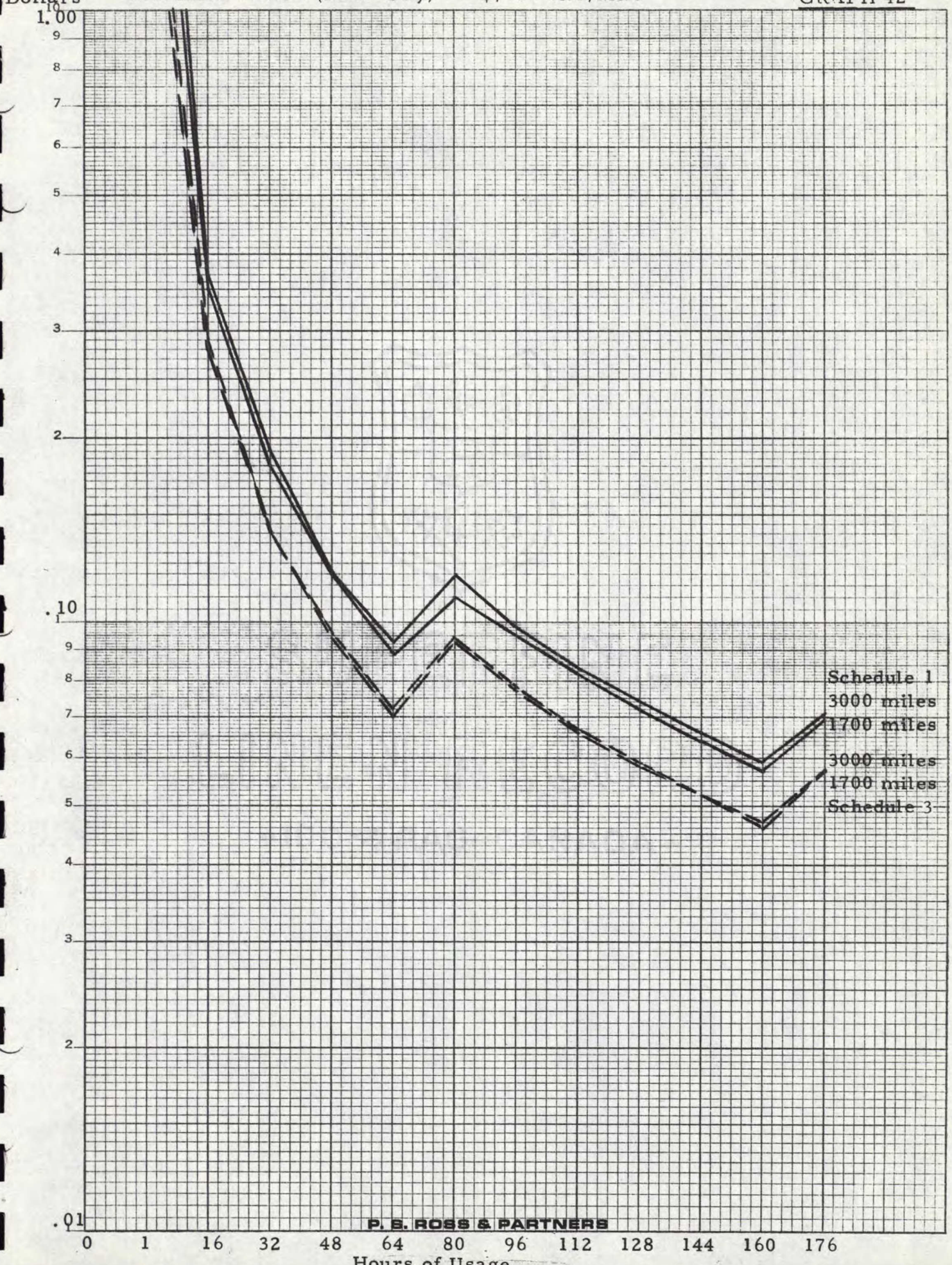

Dollars
Schedules 1 and 3 (Inter-City)
$/10^6 bits/Mile
GRAPH 42
10
1.00
9
8
7
6
5
4
3
2
.10
9
8
7
6
5
4
3
2
.01
Schedule 1
3000 miles
1700 miles
3000 miles
1700 miles
Schedule 3
P. B. ROSS & PARTNERS
0
1
16
32
48
64
80
96
112
128
144
160
176
Hours of Usage

TABLE 33

## DATALINE III

### MONTHLY CHARGES INCLUDING STATION RENTALS, ACCESS LINES & TRANSMISSION CHARGES

| Mileage Intervals | One Station | | 10 Stations | | 25 Stations | |
|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station |
| 0- 50 | $ 750 | $30.00 | $1300 | $5.20 | $ 2150 | $3.44 |
| 51- 125 | 800 | 8.90 | 1800 | 2.00 | 3400 | 1.51 |
| 126- 225 | 850 | 4.85 | 2300 | 1.32 | 4650 | 1.06 |
| 226- 350 | 900 | 3.10 | 2800 | .97 | 5900 | .81 |
| 351- 550 | 975 | 2.17 | 3550 | .79 | 7775 | .69 |
| 551- 750 | 1050 | 1.72 | 4300 | .66 | 9650 | .59 |
| 751- 950 | 1125 | 1.32 | 5050 | .59 | 11525 | .54 |
| 951-1150 | 1200 | 1.14 | 5800 | .55 | 13400 | .51 |
| 1151-1350 | 1275 | 1.02 | 6550 | .52 | 15275 | .50 |
| 1351-1550 | 1350 | .93 | 7300 | .50 | 17150 | .47 |
| 1551-1950 | 1425 | .81 | 8050 | .46 | 19025 | .44 |
| 1951-2350 | 1500 | .70 | 8800 | .41 | 20900 | .39 |
| 2351 + | 1600 | .55 | 9800 | .34 | 23400 | .32 |

DATALINE III

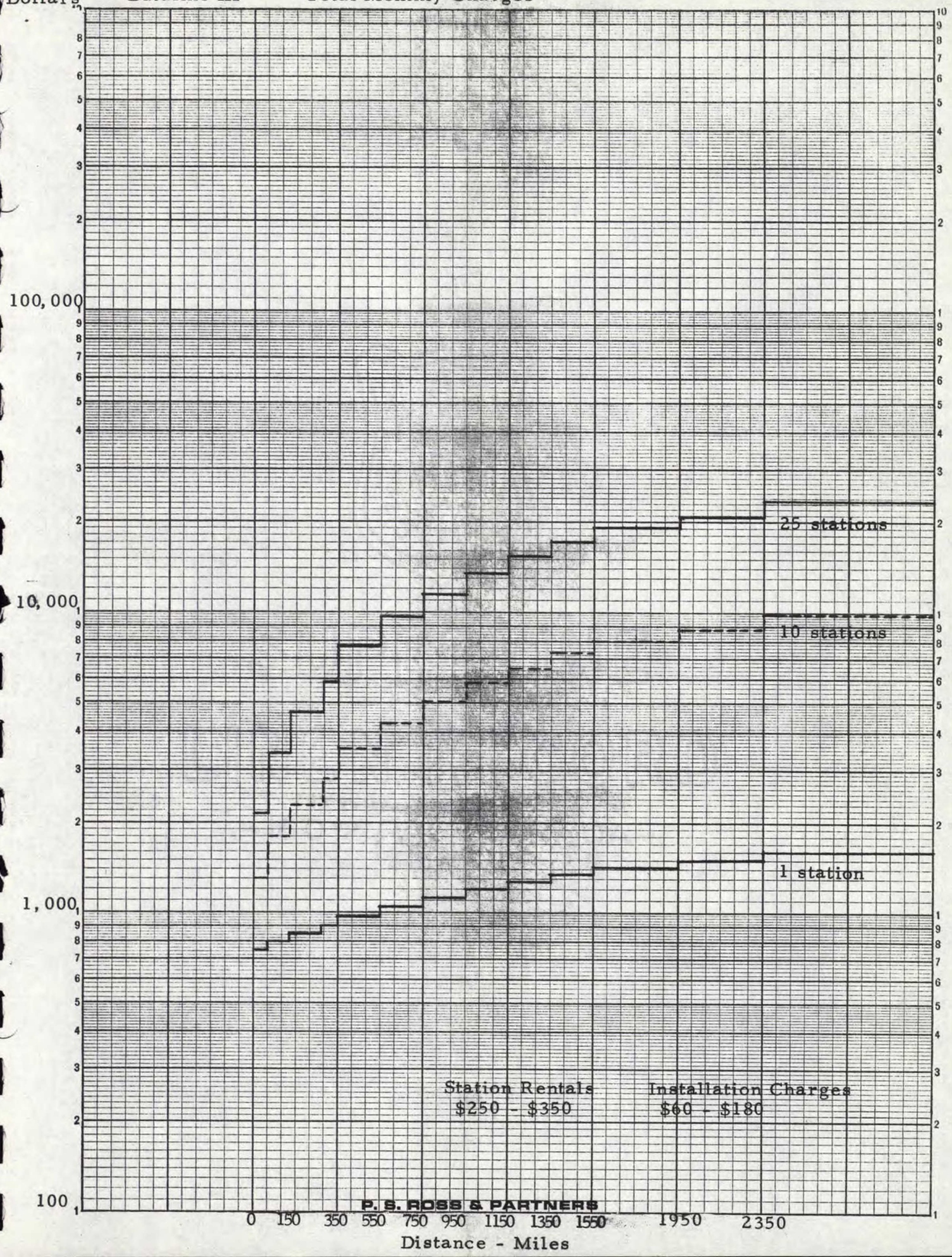
MONTHLY CHARGES INCLUDING STATION RENTALS
ACCESS LINES & TRANSMISSION CHARGES

| | 25 Miles | | 175 Miles | | 1250 Miles | | 2900 Miles | |
|---|---|---|---|---|---|---|---|---|
| Number of Stations | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station | Total Charges | $/Mile/ Station |
| 1 | $ 750 | $ 30.00 | $ 950 | $ 5.40 | $ 1375 | $ 1.10 | $ 1800 | $ .62 |
| 3 | 850 | 11.30 | 1250 | 2.38 | 2525 | .67 | 3600 | .41 |
| 6 | 1000 | 6.65 | 1700 | 1.62 | 4250 | .57 | 6300 | .36 |
| 9 | 1150 | 5.10 | 2150 | 1.36 | 5975 | .53 | 9000 | .35 |
| 12 | 1300 | 4.34 | 2600 | 1.24 | 7700 | .51 | 11700 | .34 |
| 15 | 1450 | 3.87 | 3050 | 1.16 | 9425 | .50 | 14400 | .33 |
| 18 | 1600 | 3.55 | 3500 | 1.11 | 11150 | .50 | 17100 | .33 |
| 21 | 1750 | 3.34 | 3950 | 1.07 | 12875 | .49 | 19800 | .33 |
| 24 | 1900 | 3.17 | 4400 | 1.05 | 14600 | .49 | 22500 | .32 |
| 27 | 2050 | 3.05 | 4850 | 1.03 | 16325 | .48 | 25200 | .32 |
| 30 | 2200 | 2.94 | 5300 | 1.01 | 18050 | .48 | 27900 | .32 |

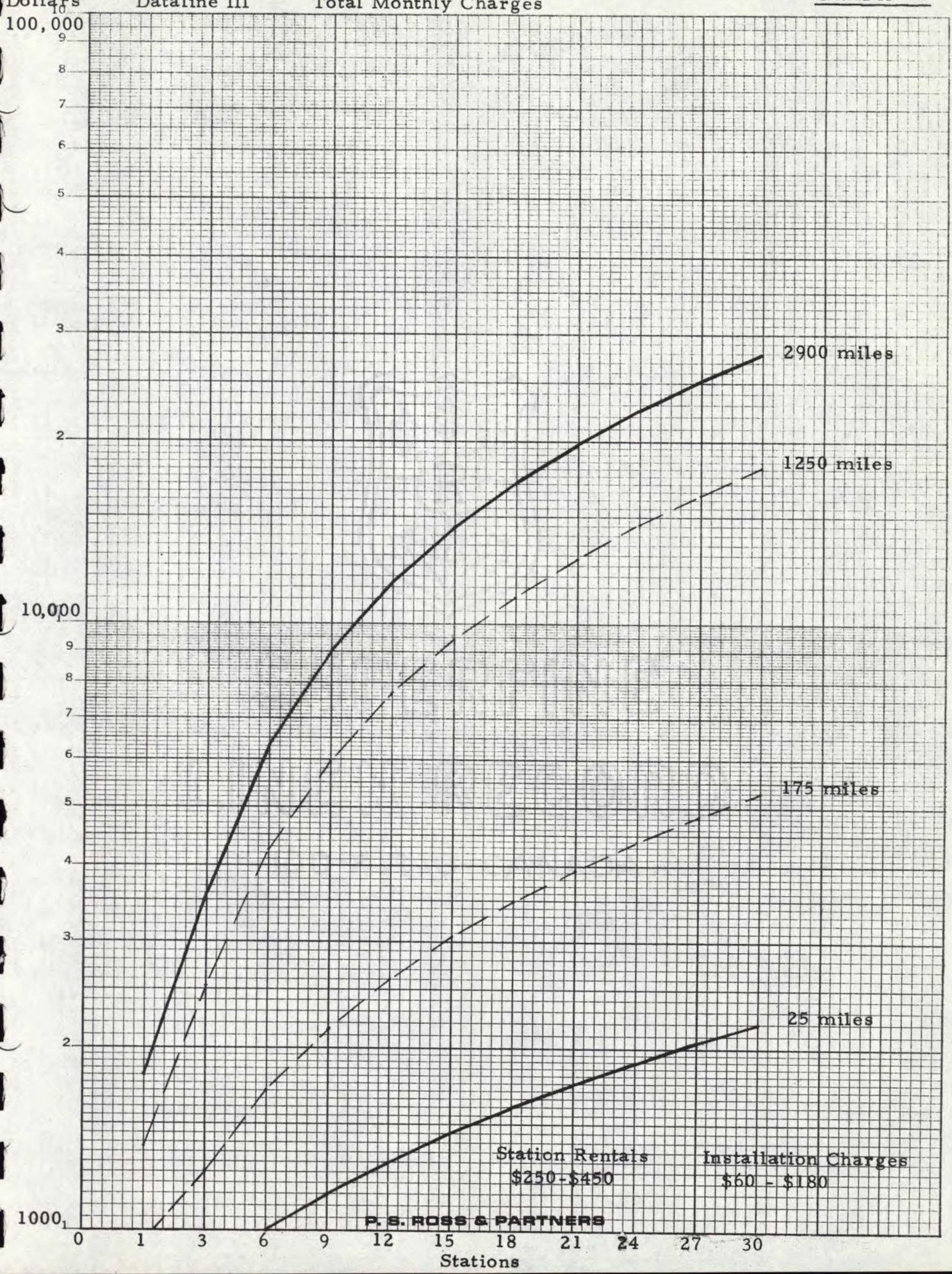


TABLE 34

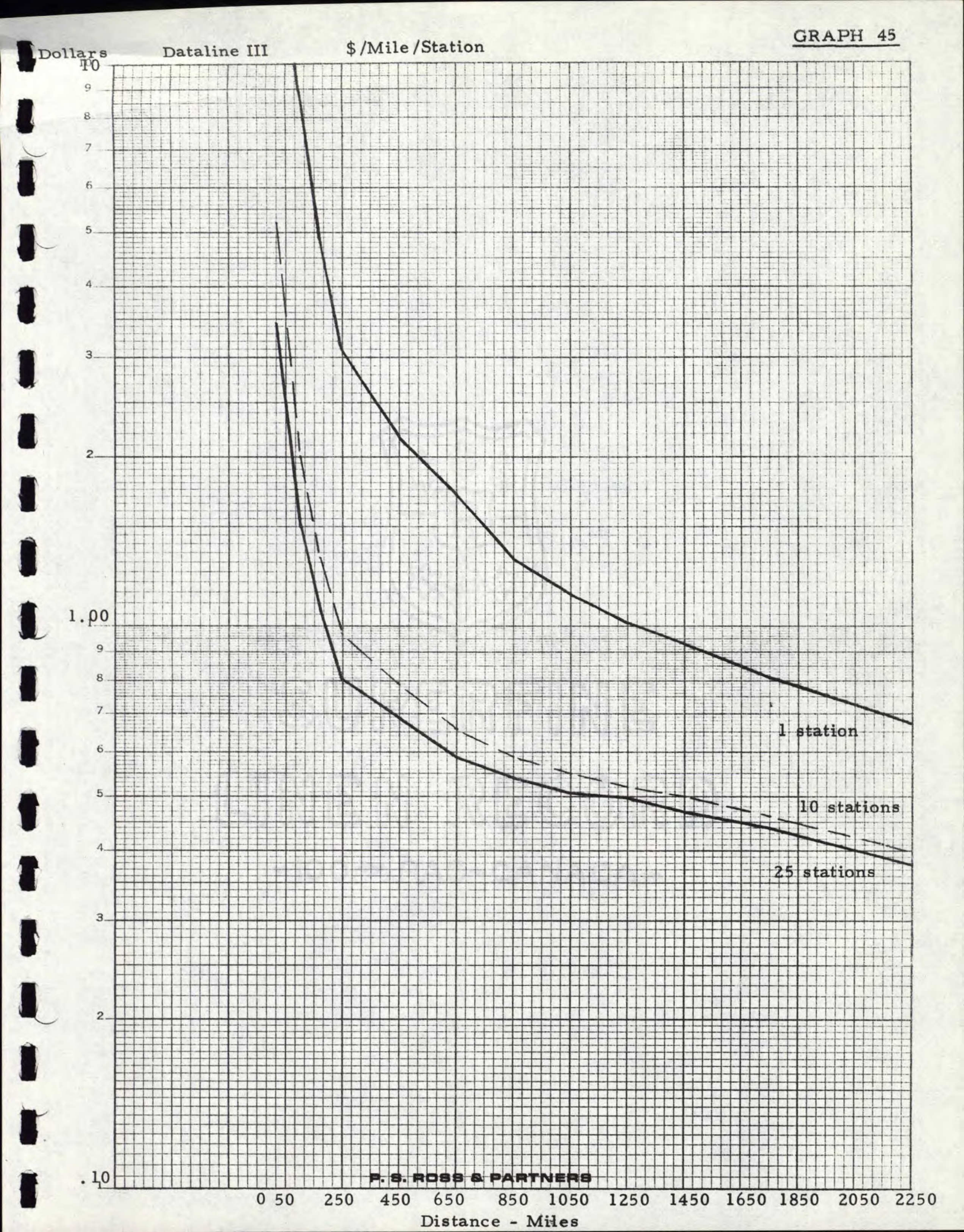
GRAPH 43


Dollars
Dataline III
Total Monthly Charges
100,000
10,000
1,000
100
25 stations
10 stations
1 station
Station Rentals
$250 - $350
Installation Charges
$60 - $180
P. S. ROSS & PARTNERS
0
150
350
550
750
950
1150
1350
1550
1950
2350
Distance - Miles

GRAPH 44


Dollars
Dataline III
Total Monthly Charges
100,000
10,000
1000
2900 miles
1250 miles
175 miles
25 miles
Station Rentals
$250-$450
Installation Charges
$60 - $180
P. S. ROSS & PARTNERS
0
1
3
6
9
12
15
18
21
24
27
30
Stations

GRAPH 45


Dollars
Dataline III
$/Mile/Station
10
9
8
7
6
5
4
3
2
1.00
9
8
7
6
5
4
3
2
.10
1 station
10 stations
25 stations
P. S. ROSS & PARTNERS
0 50 250 450 650 850 1050 1250 1450 1650 1850 2050 2250
Distance - Miles

GRAPH 46

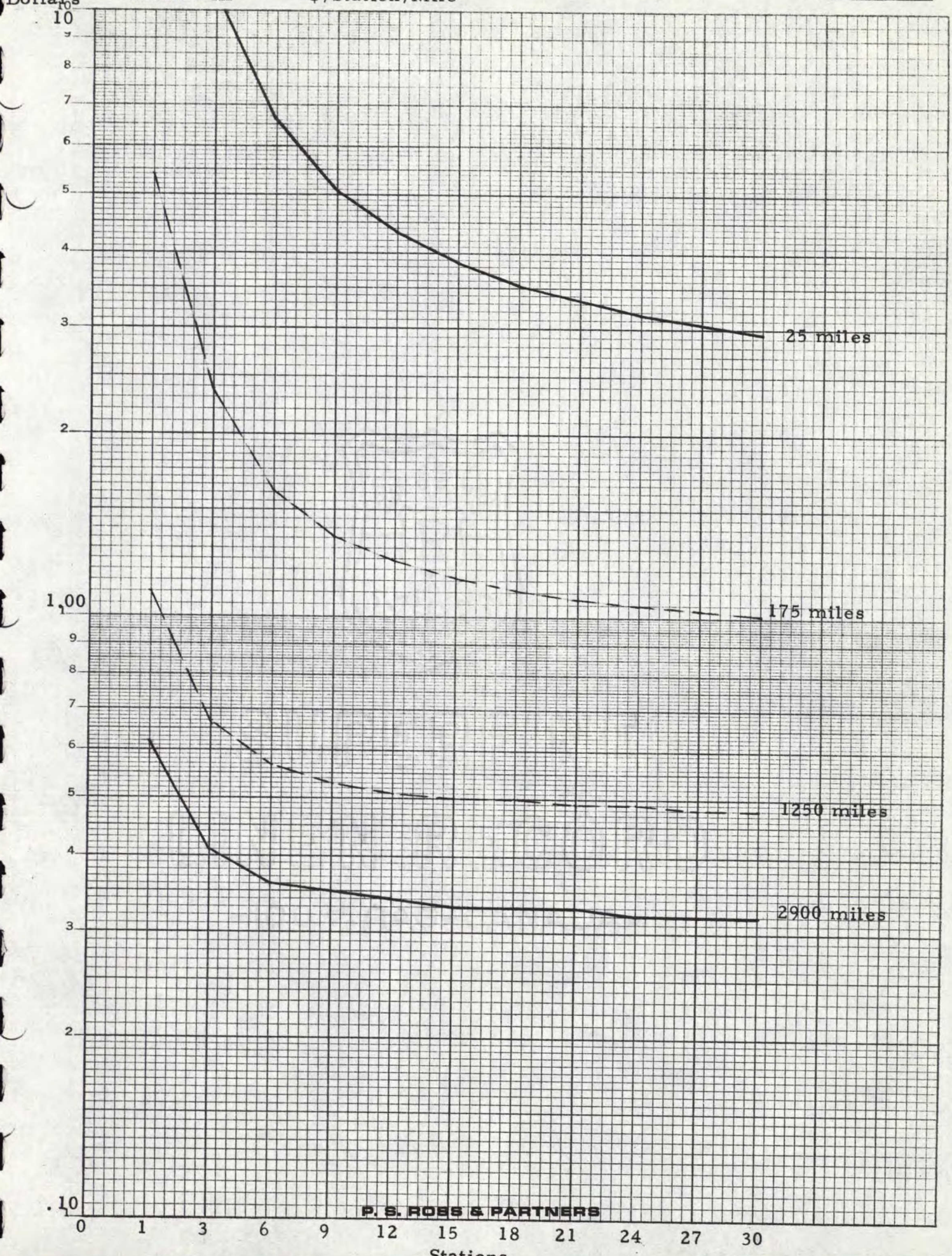

Dollars
Dataline III
$/Station/Mile
10
8
7
6
5
4
3
2
1.00
9
8
7
6
5
4
3
2
.10
25 miles
175 miles
1250 miles
2900 miles
P. S. ROSS & PARTNERS
0
1
3
6
9
12
15
18
21
24
27
30
Stations

TABLE 35

## SCHEDULE 4 - LOCAL

### MONTHLY CHARGES INCLUDING STATION RENTAL AND TRANSMISSION CHARGES

| Representative Mileages | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits |
| 1 | $ 94 | $43.50 | $836 | $17.60 | $1756 | $4.61 |
| 5 | 110 | 10.20 | 852 | 3.58 | 1772 | .93 |
| 10 | 130 | 6.00 | 872 | 1.83 | 1792 | .47 |
| 15 | 150 | 4.64 | 892 | 1.25 | 1812 | .32 |
| 20 | 170 | 3.94 | 912 | .96 | 1832 | .24 |
| 25 | 190 | 3.52 | 932 | .78 | 1852 | .19 |
| 30 | 210 | 3.25 | 952 | .67 | 1872 | .16 |

TABLE 36

| Time in Hours | One Mile | | 30 Miles | |
|---|---|---|---|---|
| | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile |
| 1 | $94 | $43.50 | $1872 | $28.90 |
| 16 | 94 | 2.71 | 1872 | 1.80 |
| 32 | 94 | 1.36 | 1872 | .90 |
| 48 | 94 | .91 | 1872 | .60 |
| 64 | 94 | .68 | 1872 | .45 |
| 80 | 94 | .54 | 1872 | .36 |
| 96 | 94 | .45 | 1872 | .30 |
| 112 | 94 | .39 | 1872 | .26 |
| 128 | 94 | .34 | 1872 | .23 |
| 144 | 94 | .30 | 1872 | .20 |
| 160 | 94 | .27 | 1872 | .18 |
| 176 | 94 | .25 | 1872 | .16 |

TABLE 37

## SCHEDULE 4 - INTER-CITY

### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| Representative Mileages | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits |
| 10 | $ 132 | $6.10 | $ 874 | $1.84 | $1794 | $.47 |
| 200 | 766 | 1.77 | 1508 | .16 | 2428 | .032 |
| 350 | 1172 | 1.55 | 1914 | .11 | 2834 | .021 |
| 700 | 2008 | 1.32 | 2750 | .083 | 3670 | .014 |
| 1000 | 2456 | 1.14 | 3198 | .067 | 4118 | .011 |
| 1400 | 2762 | .92 | 3504 | .053 | 4424 | .0083 |
| 1700 | 2888 | .79 | 3630 | .045 | 4550 | .0071 |
| 2000 | 2996 | .69 | 3738 | .039 | 4658 | .0061 |
| 2400 | 3064 | .59 | 3806 | .033 | 4726 | .0052 |
| 2700 | 3132 | .54 | 3874 | .030 | 4794 | .0047 |
| 3000 | 3200 | .49 | 3942 | .028 | 4862 | .0043 |
| 3400 | 3234 | .44 | 3976 | .025 | 4896 | .0038 |

TABLE 38

| Time in Hours | 350 Miles | | 3000 Miles | |
|---|---|---|---|---|
| | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile |
| 1 | $1172 | $1.55 | $4862 | $.75 |
| 16 | 1172 | .097 | 4862 | .047 |
| 32 | 1172 | .048 | 4862 | .023 |
| 48 | 1172 | .032 | 4862 | .016 |
| 64 | 1172 | .024 | 4862 | .012 |
| 80 | 1172 | .019 | 4862 | .0094 |
| 96 | 1172 | .016 | 4862 | .0078 |
| 112 | 1172 | .014 | 4862 | .0067 |
| 128 | 1172 | .012 | 4862 | .0059 |
| 144 | 1172 | .011 | 4862 | .0052 |
| 160 | 1172 | .0097 | 4862 | .0047 |
| 176 | 1172 | .0088 | 4862 | .0043 |

TABLE 39

## SCHEDULE 4C - LOCAL

### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| Representative Mileages | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/ 10 Bits | Total Charges | $/Mile/ 10 Bits | Total Charges | $/Mile/ 10 Bits |
| 1 | $164 | $19.00 | $1149 | $6.04 | $2200 | $1.45 |
| 5 | 196 | 4.54 | 1181 | 1.24 | 2232 | .29 |
| 10 | 236 | 2.73 | 1221 | .64 | 2272 | .15 |
| 15 | 276 | 2.05 | 1261 | .44 | 2312 | .10 |
| 20 | 316 | 1.83 | 1301 | .34 | 2352 | .078 |
| 25 | 356 | 1.65 | 1341 | .28 | 2392 | .063 |
| 30 | 396 | 1.53 | 1381 | .24 | 2432 | .053 |

TABLE 40

| Time in Hours | One Mile | | 30 Miles | |
|---|---|---|---|---|
| | Total Charges | $/$10^6$ Bits/ Mile | Total Charges | $/$10^6$ Bits/ Mile |
| 1 | $164 | $19.00 | $2432 | $9.38 |
| 16 | 164 | 1.19 | 2432 | .59 |
| 32 | 164 | .59 | 2432 | .29 |
| 48 | 164 | .40 | 2432 | .20 |
| 64 | 164 | .30 | 2432 | .15 |
| 80 | 164 | .24 | 2432 | .12 |
| 96 | 164 | .20 | 2432 | .098 |
| 112 | 164 | .17 | 2432 | .084 |
| 128 | 164 | .15 | 2432 | .073 |
| 144 | 164 | .13 | 2432 | .065 |
| 160 | 164 | .12 | 2432 | .059 |
| 176 | 164 | .11 | 2432 | .053 |

TABLE 41

## SCHEDULE 4C - INTER-CITY

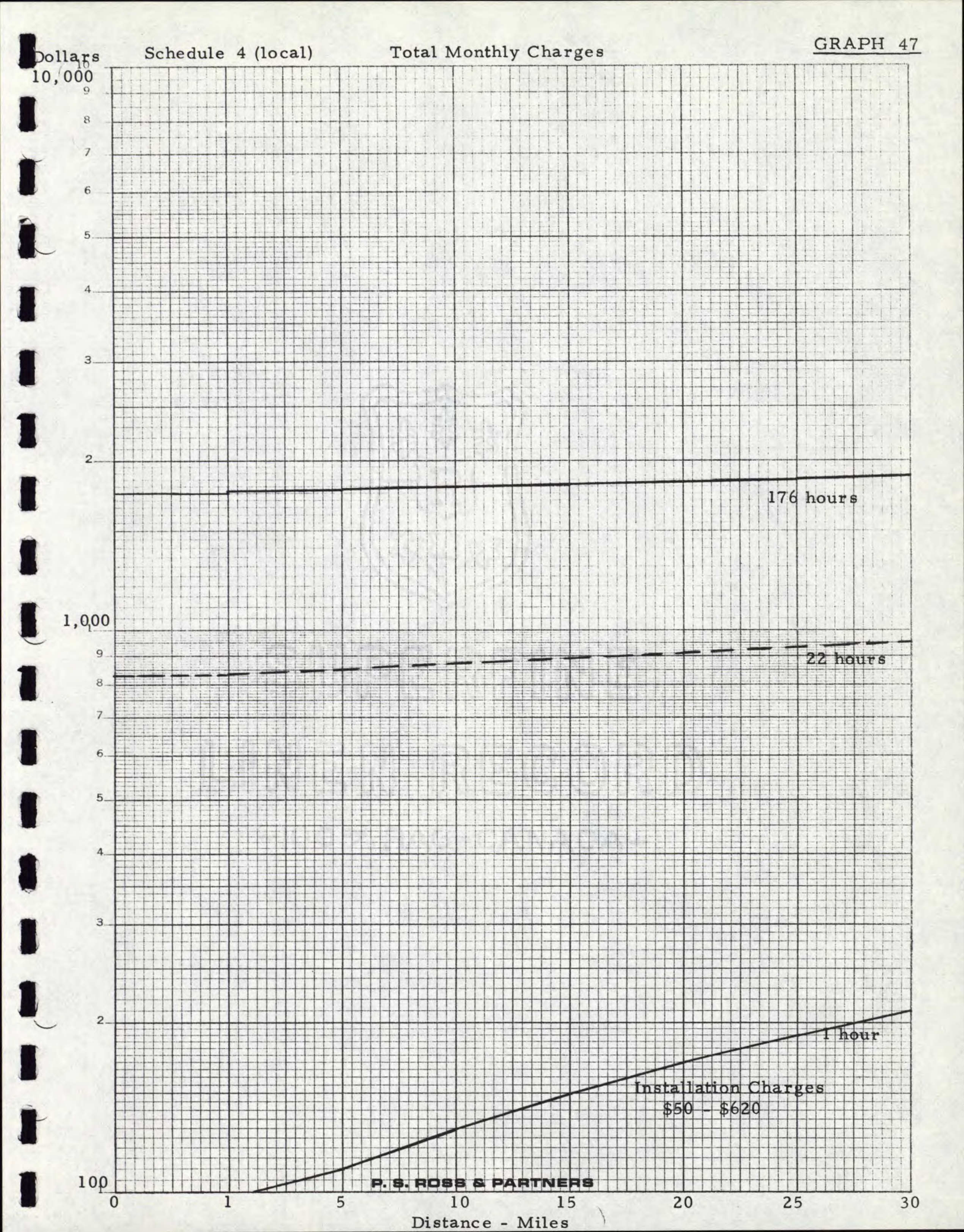
## MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| Representative Mileages | One Hour | | 22 Hours | | 176 Hours | |
|---|---|---|---|---|---|---|
| | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits | Total Charges | $/Mile/$10^6$ Bits |
| 10 | $ 200 | $2.30 | $1184 | $.62 | $2235 | $.15 |
| 200 | 834 | .48 | 1818 | .048 | 2869 | .0094 |
| 350 | 1240 | .41 | 2224 | .033 | 3275 | .0062 |
| 700 | 2076 | .34 | 3060 | .023 | 4111 | .0039 |
| 1000 | 2524 | .29 | 3508 | .018 | 4559 | .0030 |
| 1400 | 2830 | .23 | 3814 | .014 | 4865 | .0023 |
| 1700 | 2956 | .20 | 3940 | .012 | 4991 | .0019 |
| 2000 | 3064 | .17 | 4048 | .011 | 5099 | .0017 |
| 2400 | 3132 | .15 | 4116 | .0090 | 5167 | .0014 |
| 2700 | 3200 | .13 | 4184 | .0081 | 5235 | .0013 |
| 3000 | 3268 | .12 | 4252 | .0075 | 5303 | .0012 |
| 3400 | 3302 | .11 | 4286 | .0066 | 5337 | .0010 |

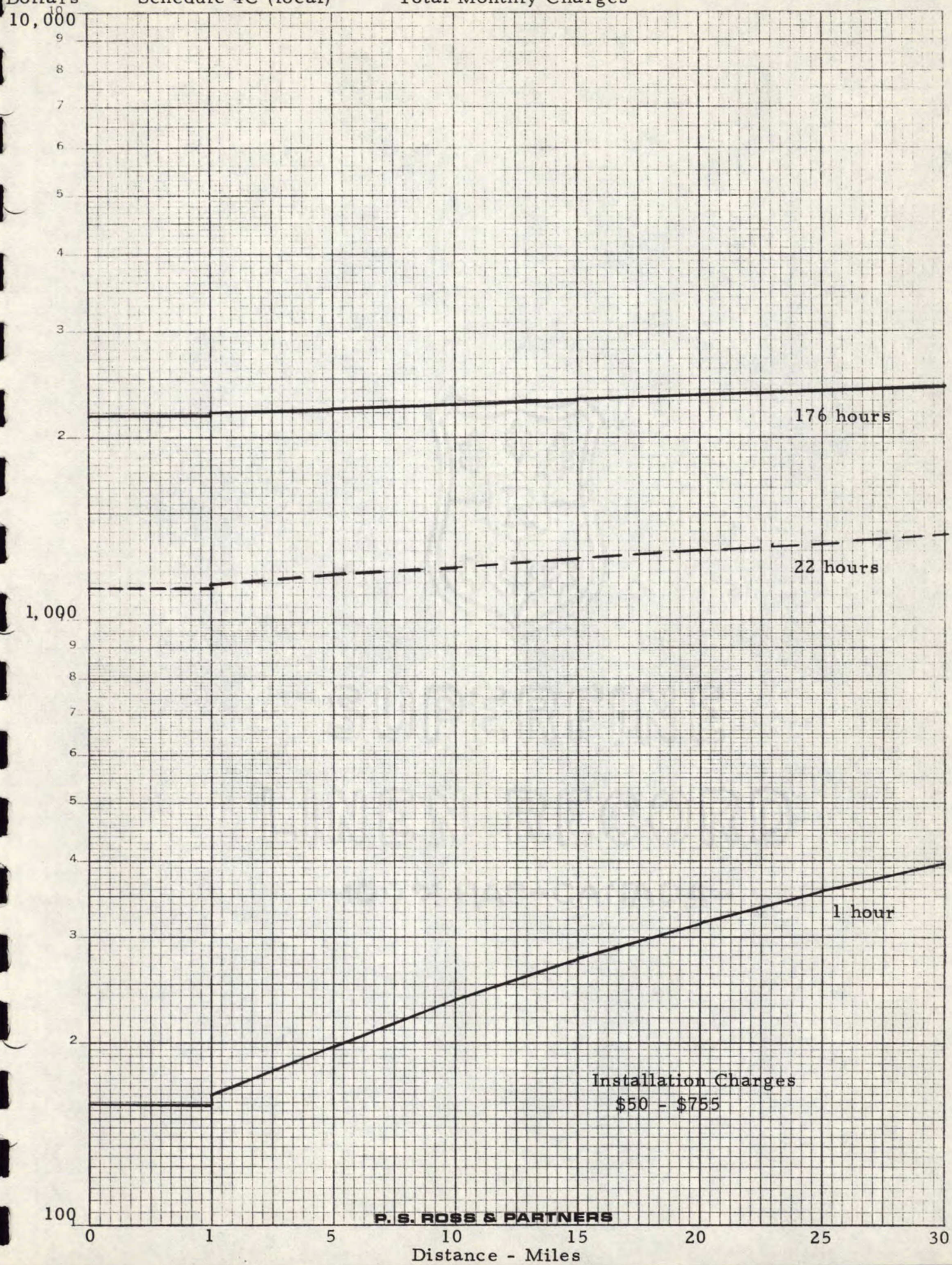
TABLE 42

| Time in Hours | 350 Miles | | 3000 Miles | |
|---|---|---|---|---|
| | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile |
| 1 | $1240 | $.41 | $3275 | $.13 |
| 16 | 1240 | .026 | 3275 | .0079 |
| 32 | 1240 | .013 | 3275 | .0040 |
| 48 | 1240 | .0085 | 3275 | .0026 |
| 64 | 1240 | .0064 | 3275 | .0020 |
| 80 | 1240 | .0051 | 3275 | .0016 |
| 96 | 1240 | .0043 | 3275 | .0013 |
| 112 | 1240 | .0038 | 3275 | .0011 |
| 128 | 1240 | .0032 | 3275 | .00098 |
| 144 | 1240 | .0029 | 3275 | .00088 |
| 160 | 1240 | .0026 | 3275 | .00079 |
| 176 | 1240 | .0023 | 3275 | .00072 |

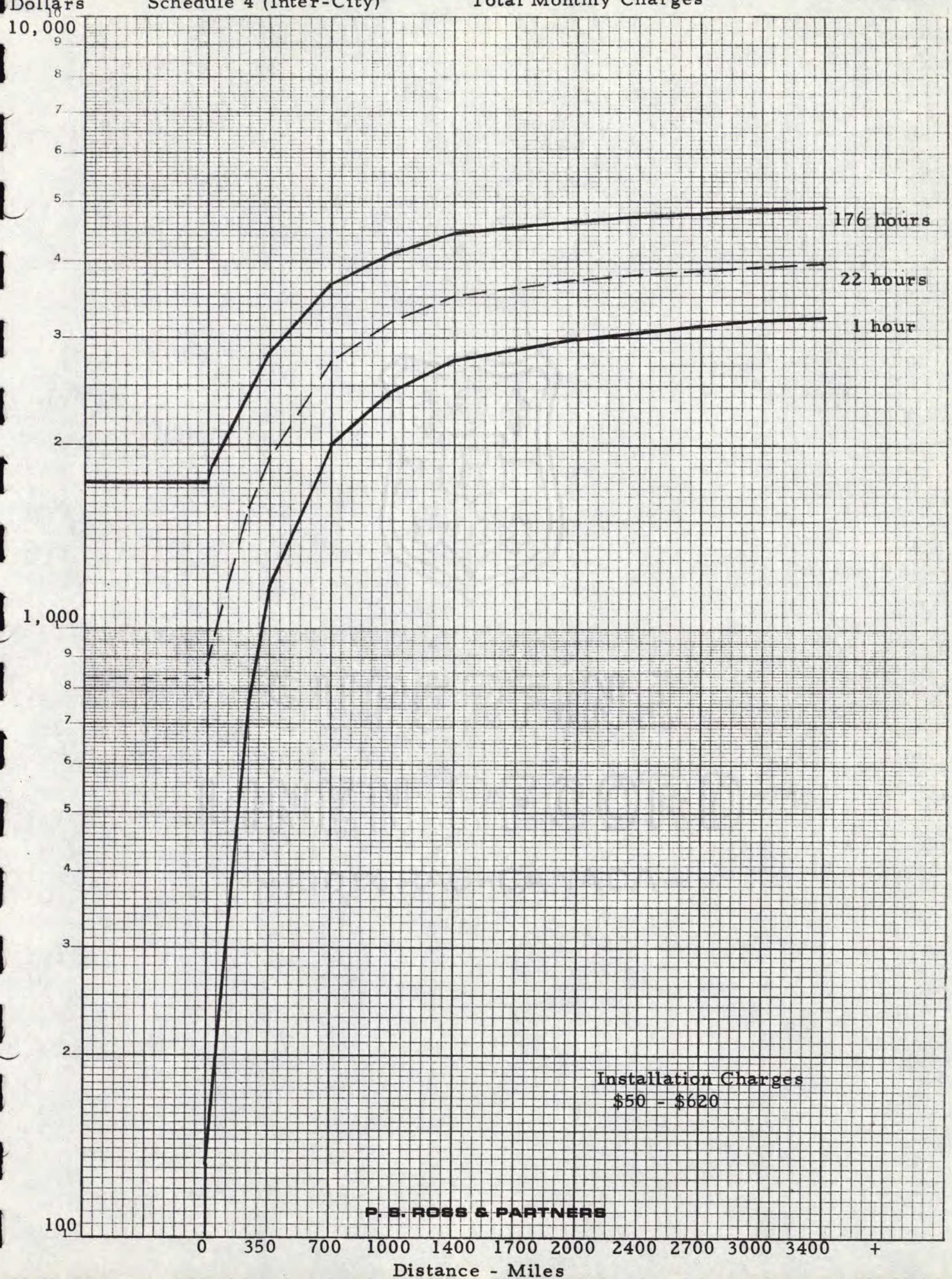
Schedule 4 (local) Total Monthly Charges



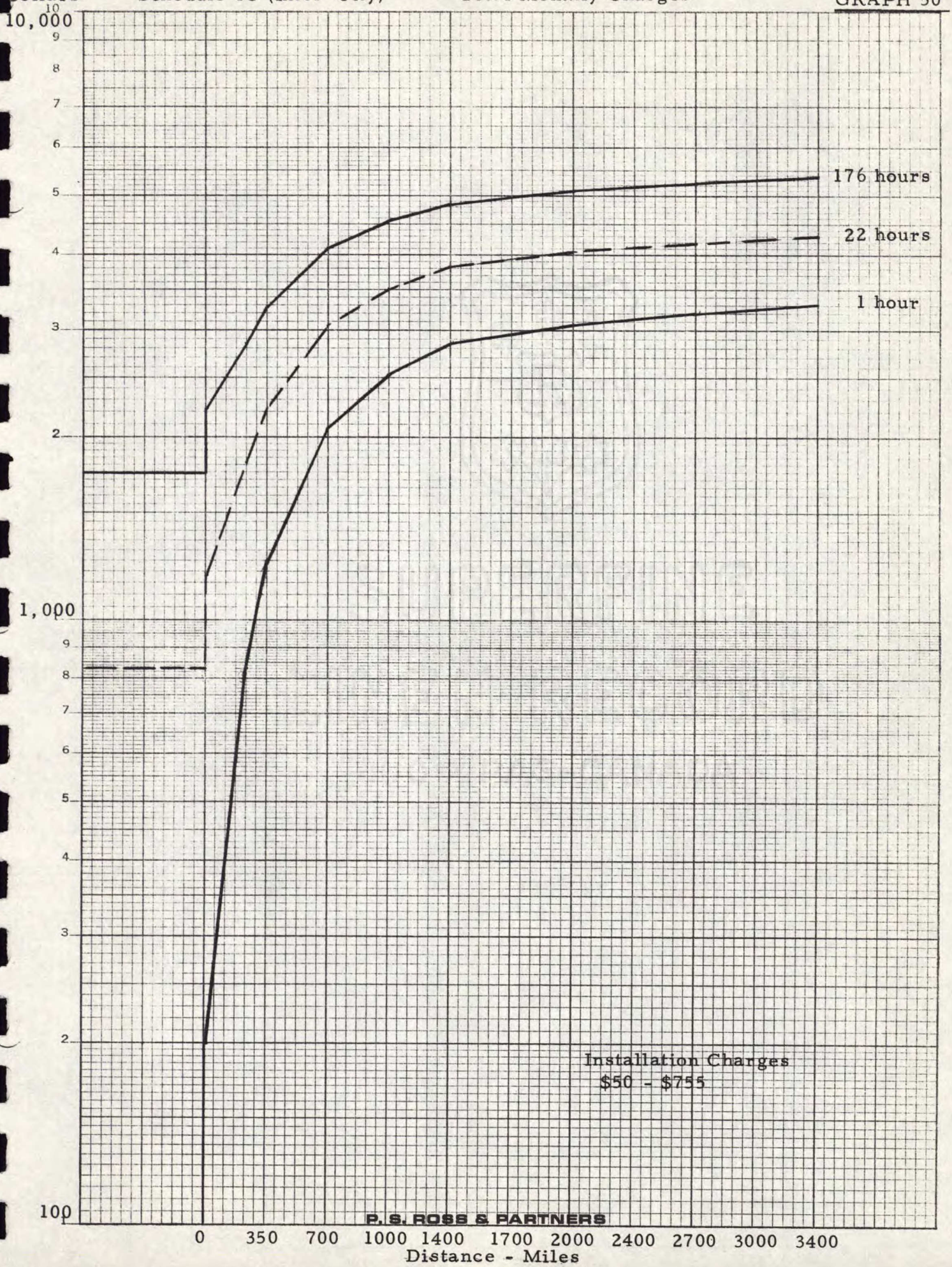
GRAPH 48


Dollars
Schedule 4C (local)
Total Monthly Charges
10,000
9
8
7
6
5
4
3
2
1,000
9
8
7
6
5
4
3
2
100
176 hours
22 hours
1 hour
Installation Charges
$50 - $755
P. S. ROSS & PARTNERS
0
1
5
10
15
20
25
30
Distance - Miles

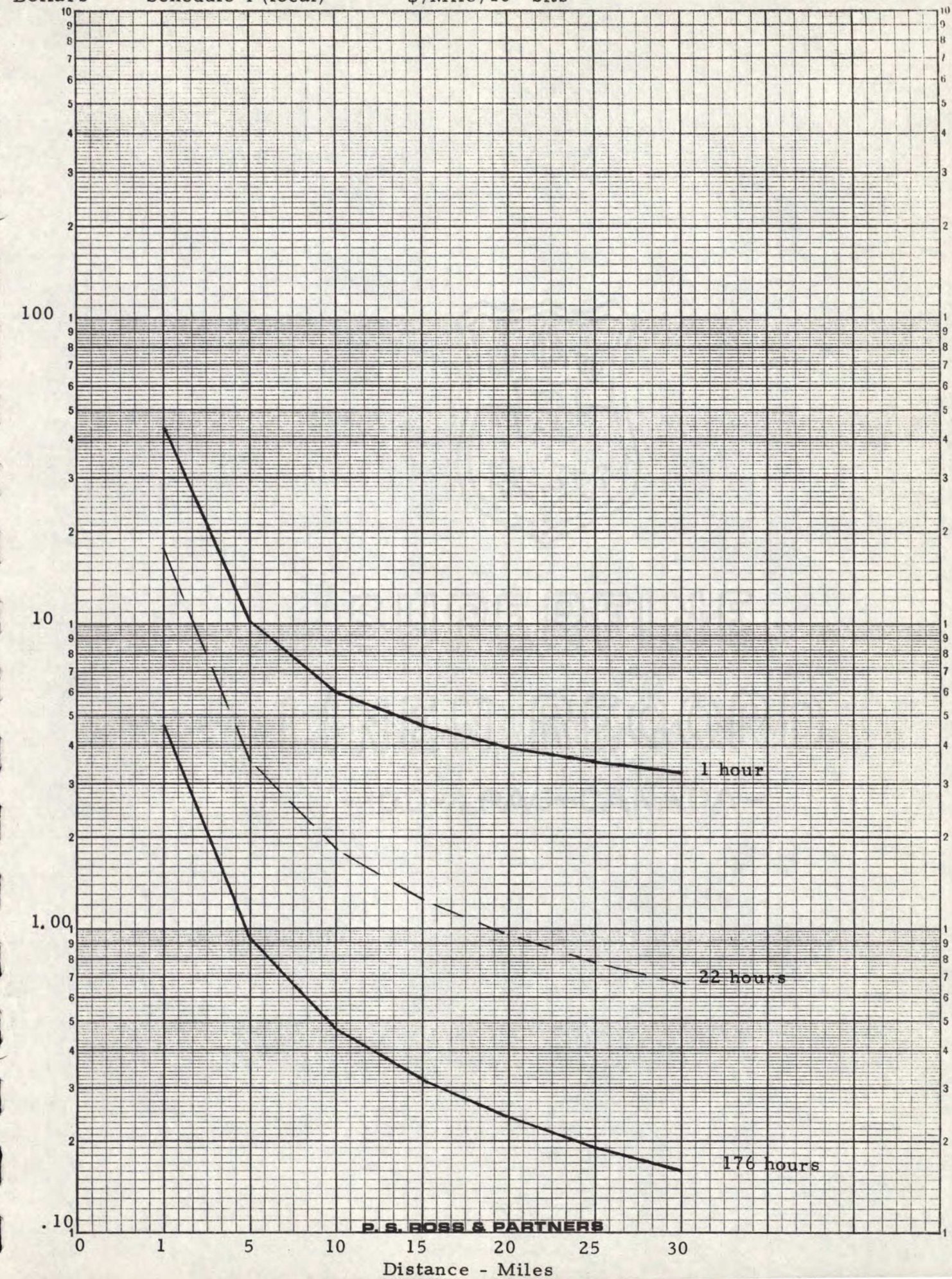
GRAPH 49


Dollars
Schedule 4 (Inter-City)
Total Monthly Charges
10,000
1,000
100
176 hours
22 hours
1 hour
Installation Charges
$50 - $620
P. S. ROSS & PARTNERS
0
350
700
1000
1400
1700
2000
2400
2700
3000
3400
+
Distance - Miles

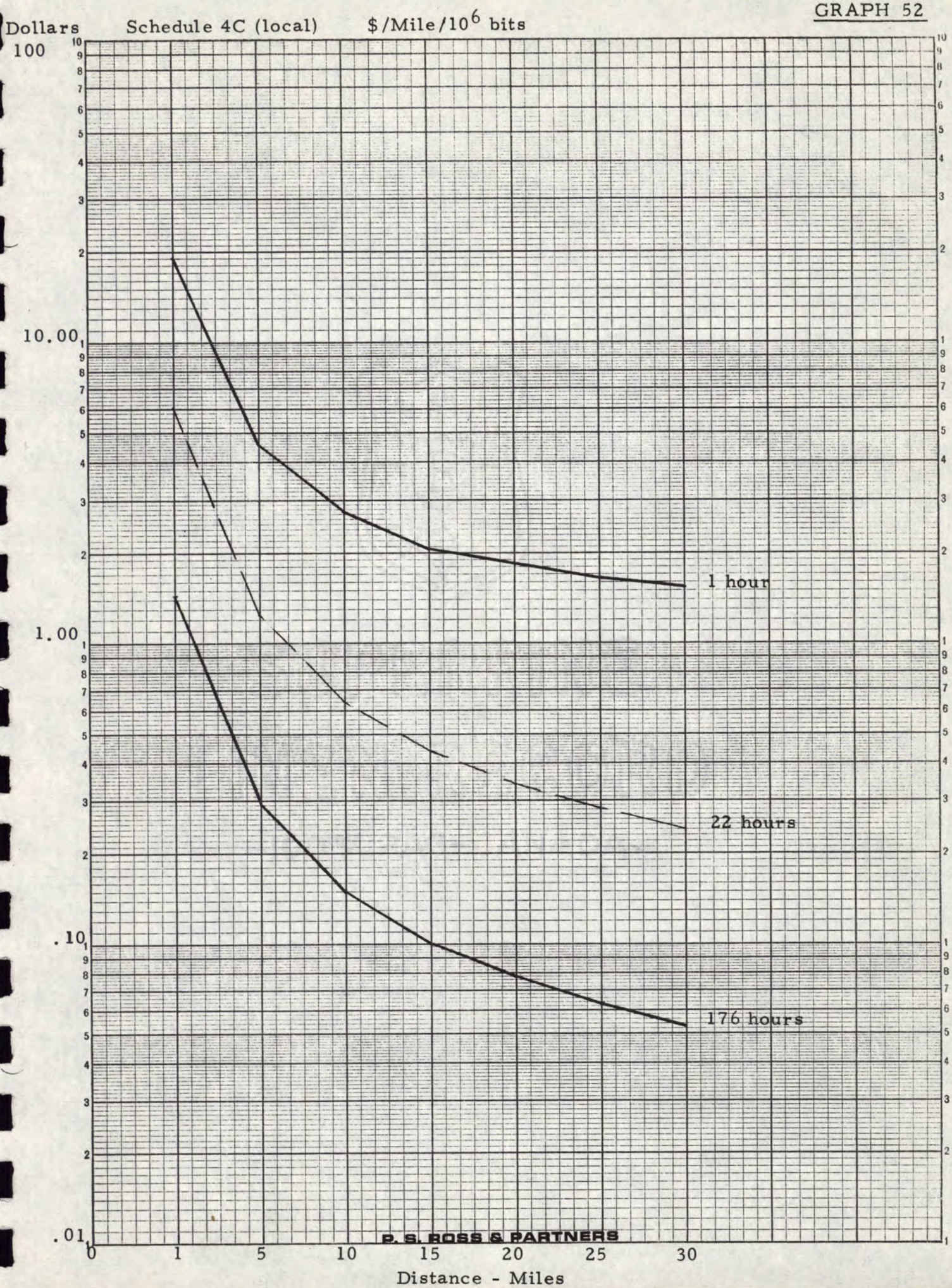
Dollars Schedule 4C (Inter-City) Total Monthly Charges GRAPH 50



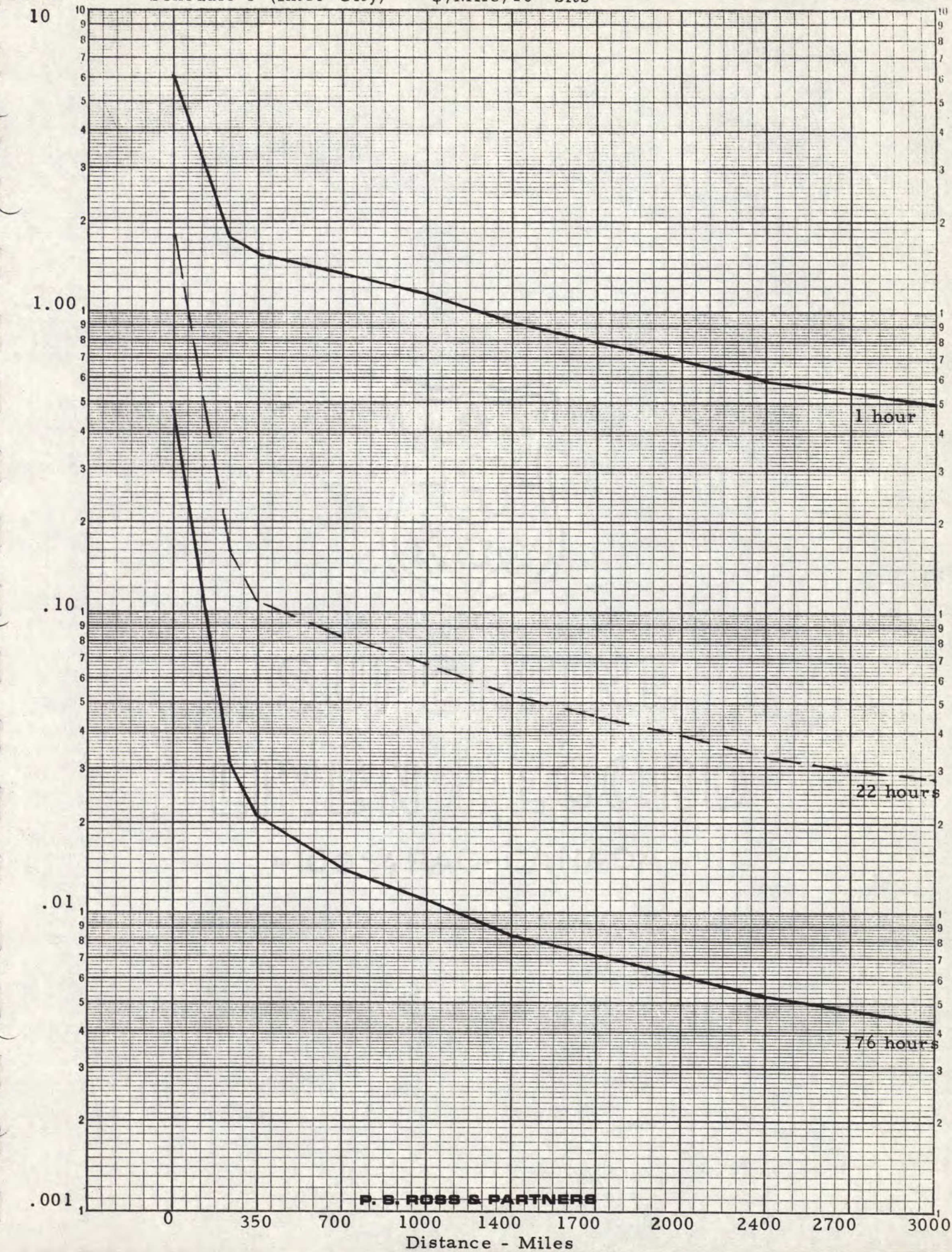
GRAPH 51

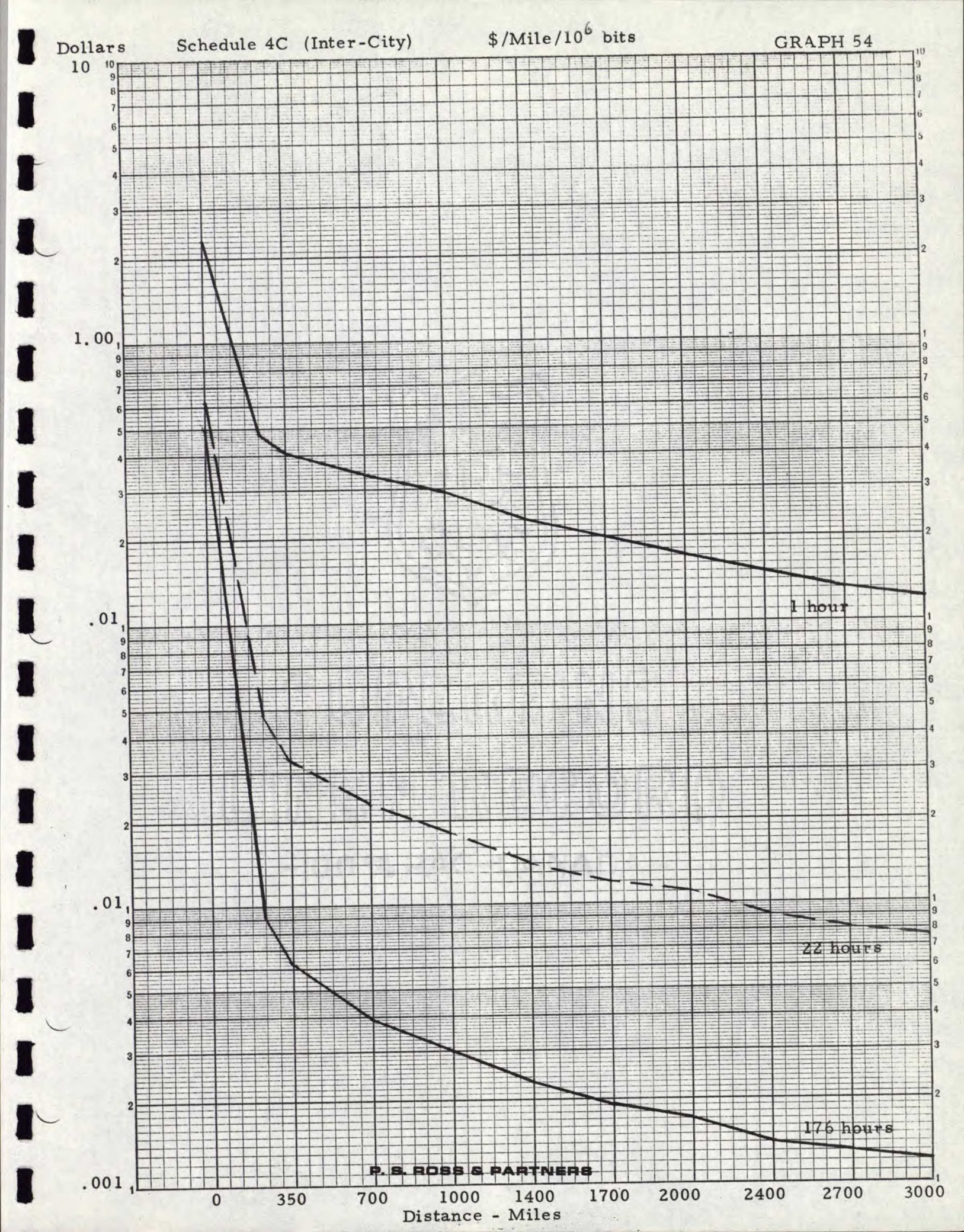

Dollars
Schedule 4 (local)
$/Mile/10^6 bits
100
10
1.00
.10
1 hour
22 hours
176 hours
P. S. ROSS & PARTNERS
0
1
5
10
15
20
25
30
Distance - Miles

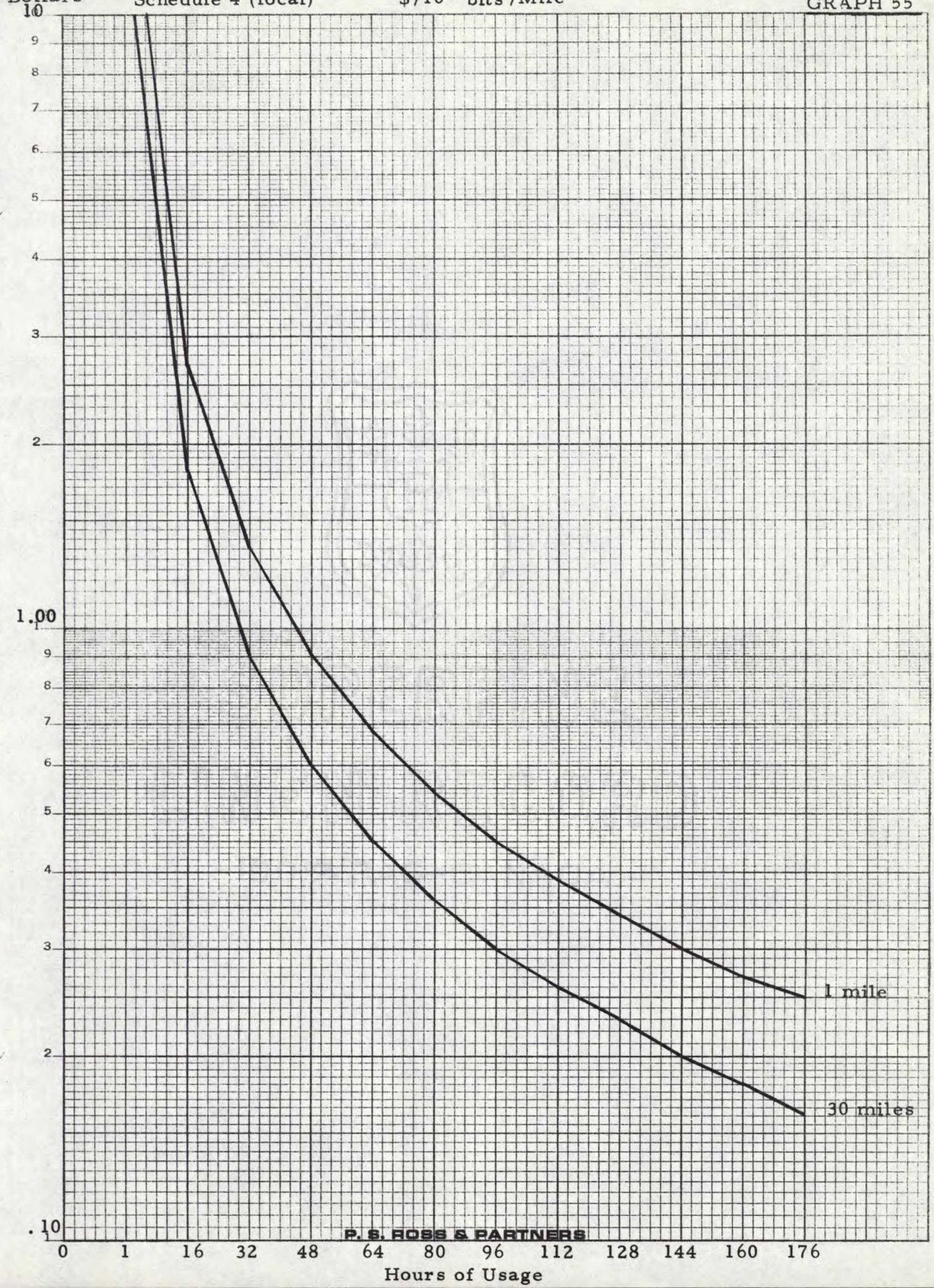
GRAPH 52


Dollars
Schedule 4C (local)
$/Mile/10^6 bits
100
10.00
1.00
.10
.01
1 hour
22 hours
176 hours
P. S. ROSS & PARTNERS
0
1
5
10
15
20
25
30
Distance - Miles

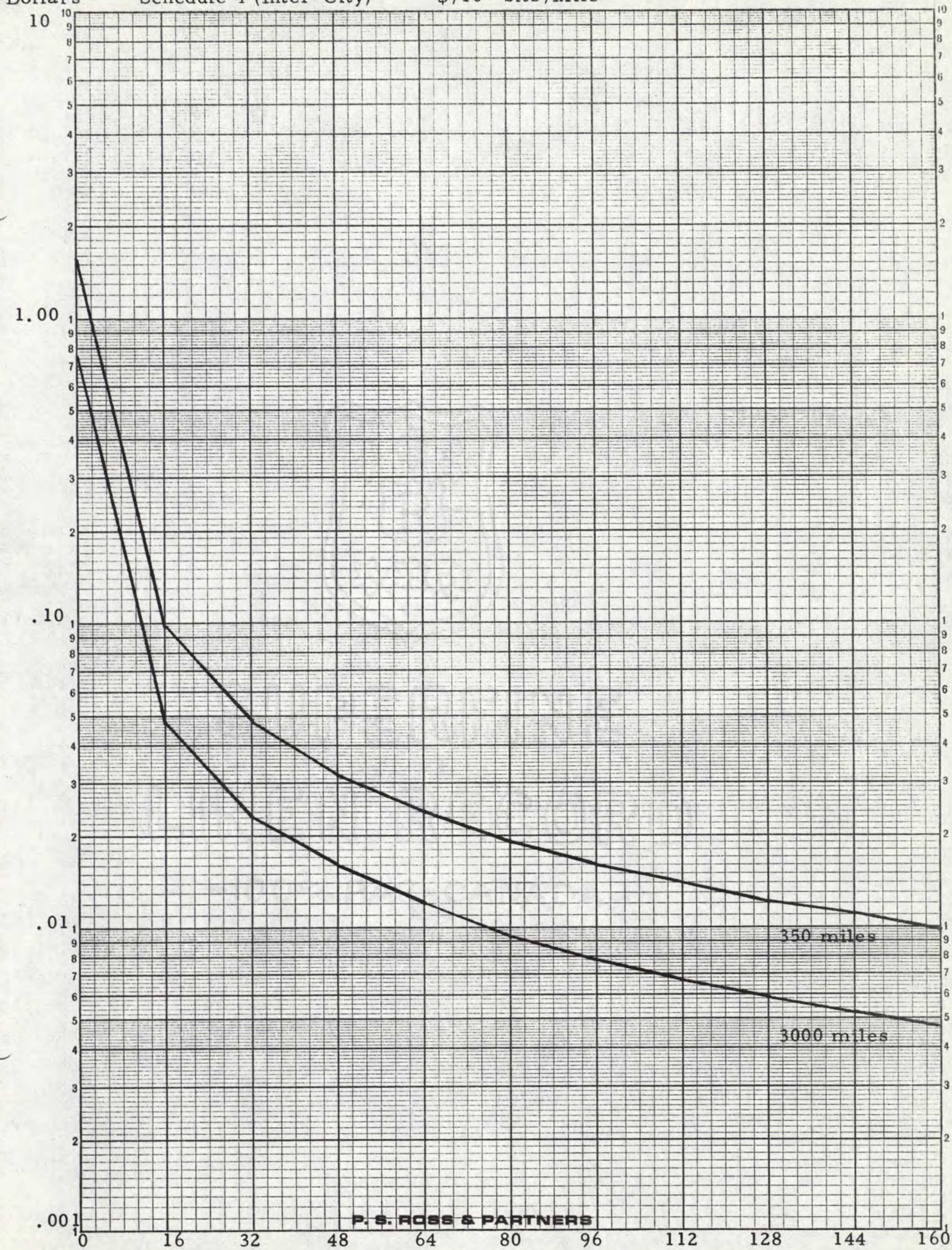
GRAPH 53

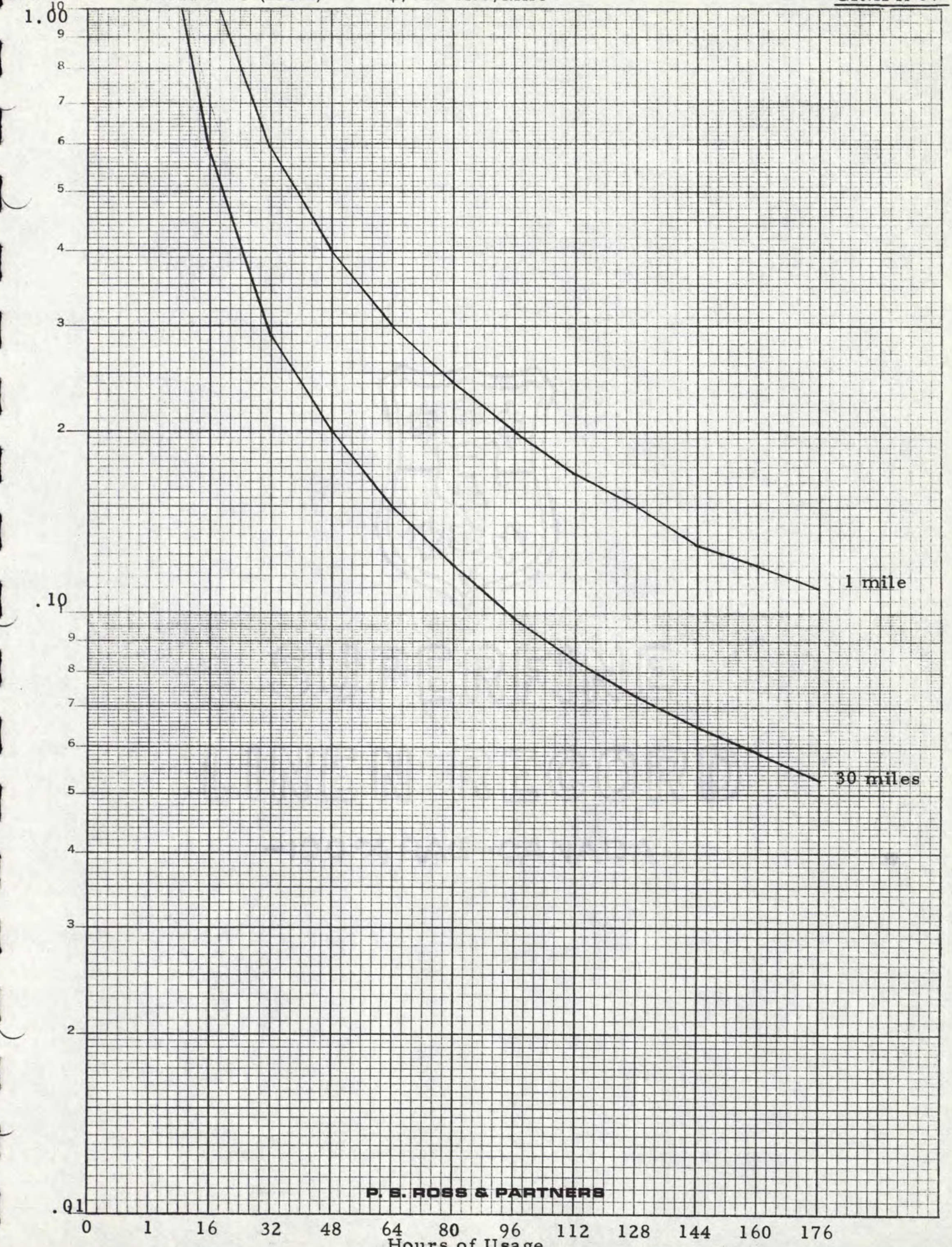

Dollars
Schedule 4 (Inter-City) $/Mile/10^6 bits
10
1.00
.10
.01
.001
1 hour
22 hours
176 hours
P. S. ROSS & PARTNERS
0
350
700
1000
1400
1700
2000
2400
2700
3000
Distance - Miles


Dollars
Schedule 4C (Inter-City)
$/Mile/10^6 bits
GRAPH 54
10
1.00
.01
.01
.001
1 hour
22 hours
176 hours
P. S. ROSS & PARTNERS
0
350
700
1000
1400
1700
2000
2400
2700
3000
Distance - Miles


Dollars
Schedule 4 (local)
$/10^6 bits /Mile
GRAPH 55
10
9
8
7
6
5
4
3
2
1.00
9
8
7
6
5
4
3
2
.10
1 mile
30 miles
P. S. ROSS & PARTNERS
0
1
16
32
48
64
80
96
112
128
144
160
176
Hours of Usage

GRAPH 56


Dollars
Schedule 4 (Inter-City)
$/10^6 bits/Mile
10
1.00
.10
.01
.001
350 miles
3000 miles
P. S. ROSS & PARTNERS
0
16
32
48
64
80
96
112
128
144
160
Hours of Usage


Dollars
Schedule 4C (local)
$/10^6 bits/Mile
GRAPH 57
1.00
.10
.01
1 mile
30 miles
P. B. ROSS & PARTNERS
0
1
16
32
48
64
80
96
112
128
144
160
176
Hours of Usage

GRAPH 58

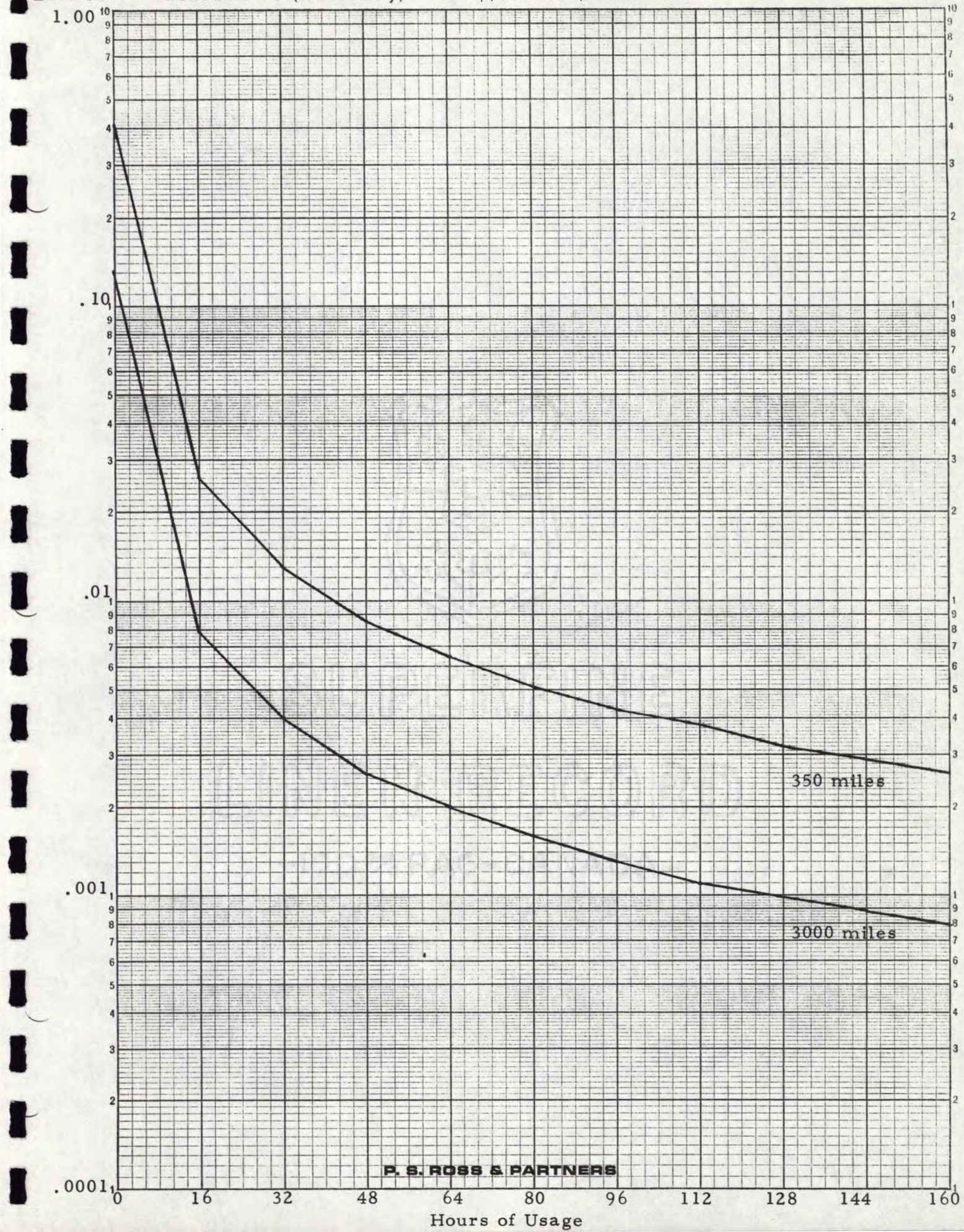

Dollars
Schedule 4C (Inter-City)
$/10^6 bits/Mile
1.00
.10
.01
.001
.0001
350 miles
3000 miles
P. S. ROSS & PARTNERS
0
16
32
48
64
80
96
112
128
144
160
Hours of Usage

TABLE 43

## CHANNEL DERIVING ARRANGEMENTS

## COMPUTER ACCESS

### MONTHLY CHARGES INCLUDING STATION RENTAL, CHANNEL CHARGES AND TRANSMISSION CHARGES

| Representative Mileages | 4 Channels Total Charges | 4 Channels $/Mile/Channel | 6 Channels Total Charges | 6 Channels $/Mile/Channel | 8 Channels Total Charges | 8 Channels $/Mile/Channel |
|---|---|---|---|---|---|---|
| 10 | $ 417 | $10.40 | $ 626 | $10.40 | $ 834 | $10.20 |
| 200 | 2952 | 3.70 | 4428 | 3.70 | 5904 | 3.70 |
| 350 | 4576 | 3.40 | 6864 | 3.40 | 9152 | 3.30 |
| 700 | 7920 | 2.80 | 11880 | 2.80 | 15840 | 2.80 |
| 1000 | 9712 | 2.40 | 14568 | 2.40 | 19424 | 2.40 |
| 1400 | 10936 | 1.95 | 16404 | 1.95 | 21872 | 1.95 |
| 1700 | 11440 | 1.70 | 17160 | 1.70 | 22880 | 1.70 |
| 2000 | 11872 | 1.50 | 17808 | 1.50 | 23744 | 1.50 |
| 2400 | 12144 | 1.30 | 18216 | 1.30 | 24288 | 1.30 |
| 2700 | 12416 | 1.15 | 18624 | 1.15 | 24832 | 1.15 |
| 3000 | 12688 | 1.06 | 19032 | 1.06 | 25376 | 1.06 |
| 3400 | 12824 | .95 | 19236 | .95 | 25648 | .95 |

TABLE 44

| 6 Channels Time in Hours | 10 Miles Total Charges | 10 Miles $/$10^6$ Bits/Mile/Channel | 700 Miles Total Charges | 700 Miles $/$10^6$ Bits/Mile/Channel | 3000 Miles Total Charges | 3000 Miles $/$10^6$ Bits/Mile/Channel |
|---|---|---|---|---|---|---|
| 1 | $626 | $16.10 | $11880 | $4.30 | $19032 | $1.64 |
| 16 | 626 | 1.00 | 11880 | .27 | 19032 | .10 |
| 32 | 626 | .50 | 11880 | .14 | 19032 | .051 |
| 48 | 626 | .34 | 11880 | .09 | 19032 | .034 |
| 64 | 626 | .25 | 11880 | .067 | 19032 | .026 |
| 80 | 626 | .20 | 11880 | .054 | 19032 | .020 |
| 96 | 626 | .17 | 11880 | .045 | 19032 | .017 |
| 112 | 626 | .14 | 11880 | .039 | 19032 | .015 |
| 128 | 626 | .13 | 11880 | .034 | 19032 | .013 |
| 144 | 626 | .11 | 11880 | .030 | 19032 | .011 |
| 160 | 626 | .10 | 11880 | .027 | 19032 | .010 |
| 176 | 626 | .091 | 11880 | .025 | 19032 | .0093 |

TABLE 45

## CHANNEL DERIVING ARRANGEMENTS

## TELEPRINTER

### MONTHLY CHARGES INCLUDING STATION RENTAL, CHANNEL CHARGES AND TRANSMISSION CHARGES

| Representative Mileages | 4 Channels | | 8 Channels | |
|---|---|---|---|---|
| | Total Charges | $/Mile/ Channel | Total Charges | $/Mile/ Channel |
| 10 | $ 377 | $9.40 | $ 614 | $7.70 |
| 200 | 2912 | 3.60 | 5684 | 3.55 |
| 350 | 4536 | 3.25 | 8932 | 3.20 |
| 700 | 7880 | 2.80 | 15620 | 2.80 |
| 1000 | 9672 | 2.40 | 19204 | 2.40 |
| 1400 | 10896 | 1.95 | 21652 | 1.95 |
| 1700 | 11400 | 1.70 | 22660 | 1.70 |
| 2000 | 11832 | 1.48 | 23524 | 1.48 |
| 2400 | 12104 | 1.26 | 24068 | 1.26 |
| 2700 | 12376 | 1.14 | 24612 | 1.14 |
| 3000 | 12648 | 1.05 | 25156 | 1.05 |
| 3400 | 12784 | .94 | 25428 | .94 |

TABLE 46

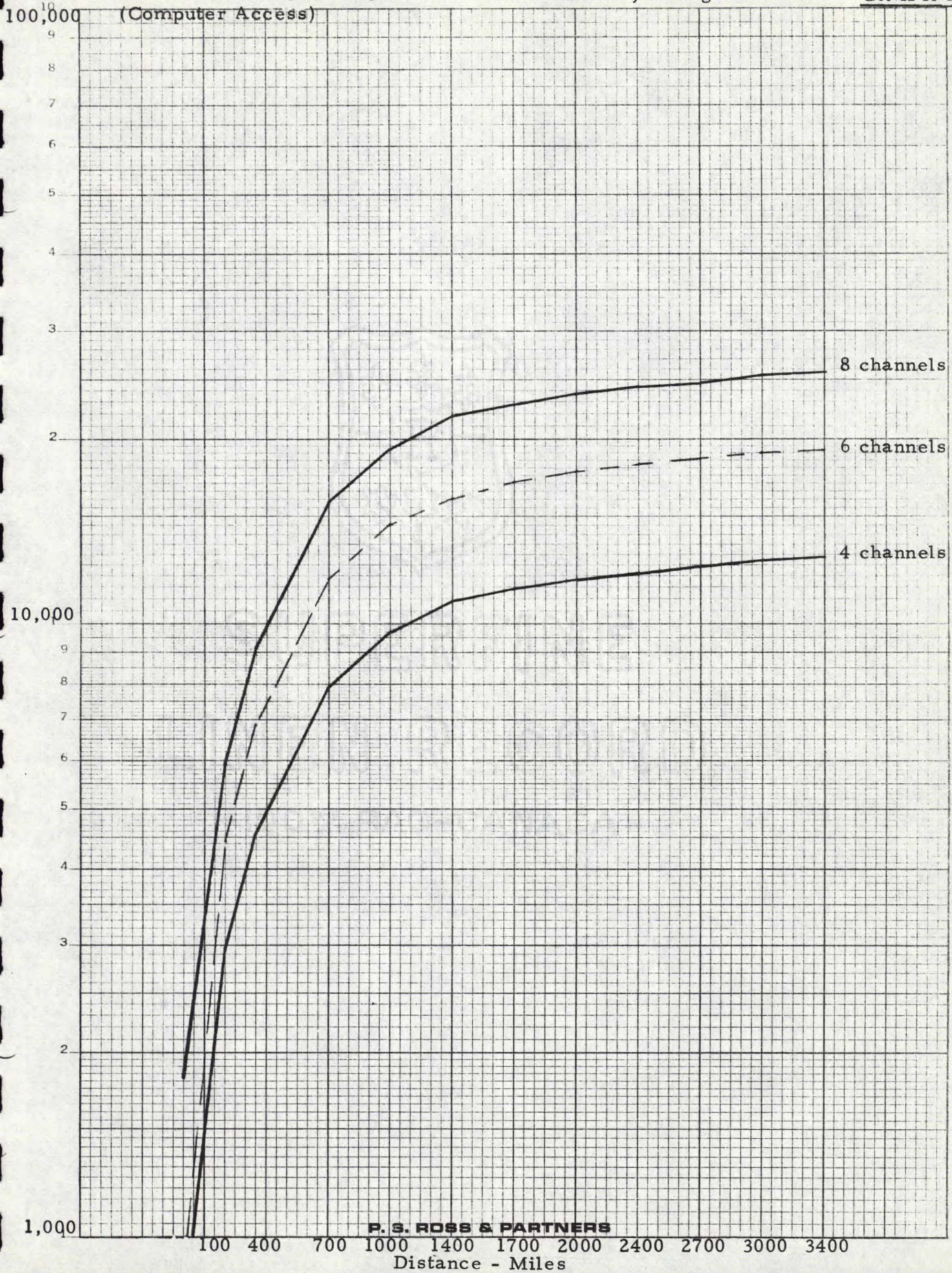
| 4 Channels | 10 Miles | | 700 Miles | | 3000 Miles | |
|---|---|---|---|---|---|---|
| Time in Hours | Total Charges | $/$10^6$ Bits/ Mile/Channel | Total Charges | $/$10^6$ Bits/ Mile/Channel | Total Charges | $/$10^6$ Bits/ Mile/Channel |
| 1 | $377 | $14.54 | $7880 | $4.32 | $12648 | $1.63 |
| 16 | 377 | .91 | 7880 | .27 | 12648 | .10 |
| 32 | 377 | .45 | 7880 | .14 | 12648 | .051 |
| 48 | 377 | .30 | 7880 | .090 | 12648 | .034 |
| 64 | 377 | .23 | 7880 | .068 | 12648 | .025 |
| 80 | 377 | .18 | 7880 | .054 | 12648 | .020 |
| 96 | 377 | .15 | 7880 | .045 | 12648 | .017 |
| 112 | 377 | .13 | 7880 | .039 | 12648 | .014 |
| 128 | 377 | .11 | 7880 | .034 | 12648 | .013 |
| 144 | 377 | .10 | 7880 | .030 | 12648 | .011 |
| 160 | 377 | .090 | 7880 | .027 | 12648 | .010 |
| 176 | 377 | .083 | 7880 | .025 | 12648 | .0092 |

Dollars

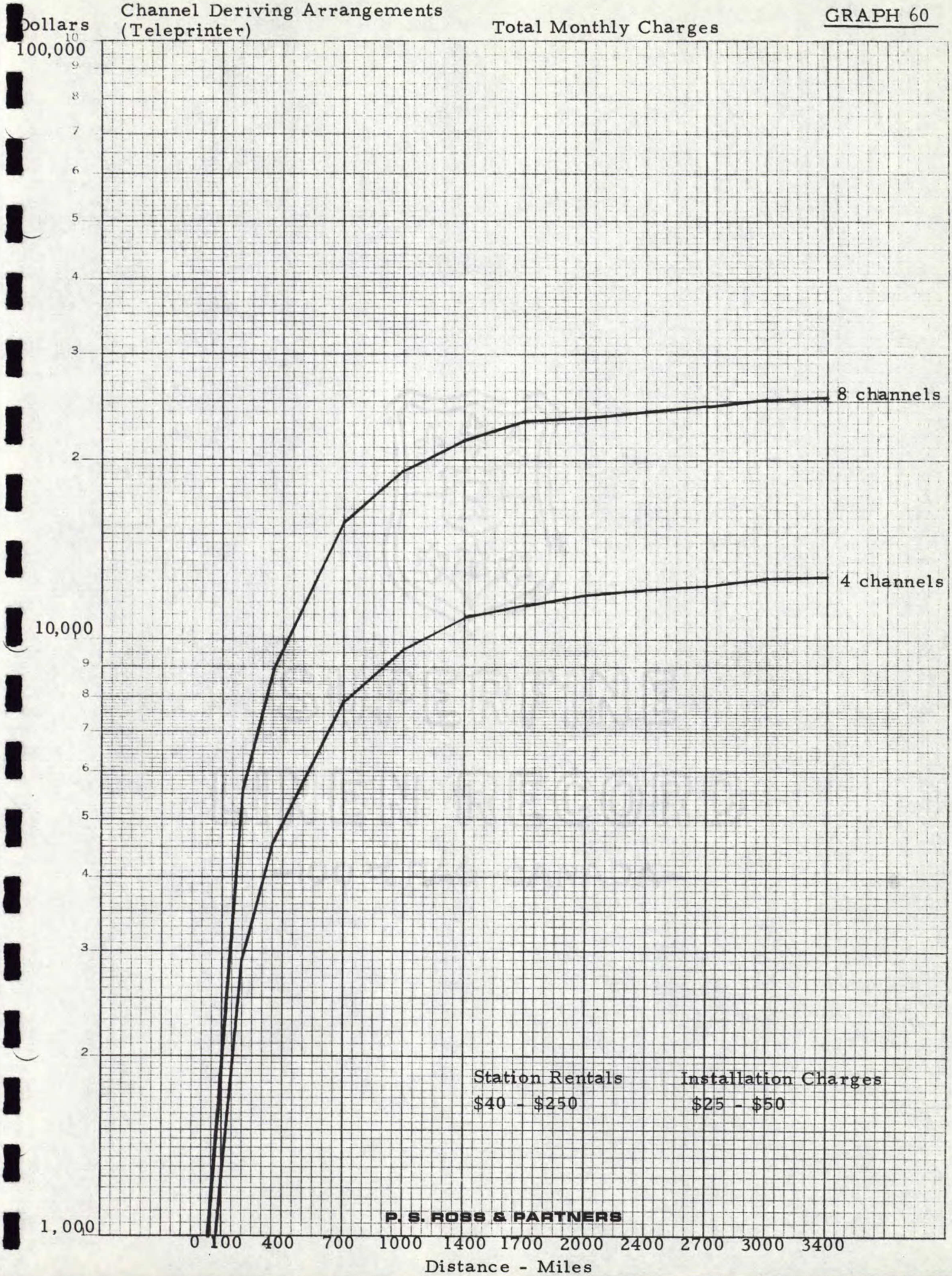
Channel Deriving Arrangements
(Computer Access)

Total Monthly Charges

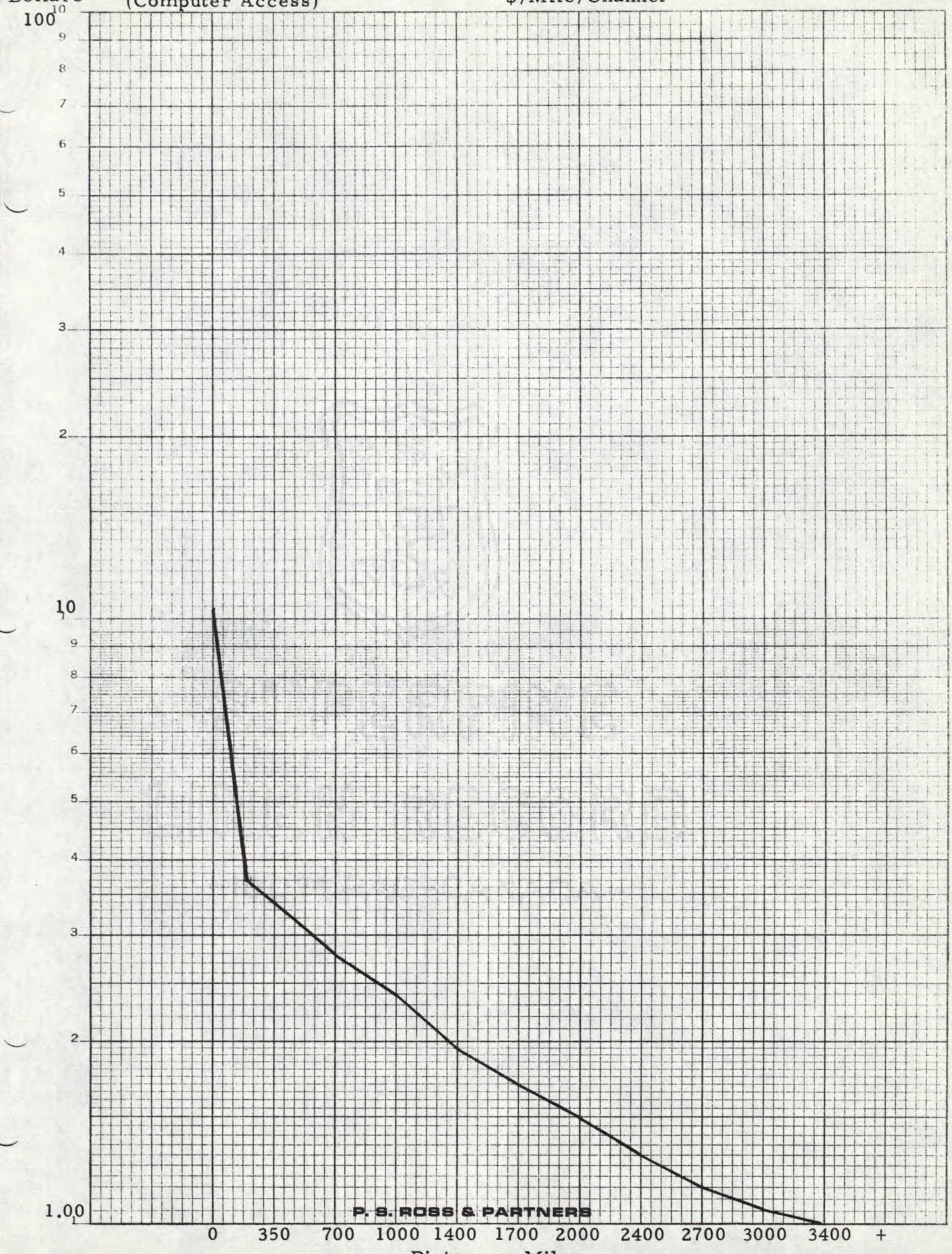
GRAPH 59




P. S. ROSS & PARTNERS


Channel Deriving Arrangements
(Teleprinter)
Total Monthly Charges
GRAPH 60
Dollars
100,000
10,000
1,000
8 channels
4 channels
Station Rentals
$40 - $250
Installation Charges
$25 - $50
P. S. ROSS & PARTNERS
0 100 400 700 1000 1400 1700 2000 2400 2700 3000 3400
Distance - Miles

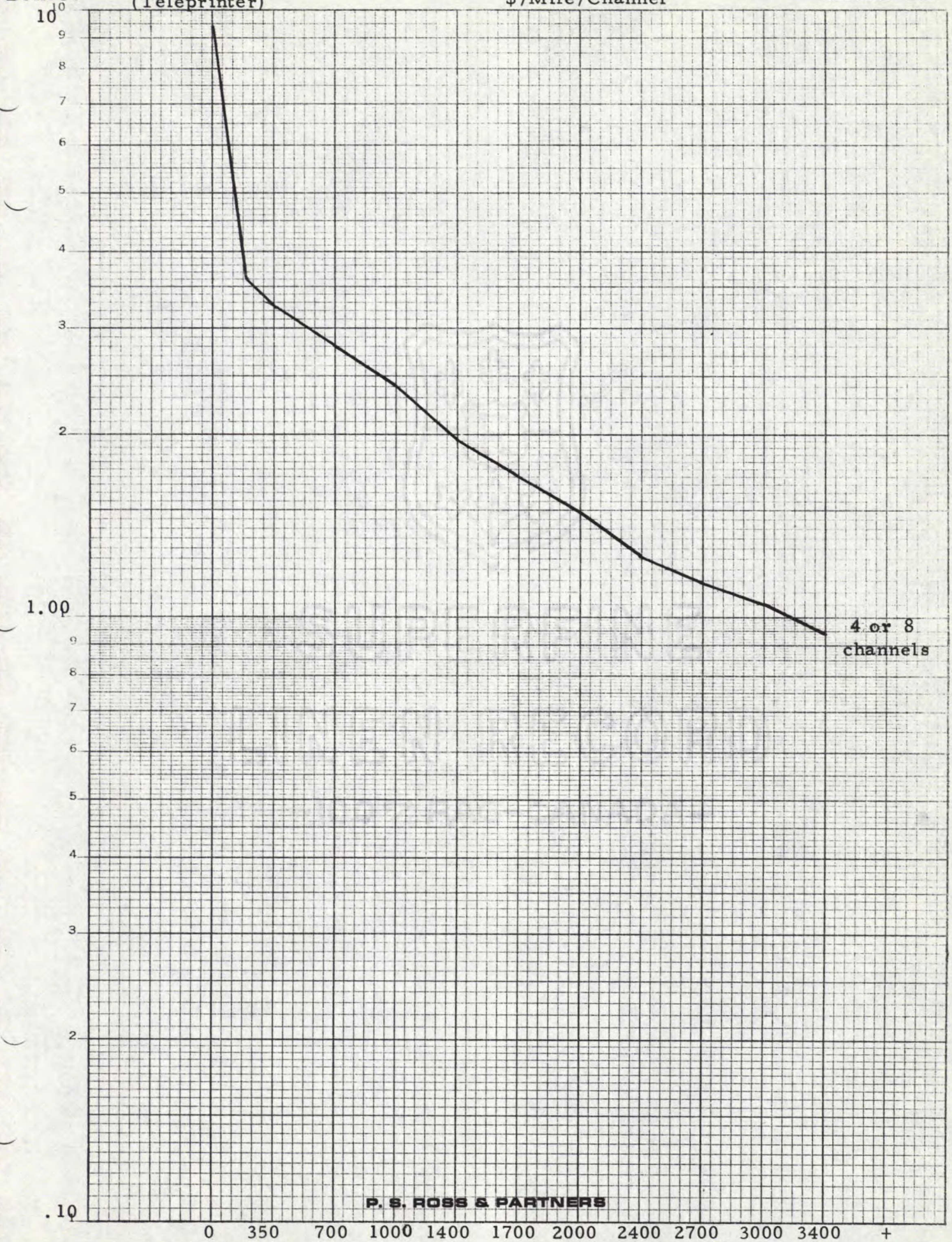
GRAPH 61

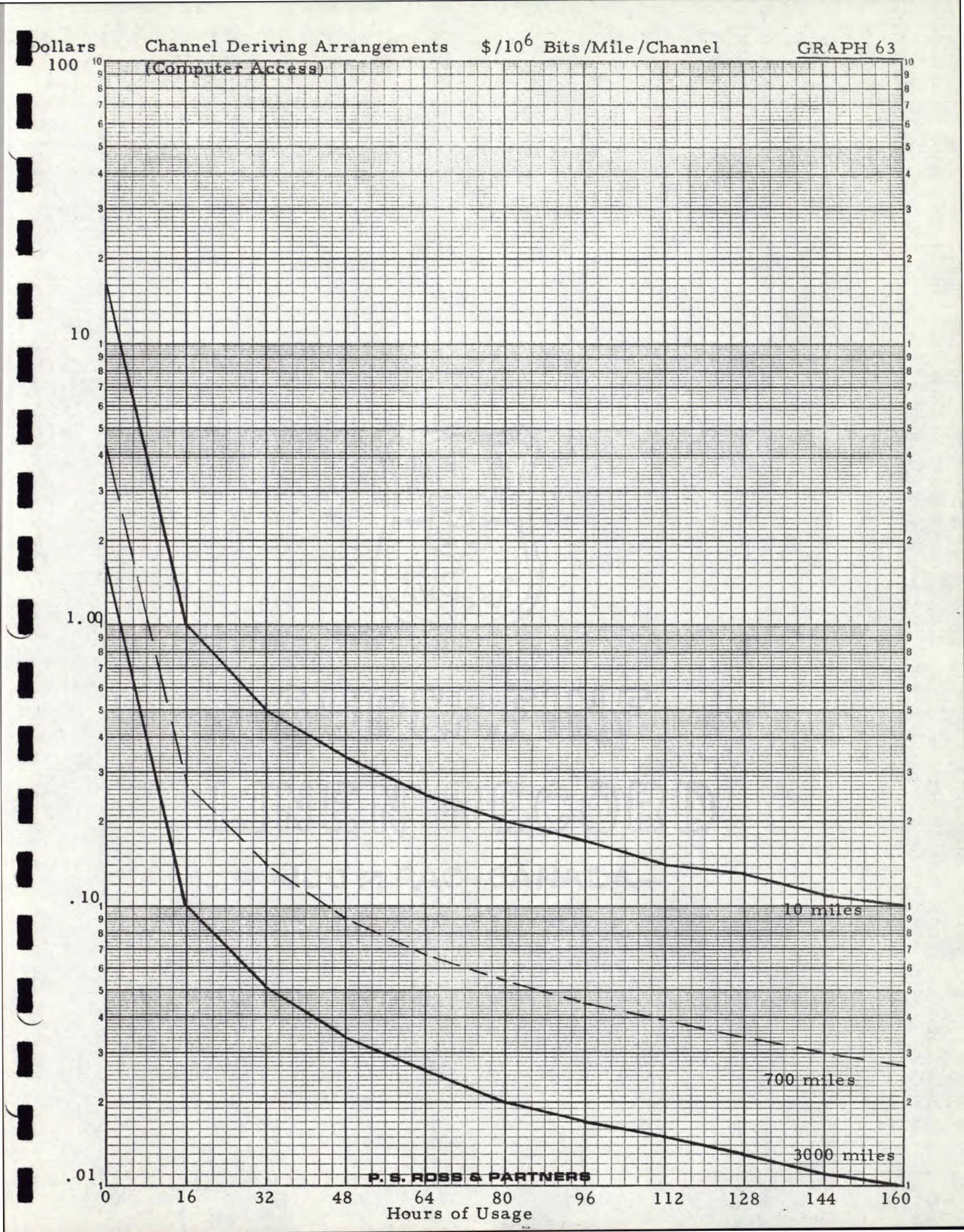

Channel Deriving Arrangements
(Computer Access)
$/Mile/Channel
Dollars
100
10
9
8
7
6
5
4
3
2
10
9
8
7
6
5
4
3
2
1.00
P. S. ROSS & PARTNERS
0
350
700
1000
1400
1700
2000
2400
2700
3000
3400
+
Distance - Miles

Channel Deriving Arrangements
(Teleprinter)

$/Mile/Channel

GRAPH 62




Dollars
Channel Deriving Arrangements
$/10^6 Bits/Mile/Channel
GRAPH 63
(Computer Access)
100
10
1.00
.10
.01
10 miles
700 miles
3000 miles
P. S. ROSS & PARTNERS
0
16
32
48
64
80
96
112
128
144
160
Hours of Usage

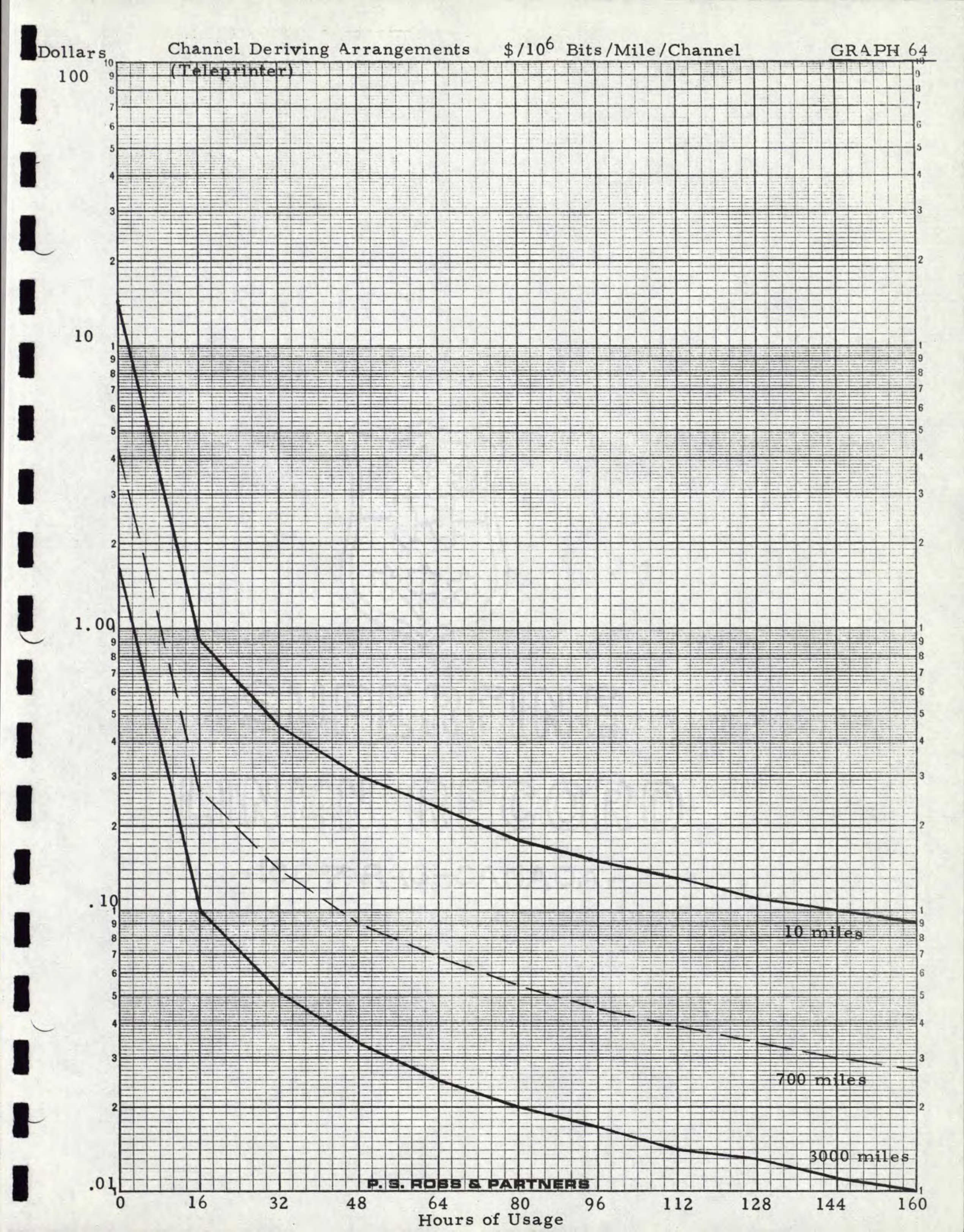

Dollars
Channel Deriving Arrangements $/10^6 Bits/Mile/Channel
GRAPH 64
(Teleprinter)
100
10
1.00
.10
.01
10 miles
700 miles
3000 miles
P. S. ROSS & PARTNERS
0
16
32
48
64
80
96
112
128
144
160
Hours of Usage

TABLE 47

## TELPAK A - SIMPLEX

### MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

| | One Hour | 22 Hours | | | | | 176 Hours |
|---|---|---|---|---|---|---|---|
| | | | $/Mile/$10^6$ Bits | | | | |
| Representative Mileages | Total Charges | Total Charges | 2400 bps | 4800 bps | 7200 bps | 9600 bps | Total Charges |
| 10 | $ 370 | $ 520 | $.025 | $.0125 | $.0083 | $.0063 | $ 670 |
| 350 | 8870 | 9020 | .012 | .0062 | .0041 | .0031 | 9170 |
| 700 | 17620 | 17770 | .012 | .0061 | .0041 | .0031 | 17920 |
| 1000 | 25120 | 25270 | .012 | .0061 | .0041 | .0030 | 25420 |
| 1400 | 35120 | 35270 | .012 | .0061 | .0040 | .0030 | 35420 |
| 1700 | 42620 | 42770 | .012 | .0060 | .0040 | .0030 | 42920 |
| 2000 | 50120 | 50270 | .012 | .0060 | .0040 | .0030 | 50420 |
| 2400 | 60120 | 60270 | .012 | .0060 | .0040 | .0030 | 60420 |
| 2700 | 67620 | 67770 | .012 | .0060 | .0040 | .0030 | 67920 |
| 3000 | 75120 | 75270 | .012 | .0060 | .0040 | .0030 | 75420 |
| 3400 | 85120 | 85270 | .012 | .0060 | .0040 | .0030 | 85420 |

TABLE 48

At 4800 bps

| | 350 Miles | | 3000 Miles | |
|---|---|---|---|---|
| Time in Hours | Total Charges | $/$10^6$ Bits/Mile | Total Charges | $/$10^6$ Bits/Mile |
| 1 | $8870 | $.12 | $75420 | $.12 |
| 16 | 8870 | .0076 | 75420 | .0076 |
| 32 | 8870 | .0038 | 75420 | .0038 |
| 48 | 8870 | .0025 | 75420 | .0025 |
| 64 | 8870 | .0019 | 75420 | .0019 |
| 80 | 8870 | .0015 | 75420 | .0015 |
| 96 | 8870 | .0013 | 75420 | .0013 |
| 112 | 8870 | .0011 | 75420 | .0011 |
| 128 | 8870 | .00096 | 75420 | .00096 |
| 144 | 8870 | .00085 | 75420 | .00085 |
| 160 | 8870 | .00076 | 75420 | .00076 |
| 176 | 8870 | .00069 | 75420 | .00069 |

TABLE 49

## TELPAK A - DUPLEX

## MONTHLY CHARGES INCLUDING STATION RENTALS AND TRANSMISSION CHARGES

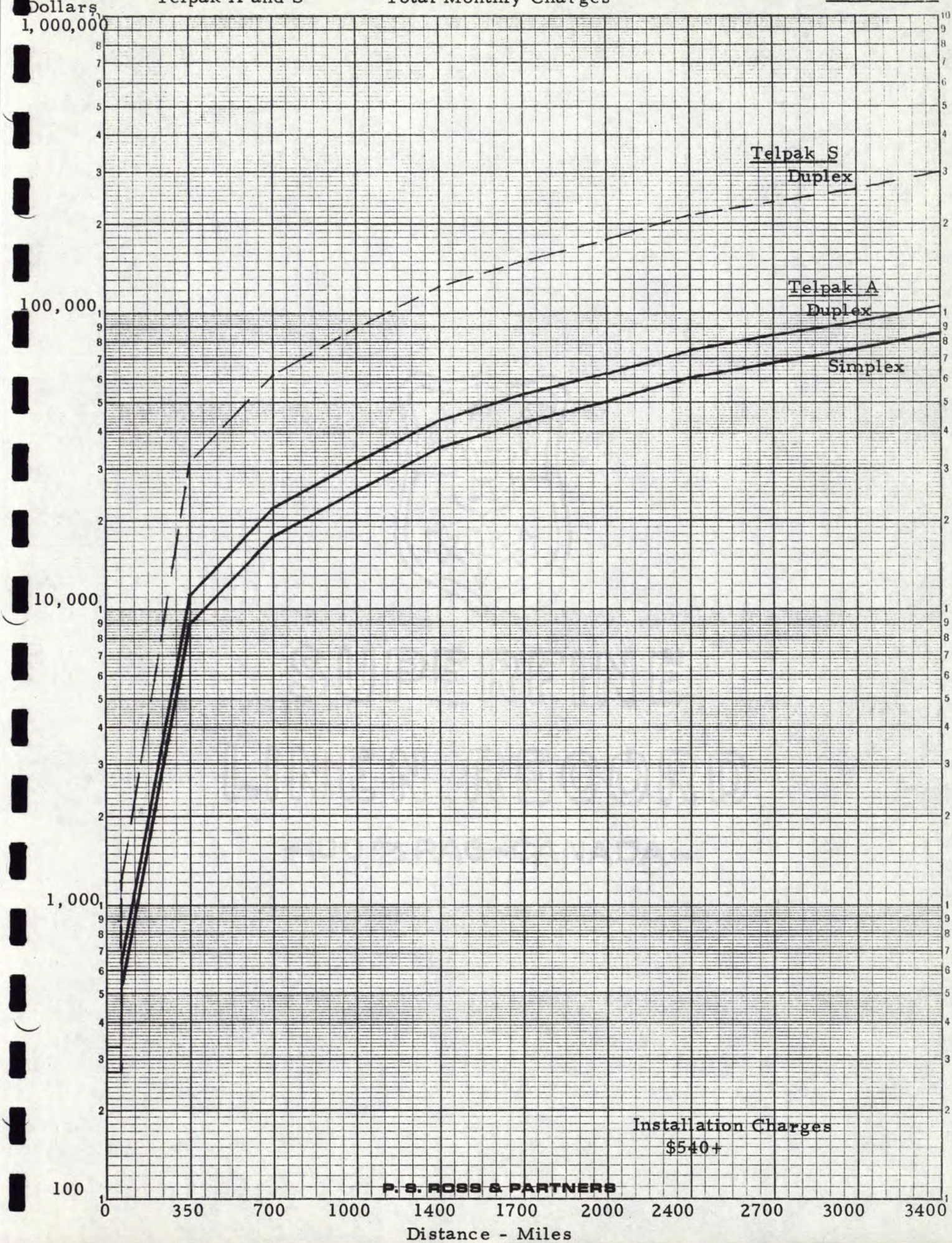
| | One Hour | 22 Hours | | | | | 176 Hours |
|---|---|---|---|---|---|---|---|
| | | | $/Mile/$10^6$ Bits | | | | |
| Representative Mileages | Total Charges | Total Charges | 2400 bps | 4800 bps | 7200 bps | 9600 bps | Total Charges |
| 10 | $ 490 | $ 640 | $.031 | $.015 | $.010 | $.0077 | $ 790 |
| 350 | 11030 | 11180 | .015 | .0077 | .0051 | .0038 | 11330 |
| 700 | 21880 | 22030 | .015 | .0076 | .0050 | .0038 | 22180 |
| 1000 | 31180 | 31330 | .015 | .0075 | .0050 | .0038 | 31480 |
| 1400 | 43580 | 43730 | .015 | .0075 | .0050 | .0038 | 43880 |
| 1700 | 52880 | 53030 | .015 | .0075 | .0050 | .0037 | 53180 |
| 2000 | 62180 | 62330 | .015 | .0075 | .0050 | .0037 | 62480 |
| 2400 | 74580 | 74730 | .015 | .0075 | .0050 | .0037 | 74880 |
| 2700 | 83880 | 84030 | .015 | .0075 | .0050 | .0037 | 84180 |
| 3000 | 93180 | 93330 | .015 | .0075 | .0050 | .0037 | 93480 |
| 3400 | 105580 | 105730 | .015 | .0075 | .0050 | .0037 | 105880 |

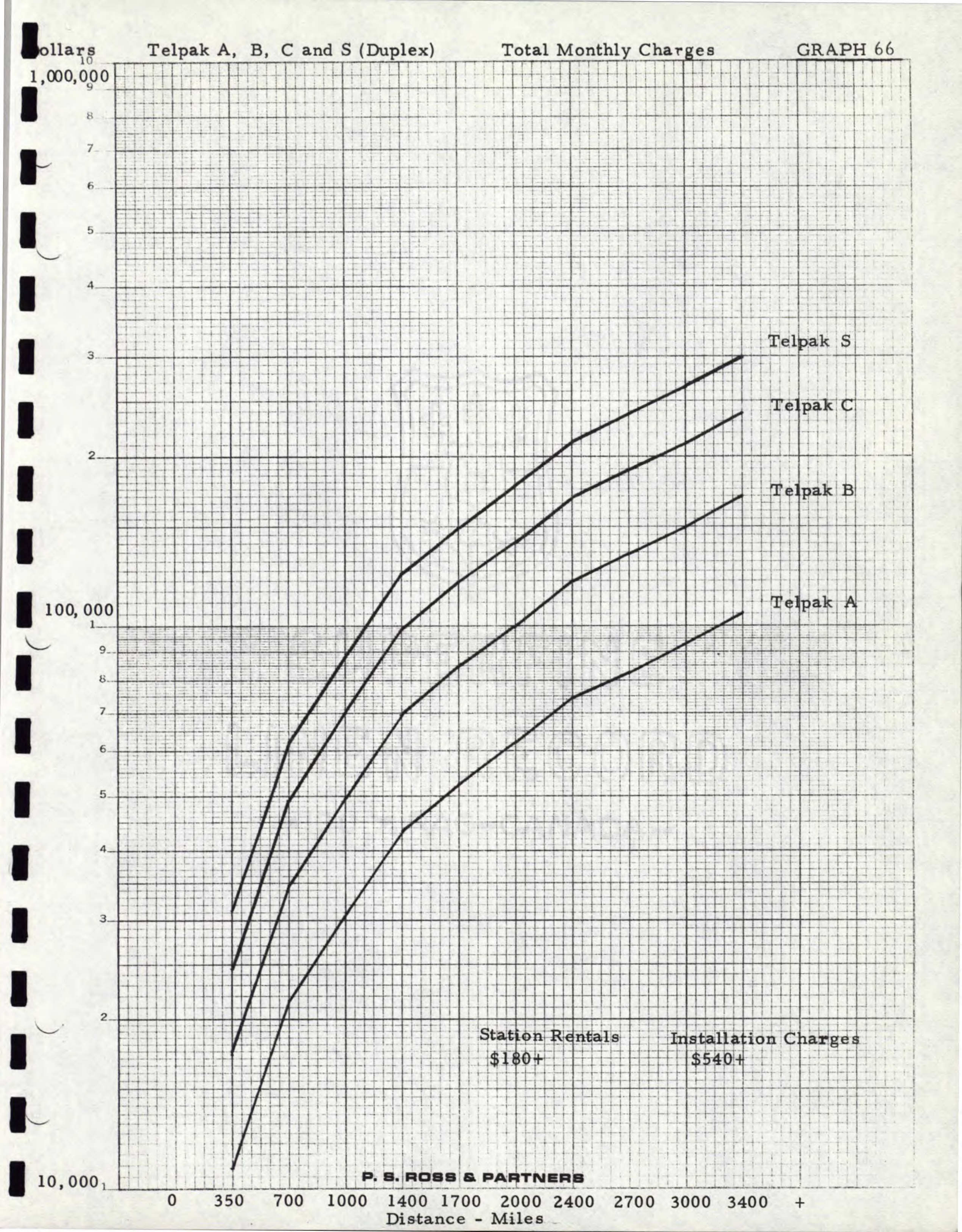
TABLE 50

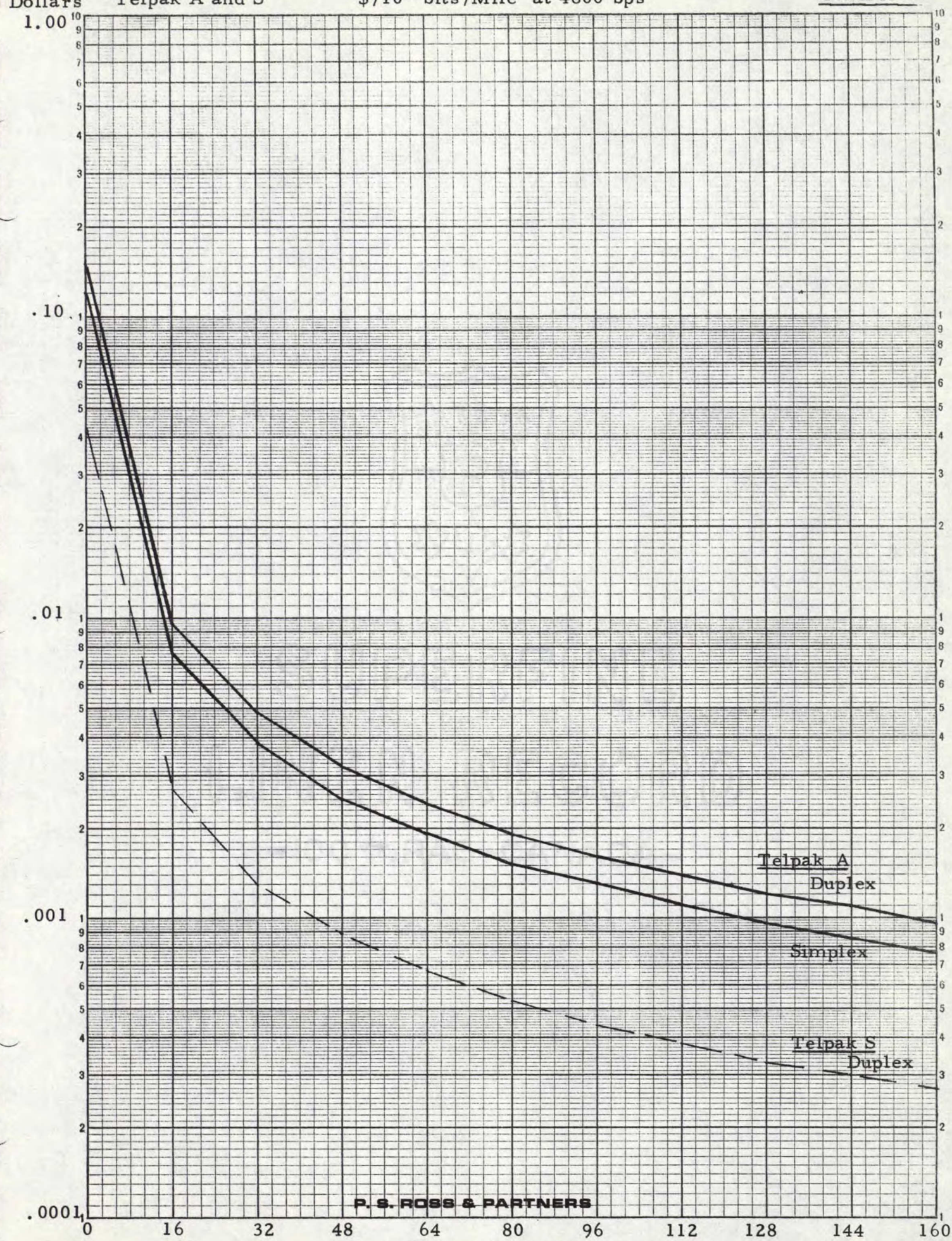
At 4800 bps

| | 350 Miles | | 3000 Miles | |
|---|---|---|---|---|
| Time in Hours | Total Charges | $/$10^6$ Bits/ Mile | Total Charges | $/$10^6$ Bits/ Mile |
| 1 | $11030 | $.15 | $93480 | $.15 |
| 16 | 11030 | .0095 | 93480 | .0094 |
| 32 | 11030 | .0048 | 93480 | .0047 |
| 48 | 11030 | .0032 | 93480 | .0031 |
| 64 | 11030 | .0024 | 93480 | .0023 |
| 80 | 11030 | .0019 | 93480 | .0019 |
| 96 | 11030 | .0016 | 93480 | .0016 |
| 112 | 11030 | .0014 | 93480 | .0014 |
| 128 | 11030 | .0012 | 93480 | .0012 |
| 144 | 11030 | .0011 | 93480 | .0011 |
| 160 | 11030 | .00095 | 93480 | .00095 |
| 176 | 11030 | .00086 | 93480 | .00086 |

Telpak A and S Total Monthly Charges GRAPH 65




ollars
Telpak A, B, C and S (Duplex)
Total Monthly Charges
GRAPH 66
1,000,000
100,000
10,000
Telpak S
Telpak C
Telpak B
Telpak A
Station Rentals
$180+
Installation Charges
$540+
P. S. ROSS & PARTNERS
0 350 700 1000 1400 1700 2000 2400 2700 3000 3400 +
Distance - Miles


Dollars
Telpak A and S
$/10^6 bits/Mile at 4800 bps
GRAPH 67
1.00
.10
.01
.001
.0001
0
16
32
48
64
80
96
112
128
144
160
Hours of Usage
Telpak A
Duplex
Simplex
Telpak S
Duplex
P. S. ROSS & PARTNERS

# APPENDIX C

## ANALYSIS OF INTER-SERVICE RATE RELATIONSHIPS

Of the three principal factors that influence total charges – distance, usage and number of stations – only distance is common to all services. The following chart depicts the service in groups which reflect those factors which determine total charges.

| Usage and Distance | Distance and Stations |
|---|---|
| Telex and Data Telex | Computer Inquiry Service |
| TWX | Dataline II |
| Datacom | Dataline III |
| Dataspeed | |
| Broadband | |
| Multicom | |
| Dataphone | |
| **Others** | **Distance Alone** |
| Schedules 1-3A | Telpak A-S |
| Channel Deriving Arrangements | Schedules 4-4C |

When computing total charges and services where distance and usage are the important factors, the measures are mileage and the number of bits transmitted. This latter, in turn, is a function of the service speed and monthly hours of use. Therefore, any comparison of the various services can best be done by reducing all service charges to a charge per bit mile.

The following analysis first compares services within each of the three major groups and then compares the groups to each other. Within a group, obvious sub-groups and exceptions may exist. In the first group, Distance and Usage, the services of Telex and Data Telex, TWX, Datacom and Dataspeed form a sub-group, as do Broadband, Multicom, and Dataphone. The main common feature of the services in each sub-group is their similarity in charges and the gap between these charges.

In this analysis, certain assumptions were made regarding hours of usage and numbers of stations. All other assumptions made remained identical to those made previously. The assumptions made are consistent from service to service, except where noted.

Telex, Data Telex, TWX, Datacom and Dataspeed all behave in a similar fashion relative to distance. As mileage increases, the charge

per bit mile drops, the rate of decrease being almost identical for all services. The highest charges are for Telex and the lowest for Data Telex. At given mileages, the rates for these four services are somewhat alike with TWX, Datacom and Data Telex rates falling between the higher rates of Telex and lower rates of Dataspeed.

A similar situation is reflected in the remaining services in this group: Broadband, Multicom and Dataphone. The first two services have internal speed differences affecting their charges per bit mile, although the difference is not great. Their rate of decline is about the same as it was for the services previously discussed, although in absolute terms the charges per bit mile are substantially less than for the slower services.

Considering these charges relative to speed, it is apparent that charges drop as speed increases and that, at similar speeds and distances, the charges per bit mile are very close for the Telex, Data Telex, TWX, Datacom, Dataspeed group and for Broadband, Multicom and Dataphone. However, the Multicom high speed service is the only high speed transmission in this group and its charges per bit mile are competitive with other Multicom and Broadband and Dataphone charges at lower speeds.

The second major grouping, Distance and Stations, comprises three services with speeds of 180 bps, 300 bps and 2000 bps. The charges per station per bit mile over increasing distances all decline at approximately the same rate. The highest charges belong to the slowest service, Telex Computer Inquiry service, with Dataline II having slightly lower charges. The fastest service, Dataline III, is much more economical for given distances and throughput. The same relationships hold true when the basis of comparison is speed rather than distance. Consequently, at given distances and utilizations, the charges per station per bit mile are less for high speed services than for low speed ones.

Those services where the only rate determinant is distance have been grouped to compare the effect of distance and speed on each. In all services of this type a further dimension is involved, that of local and inter-city rates for Schedules 4 to 4C and of simplex and duplex for Telpaks A to S. For the purposes of this study only the most common conditions have been considered – inter-city and duplex.

These services are all private line, so that the total monthly charges are independent of the number of hours of usage or the speed of the service. The lower-speed less-expensive services are more costly in most cases in terms of charges per bit mile for a given

distance and usage, because with the higher speed services the increased speed more than offsets the lower total charge.

Schedule 4 inter-city at 600 bps has the highest charge per bit mile in terms of either distance or speed. This charge drops considerably as mileage increases. On the other hand, Telpak S at 9600 bps has the lowest charges of all the services in this group. With increasing mileage, charges for Schedules 4 and 4C keep dropping in nearly linear fashion. Telpak services drop initially at very low mileages but level off and become constant up to the maximum distance. Mileage, in the case of all these services, has less impact on charges per bit mile than does speed.

When these charges are related to speed, a wide range of charges per bit mile is noted, the highest being Schedule 4 and the lowest Telpak S. Considerable overlap exists between Telpak A at low speeds and Schedule 4C at higher speeds. Charges for all services drop at about the same rate as speed increases.

The final services, Schedules 1, 2, 3 and 3A and Channel Deriving Arrangements for Teleprinter and Computer Access must be treated separately because the manner in which their rates are established differs from that of other services. Inter-city charges per bit mile are similar for both Schedule 1 and Schedule 3 services. The trends relative to distance are also similar. As mileage increases, charges drop, the reduction being greater at low mileages and levelling off somewhat at greater distances. The effect is similar for local services. As speeds increase from 50 bps to 75 bps for Schedules 1 and 3 respectively, charges per bit mile drop because total monthly charges are independent of speed or hours of usage. Charges for the same number of hours utilization for the two speeds will be lower at 75 bps than at 50 bps. It is also lower at greater mileages, with the greatest drop occurring above very low mileages. Relative to speed, the highest rates are for Schedule 1 and the lowest for Schedule 3 at high mileage. Reductions in charges per bit mile for speed are small. The most significant drops occur because of increases in distance.

Channel Deriving Arrangements are made up of the two previously mentioned components, each with a different method of rate calculation. However, when these components are evaluated in relation to each other, their charges per bit mile are quite similar. These charges decline as distances increase and the rate of decline is about the same for both services. The service with the highest charges is Teleprinter at 82.5 bps and the lowest charges are for Teleprinter at 180 bps.

Of the two components of Channel Deriving Arrangements, only Teleprinter is offered in more than one speed. The rate of decline in charges per bit mile is greater as a result of speed changes from 82.5 bps to 180 bps than as a result of distance increases. Therefore, speed has more influence in reducing charges per bit mile for Teleprinter than does distance. Charges for Computer Access and higher speed Teleprinter are almost identical.

All fourteen services are presented on Graph 79 in terms of their charges per bit mile and speed. On this graph each service can be seen in relation to all other services, particularly from the point of view of cost to the user. However, it should be remembered that the graph and supporting tables are only as valid as the assumptions which underlie the analysis. As mentioned previously, in the report, it was necessary to be selective. For example, the analysis has considered all fourteen services but in some cases local service was omitted and for others simplex not considered. Where services have more than one speed, these are joined by broken lines. The five or six points for each service represent different mileages, with the lowest mileages representing the highest charges. From this comparison, it is apparent that a trend curve could be drawn from top left to lower right (or from low speed/high charges to high speed/low charges). The high point on this curve would be low-mileage Schedules 1 and 3 and Telex services at 50 bps. At the other extreme would be long distance Multicom services at 50,000 bps. Two definite groupings seem to emerge: the first from 50 bps to 180 bps with charges per bit mile from just below $.10 to about $1.00; and the second group from 2000 bps to 10,000 bps with charges per bit mile from $.001 to about $.05. Other services exist outside these groups but these are, for the most part, specialized. These two groups, on the other hand, contain the most competitive services offered by the carriers.

The graph also reveals the very broad range of charges which a user may incur. Charges range from $.001 to $15.00 per bit mile showing how important careful selection of services can be and the savings that are available to the high volume user.

As previously mentioned, the validity of these comparisons holds only in terms of relative relationships and trends. It is certainly clear that every user of data transmission services must analyse his own particular situation in every detail before deciding on the optimum type or combination of types of service which will serve him best. This is true, in the first place, because of the general complexity of the rate structure as mentioned in the report. However, the user's problem is

not simplified by either the tariff books of the carriers or the number of alternative offerings which are available to him.

TABLE 53

## USAGE AND DISTANCE GROUP

## MONTHLY DATA TRANSMISSION CHARGES PER MILE PER MILLION BITS

### TELEX AND DATA TELEX

Charges/Mile/$10^6$ Bits

| Mileages | 50 bps | 180 bps |
|---|---|---|
| 20 | $4.19 | $1.16 |
| 200 | .70 | .20 |
| 400 | .44 | .12 |
| 1200 | .20 | .055 |
| 2700 | .13 | .035 |

### TWX

Charges/Mile/$10^6$ Bits

| Mileages | 110 bps |
|---|---|
| 150 | $.31 |
| 800 | .084 |
| 1300 | .065 |
| 2000 | .062 |
| 3100 | .054 |

### DATACOM DATASPEED

Charges/Mile/$10^6$ Bits

| Mileages | 110 bps | 600 bps | 1200 bps |
|---|---|---|---|
| 10 | $1.91 | $.63 | $.32 |
| 200 | .36 | .08 | .04 |
| 400 | .24 | .05 | .025 |
| 1200 | .11 | .023 | .011 |
| 1600 | .087 | .018 | .0089 |
| 3000 | .054 | .011 | .0055 |

## USAGE AND DISTANCE GROUP

## MONTHLY DATA TRANSMISSION CHARGES PER MILE PER MILLION BITS

### BROADBAND

Charges/Mile/$10^6$ Bits

| Mileages | 1800 bps | 2400 bps | 4800 bps |
|---|---|---|---|
| 175 | $.011 | $.0082 | $.0082 |
| 525 | .0045 | .0034 | .0035 |
| 1225 | .0031 | .0023 | .0022 |
| 1925 | .0029 | .0022 | .0019 |
| 3000 | .0025 | 0018 | .0014 |

### MULTICOM

Charges/Mile/$10^6$ Bits

| Mileages | 2400 bps | 4800 bps | 19200 bps | 40800 bps | 50000 bps |
|---|---|---|---|---|---|
| 100 | $.016 | $.0098 | $.019 | $.016 | $.013 |
| 300 | .0054 | .0044 | .0079 | .0067 | .0055 |
| 1200 | .0025 | .0020 | .0031 | .0027 | .0020 |
| 2000 | .0022 | .0015 | .0019 | .0017 | .0014 |
| 2800 | .0018 | .0012 | .0014 | .0012 | .0010 |

### DATAPHONE

Charges/Mile/$10^6$ Bits

| Mileages | 600 bps | 2000 bps |
|---|---|---|
| 10 | $.31 | $.093 |
| 200 | .064 | .0019 |
| 400 | .042 | .0013 |
| 1200 | .020 | .00059 |
| 1600 | .016 | .00047 |
| 3000 | .0098 | .00030 |

TABLE 55

## DISTANCE AND STATIONS GROUP

## MONTHLY DATA TRANSMISSION CHARGES PER MILE PER MILLION BITS

### TELEX COMPUTER INQUIRY SERVICE - 12 STATIONS

Charges/Mile/Station/$10^6$ Bits

| Mileages | 180 bps |
|---|---|
| Local (10) | $.34 |
| 25 | .20 |
| 175 | .041 |
| 450 | .024 |
| 1250 | .019 |
| 2900 | .015 |

### DATALINE II - 10 STATIONS

Charges/Mile/Station/$10^6$ Bits

| Mileages | 300 bps |
|---|---|
| 25 | $.13 |
| 175 | .028 |
| 450 | .016 |
| 1250 | .013 |
| 2900 | .010 |

### DATALINE III - 10 STATIONS

Charges/Mile/Station/$10^6$ Bits

| Mileages | 2000 bps |
|---|---|
| 25 | $.033 |
| 175 | .0083 |
| 450 | .0050 |
| 1250 | .0033 |
| 2900 | .0021 |

TABLE 56

## DISTANCE ALONE GROUP

## MONTHLY DATA TRANSMISSION CHARGES PER MILE PER MILLION BITS

### SCHEDULE 4

Charges/Mile/$10^6$ Bits

| Local | | Inter-City | |
|---|---|---|---|
| Mileages | 600 bps | Mileages | 600 bps |
| 1 | $17.60 | 10 | $1.84 |
| 5 | 3.58 | 350 | .11 |
| 15 | 1.25 | 1000 | .067 |
| 20 | .96 | 2000 | .039 |
| 30 | .67 | 3000 | .028 |

### SCHEDULE 4C

Charges/Mile/$10^6$ Bits

| Local | | Inter-City | |
|---|---|---|---|
| Mileages | 2400 bps | Mileages | 2400 bps |
| 1 | $6.04 | 10 | $.62 |
| 5 | 1.24 | 350 | .033 |
| 15 | .44 | 1000 | .018 |
| 20 | .34 | 2000 | .011 |
| 30 | .24 | 3000 | .0075 |

TABLE 57

## DISTANCE ALONE GROUP

## MONTHLY DATA TRANSMISSION CHARGES PER MILE PER MILLION BITS

### TELPAK A

Charges/Mile/$10^6$ Bits

| | Simplex | | | | Duplex | | | |
|---|---|---|---|---|---|---|---|---|
| Mileages | 2400 bps | 4800 bps | 7200 bps | 9600 bps | 2400 bps | 4800 bps | 7200 bps | 9600 bps |
| 10 | $.025 | $.0125 | $.0083 | $.0063 | $.031 | $.015 | $.010 | $.0077 |
| 350 | .012 | .0062 | .0041 | .0031 | .015 | .0077 | .0051 | .0038 |
| 1000 | .012 | .0061 | .0041 | .0030 | .015 | .0075 | .0050 | .0038 |
| 2000 | .012 | .0060 | .0040 | .0030 | .015 | .0075 | .0050 | .0037 |
| 3000 | .012 | .0060 | .0040 | .0030 | .015 | .0075 | .0050 | .0037 |

### TELPAK S

Charges/Mile/$10^6$ Bits

| | Duplex | | | |
|---|---|---|---|---|
| Mileages | 2400 bps | 4800 bps | 7200 bps | 9600 bps |
| 10 | $.0053 | $.0027 | $.0018 | $.0013 |
| 350 | .0039 | .0019 | .0013 | .00097 |
| 1000 | .0039 | .0019 | .0013 | .00097 |
| 2000 | .0039 | .0019 | .0013 | .00097 |

# OTHERS

## MONTHLY DATA TRANSMISSION CHARGES PER MILE PER MILLION BITS

### SCHEDULE 1

Charges/Mile/$10^6$ Bits

| Local | | Inter-City | |
|---|---|---|---|
| Mileages | 50 bps | Mileages | 50 bps |
| 1 | $141 | 10 | $15.33 |
| 5 | 28.79 | 350 | .76 |
| 15 | 10.10 | 1000 | .48 |
| 20 | 7.77 | 2000 | .41 |
| 30 | 5.43 | 3000 | .38 |

### SCHEDULE 3

Charges/Mile/$10^6$ Bits

| Local | | Inter-City | |
|---|---|---|---|
| Mileages | 75 bps | Mileages | 75 bps |
| 1 | $93.60 | 10 | $11.75 |
| 5 | 19.23 | 350 | .57 |
| 15 | 6.82 | 1000 | .38 |
| 20 | 5.28 | 2000 | .33 |
| 30 | 3.73 | 3000 | .31 |

TABLE 59

## CHANNEL DERIVING ARRANGEMENTS

### TELEPRINTER

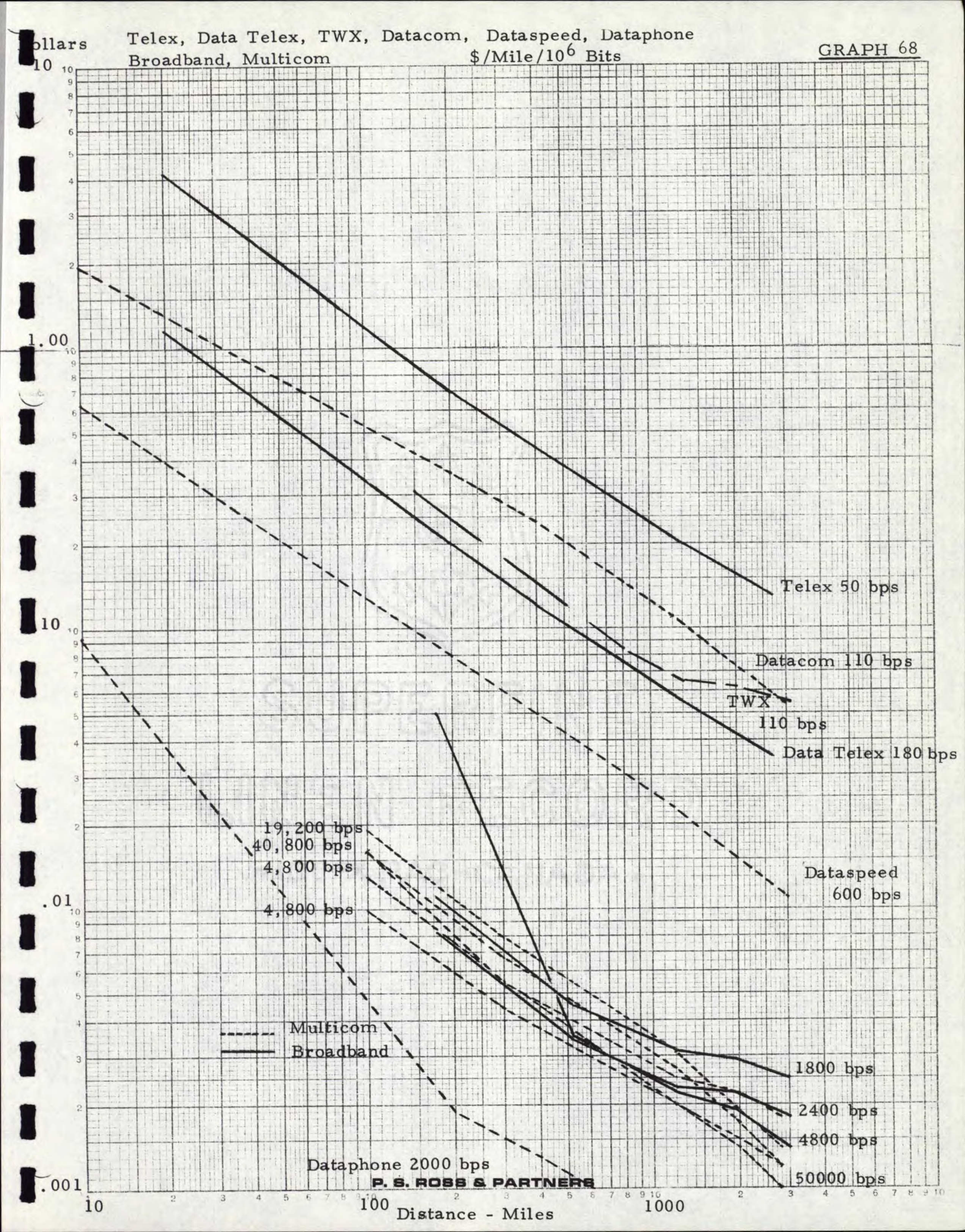
Charges/Mile/$10^6$ Bits

| Mileages | 82.5 bps | 180 bps |
|---|---|---|
| 10 | $1.18 | $.66 |
| 350 | .49 | .23 |
| 1400 | .30 | .14 |
| 2000 | .23 | .10 |
| 3000 | .16 | .074 |

### COMPUTER ACCESS

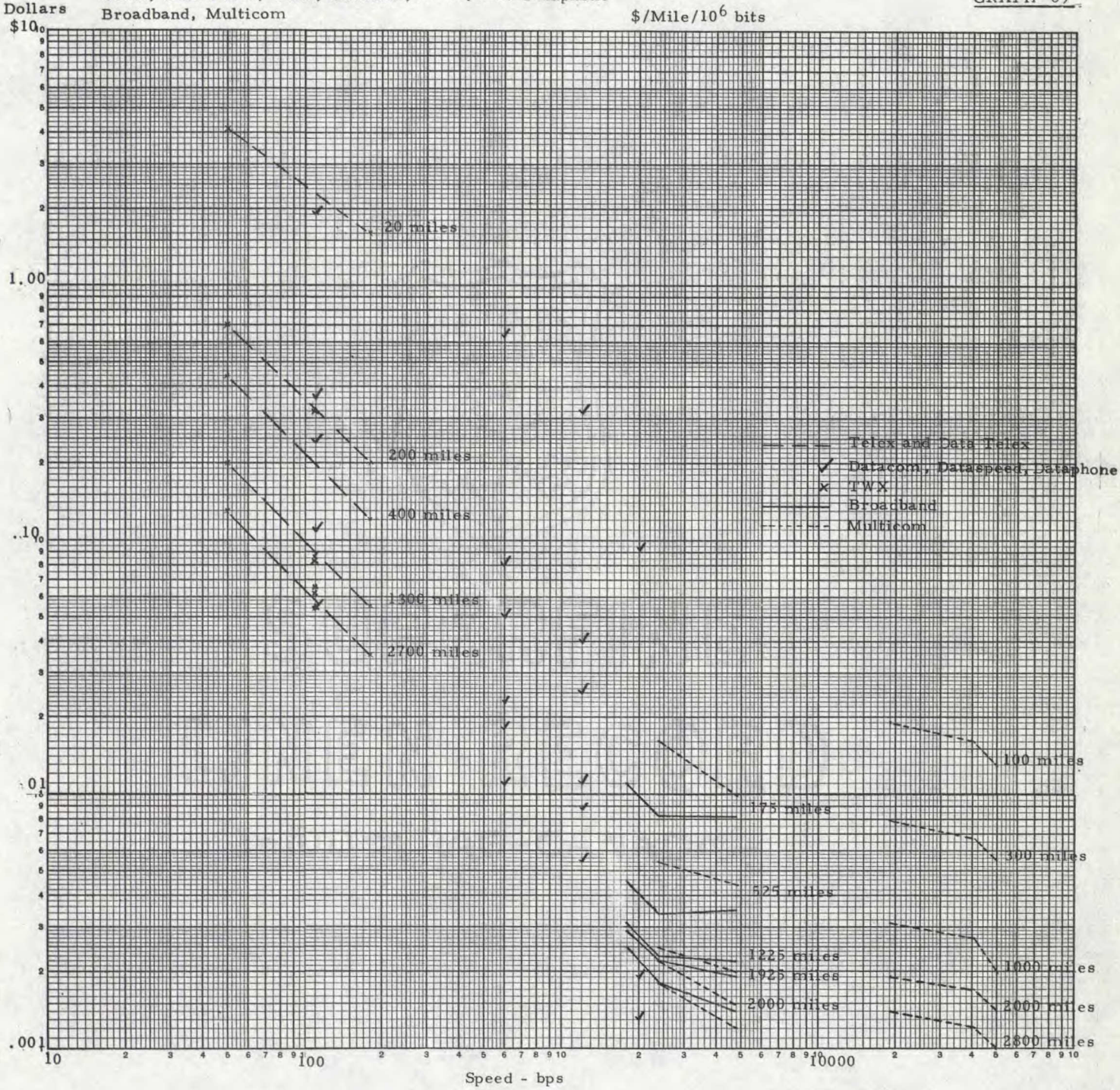
Charges/Mile/$10^6$ Bits

| Mileages | 180 bps |
|---|---|
| 10 | $.73 |
| 350 | .24 |
| 1000 | .17 |
| 2000 | .11 |
| 3000 | .075 |


Dollars
Telex, Data Telex, TWX, Datacom, Dataspeed, Dataphone
Broadband, Multicom
$/Mile/10^6 Bits
GRAPH 68
10
1.00
10
.01
.001
Telex 50 bps
Datacom 110 bps
TWX
110 bps
Data Telex 180 bps
19,200 bps
40,800 bps
4,800 bps
4,800 bps
Dataspeed
600 bps
Multicom
Broadband
1800 bps
2400 bps
4800 bps
50000 bps
Dataphone 2000 bps
P. S. ROSS & PARTNERS
10
100
1000
Distance - Miles

Telex, Data Telex, TWX, Datacom, Dataspeed, Dataphone
Broadband, Multicom

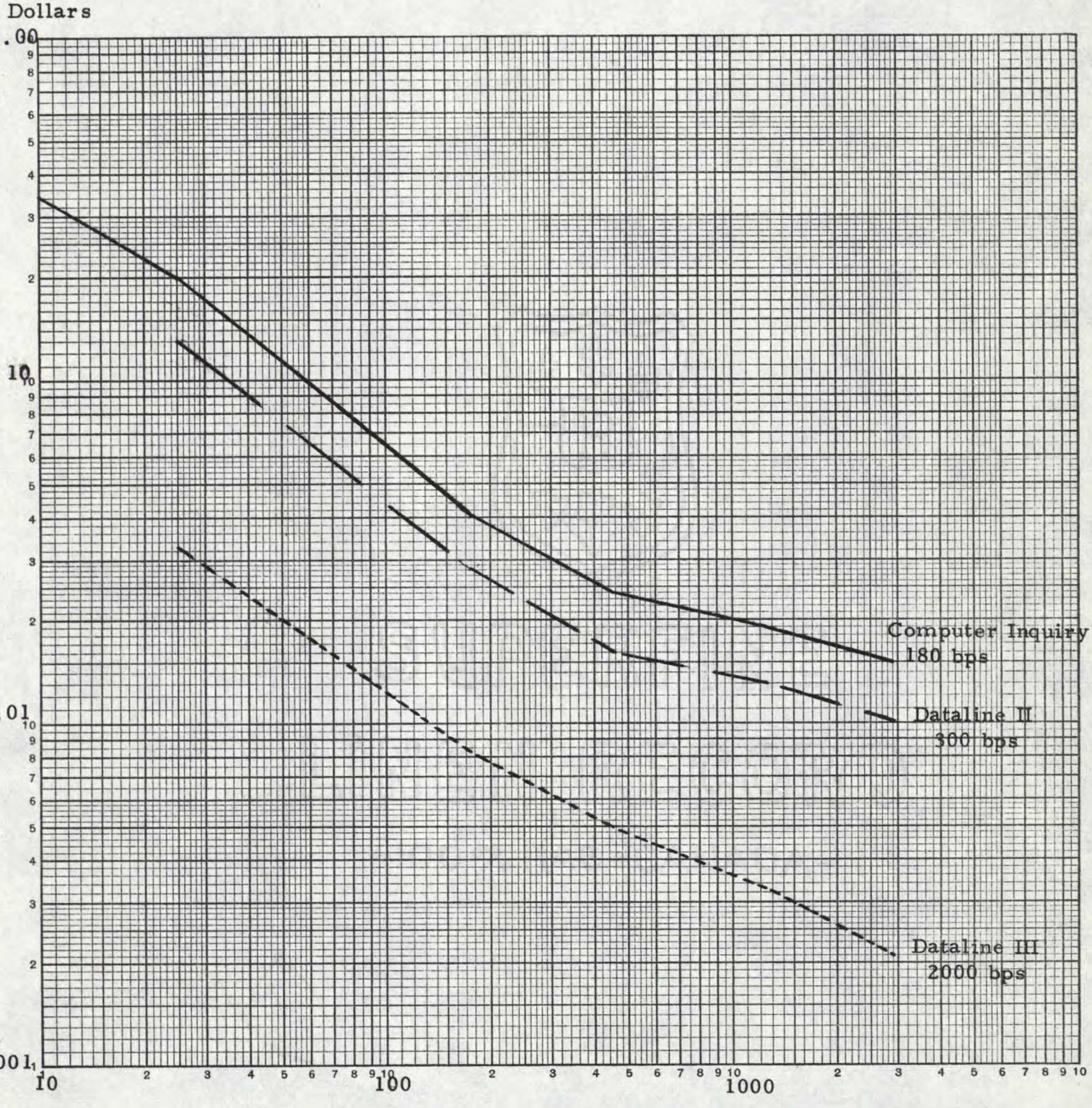
GRAPH 69



GRAPH 70

Telex Computer Inquiry Service
Dataline II and Dataline III

$/Mile/Station/$10^6$ bits

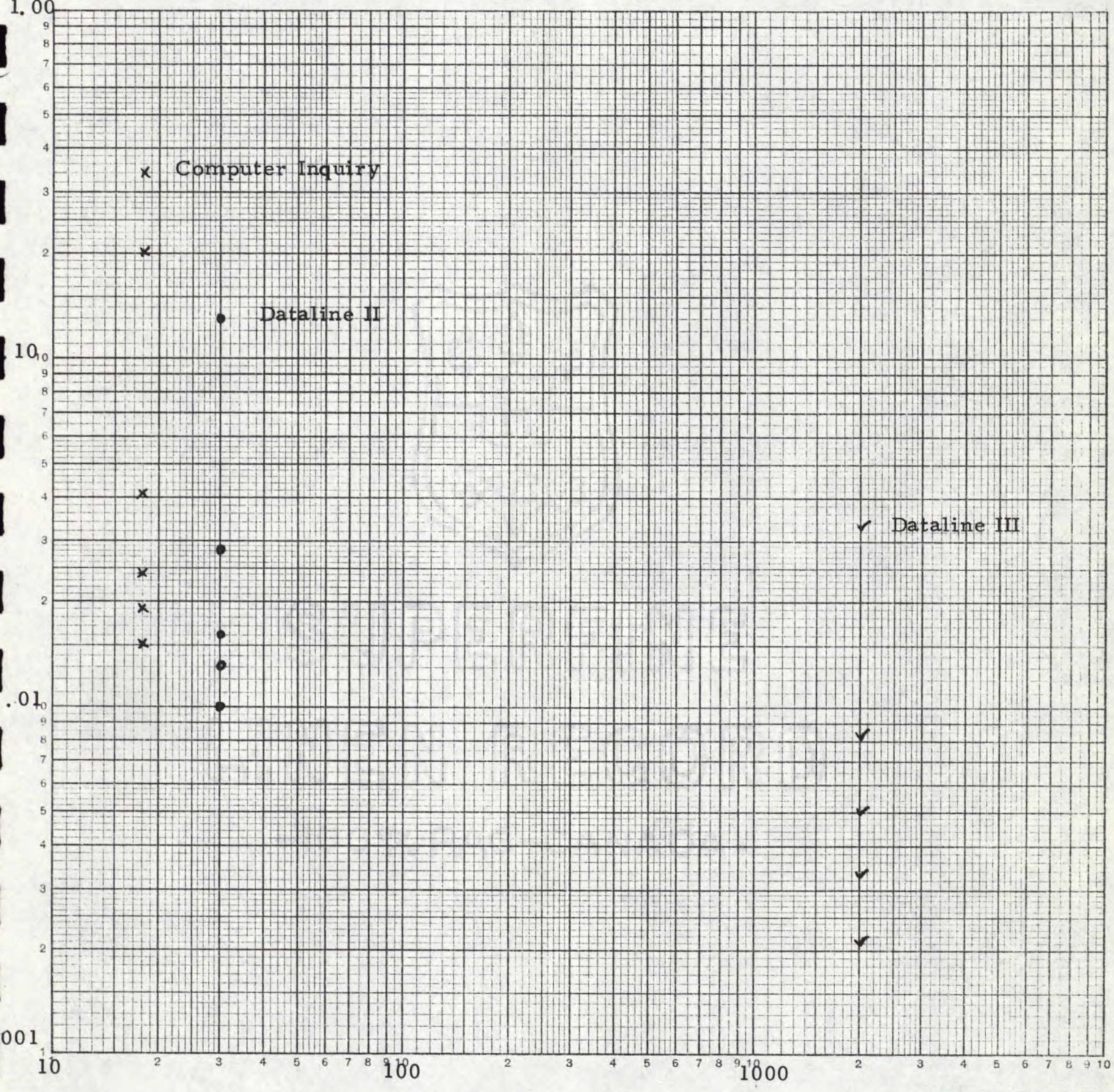


GRAPH 71

Telex Computer Inquiry Service
Dataline II and Dataline III

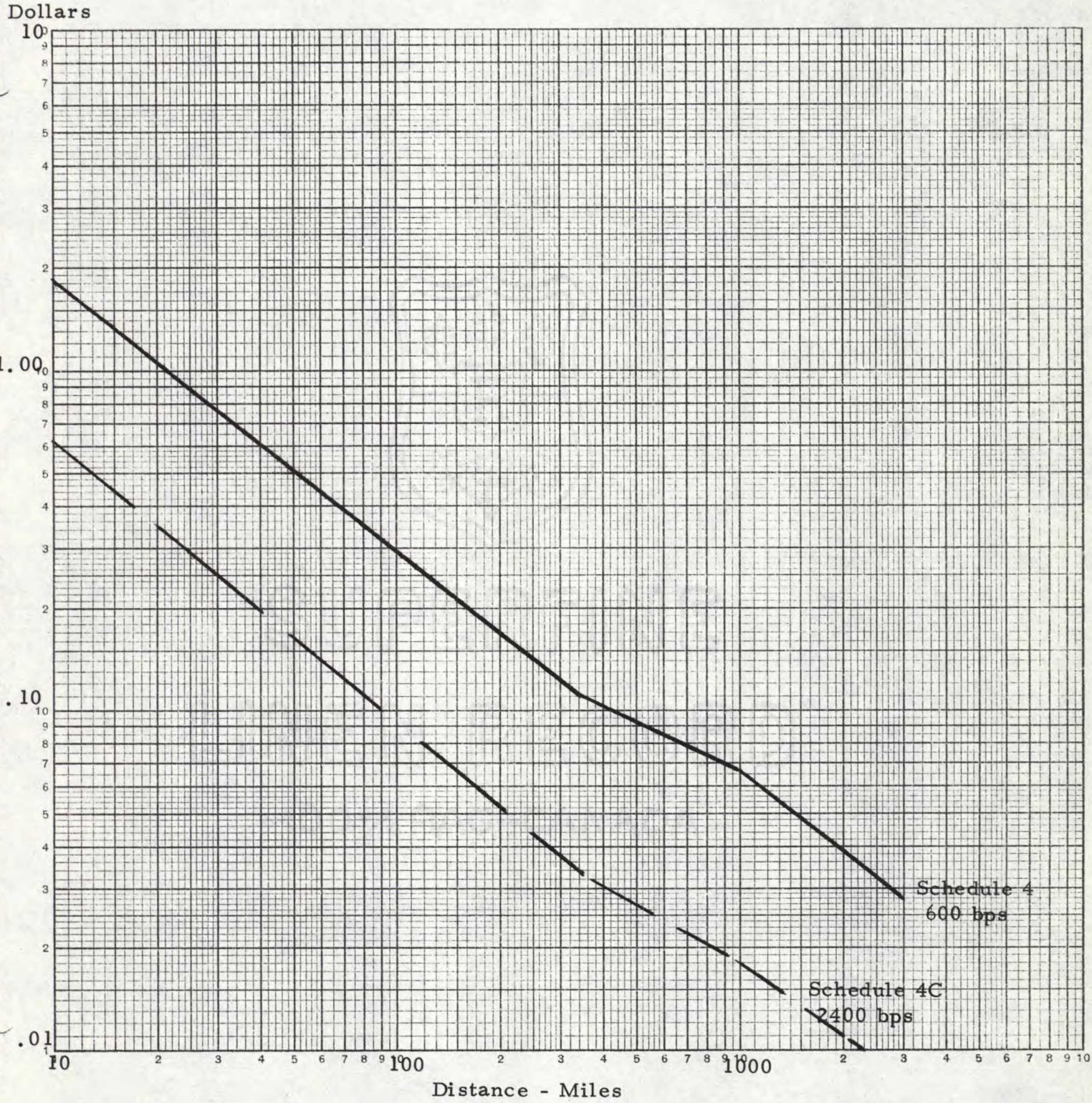
$/Mile/Station/$10^6$ bits

(for 25, 175, 450, 1250 and 2900 miles)



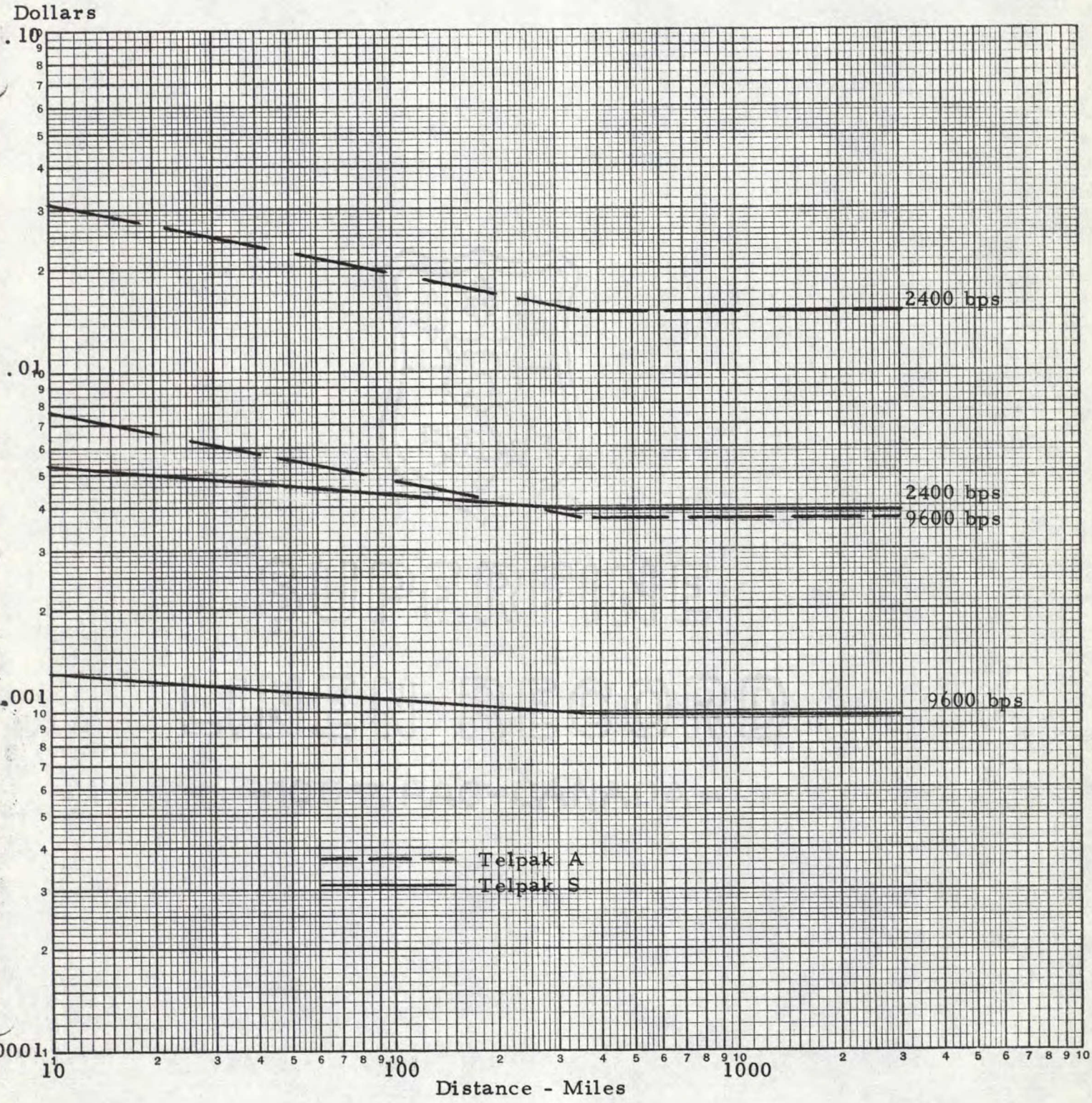

P. S. ROSS & PARTNERS

Schedules 4 and 4C (Inter-City) $/Mile/$10^6$ bits



GRAPH 73

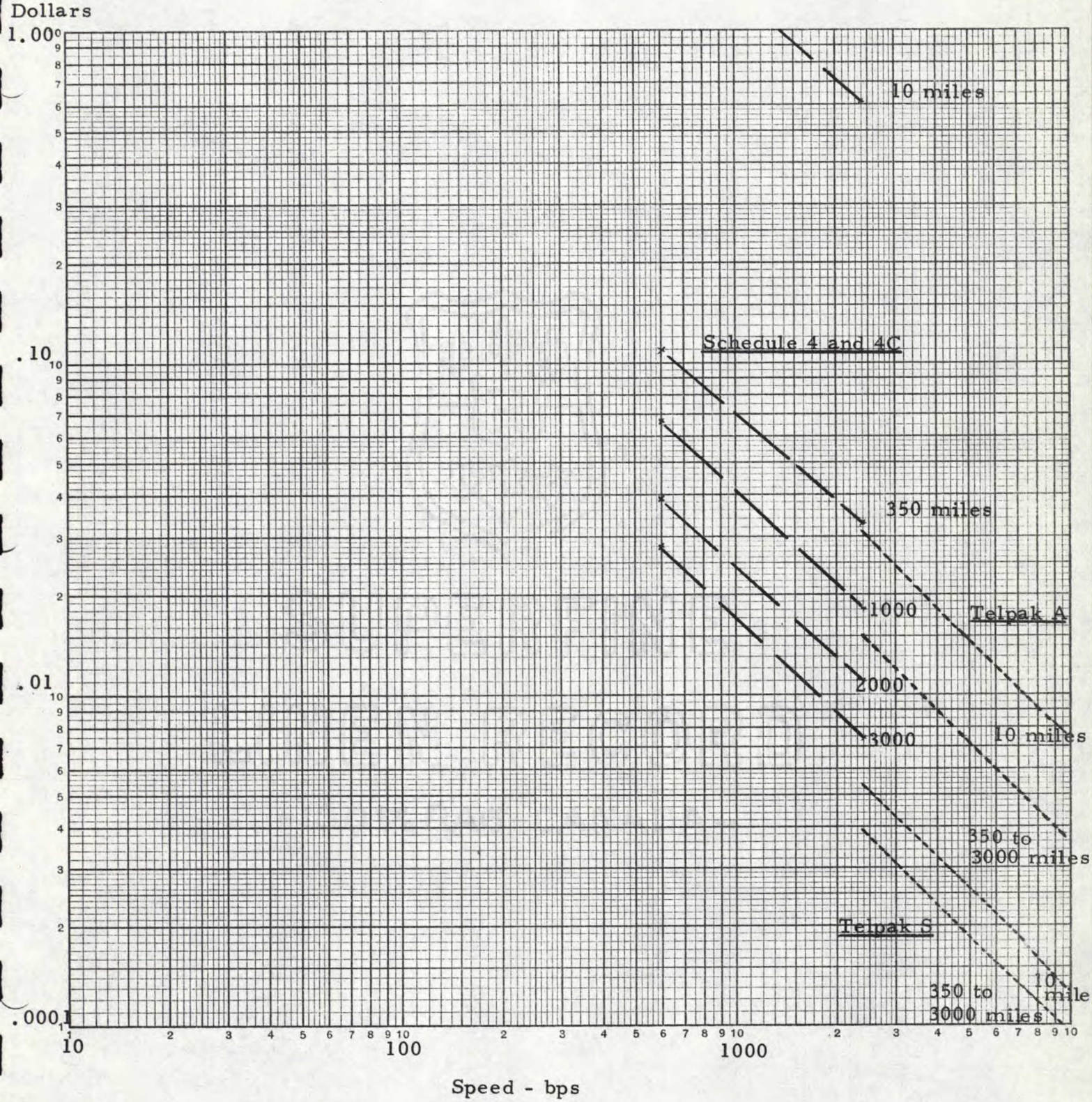
Telpak A and S (Duplex) $/Mile/$10^6$ bits



GRAPH 74

Schedules 4 and 4C (Inter-City)
Telpak A and S (Duplex)

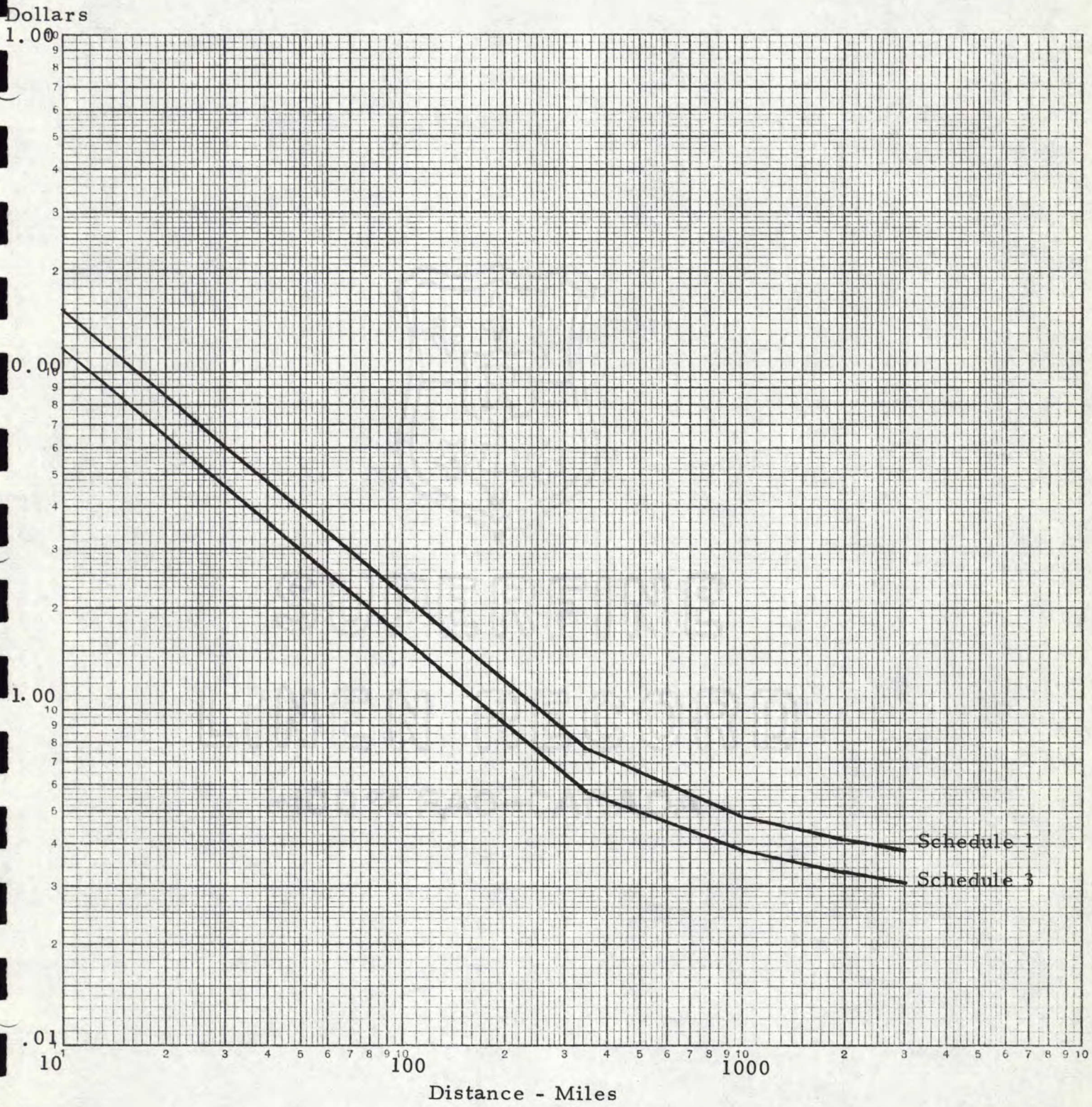
$/Mile/$10^6$ bits




P. S. ROSS & PARTNERS

GRAPH 75

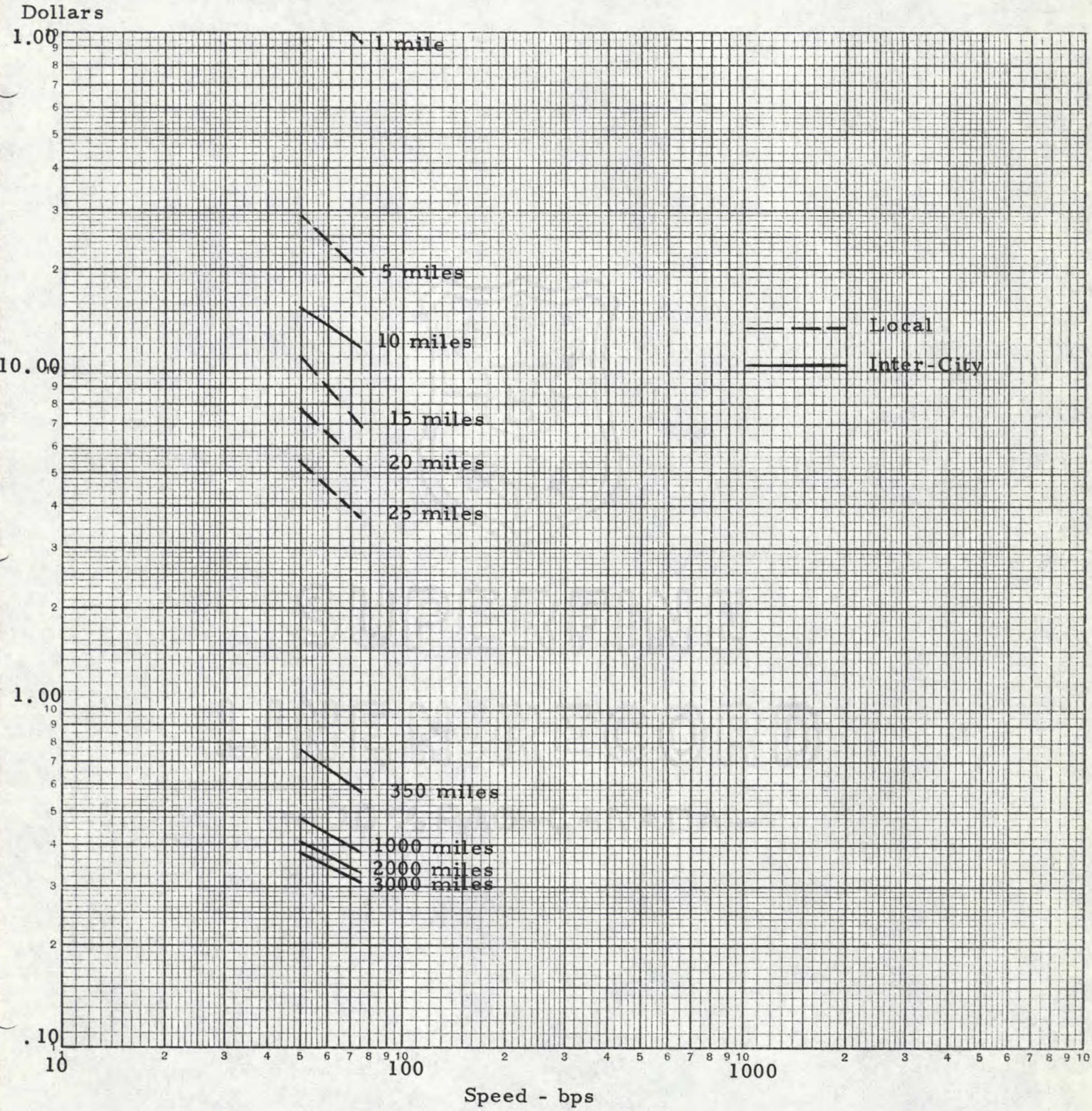
Schedules 1 and 3 (Inter-City) $/Mile/$10^6$ bits




P. S. ROSS & PARTNERS

GRAPH 76

Schedules 1 and 3 (Local and Inter-City) $/Mile/$10^6$ bits

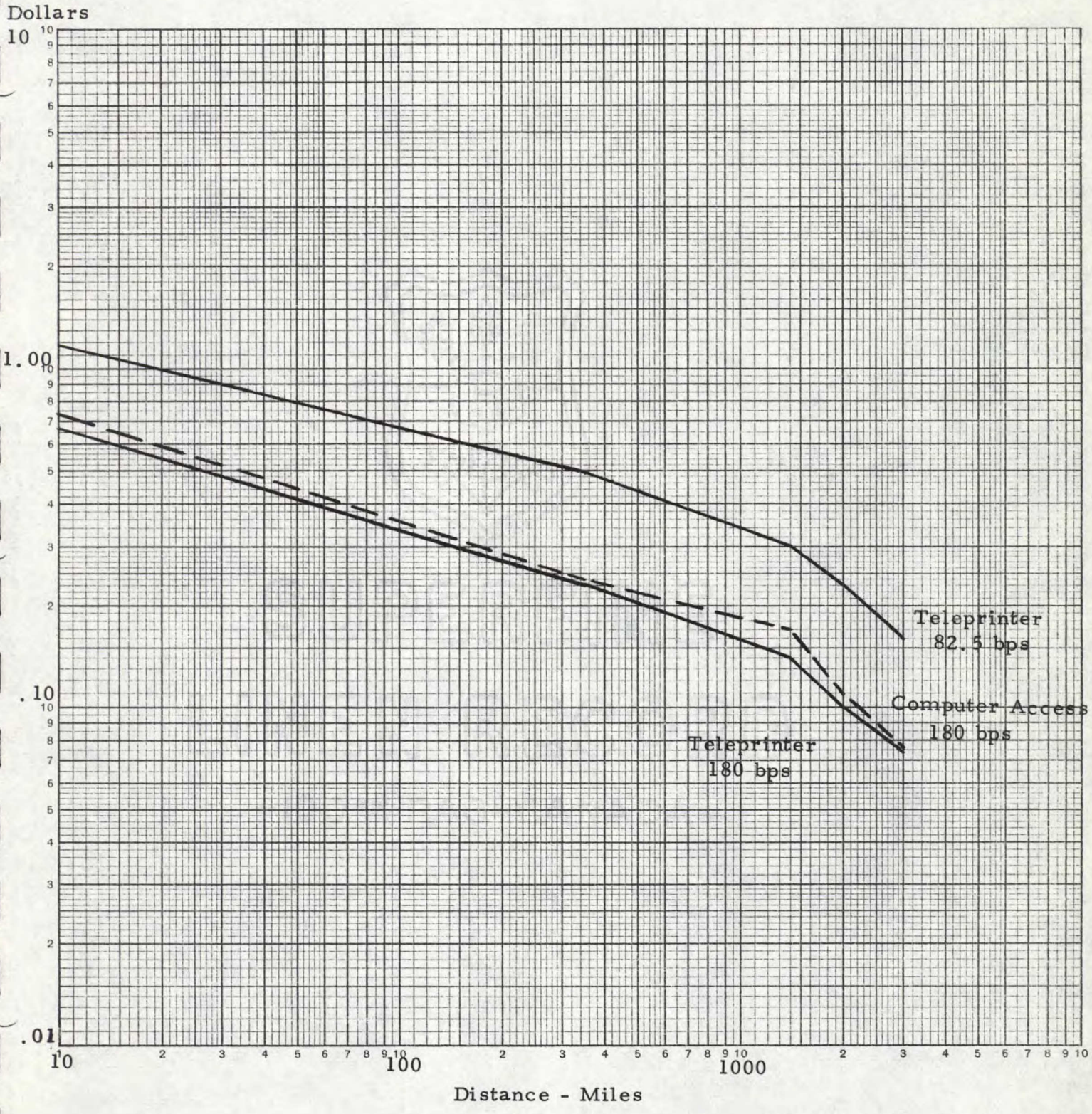



P. S. ROSS & PARTNERS

Channel Deriving Arrangements
Teleprinter and Computer Access

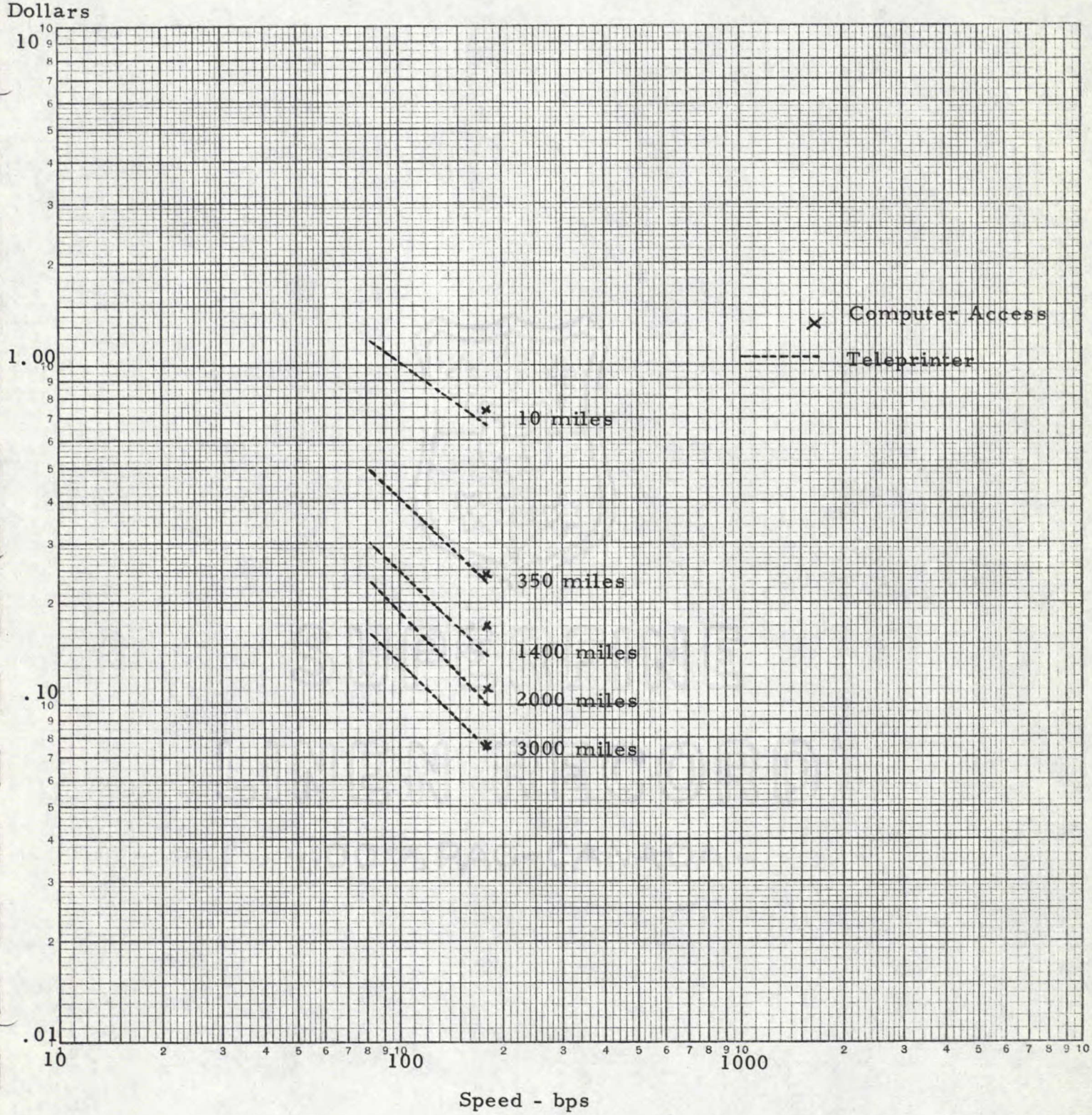
$/Mile/$10^6$ bits

GRAPH 77



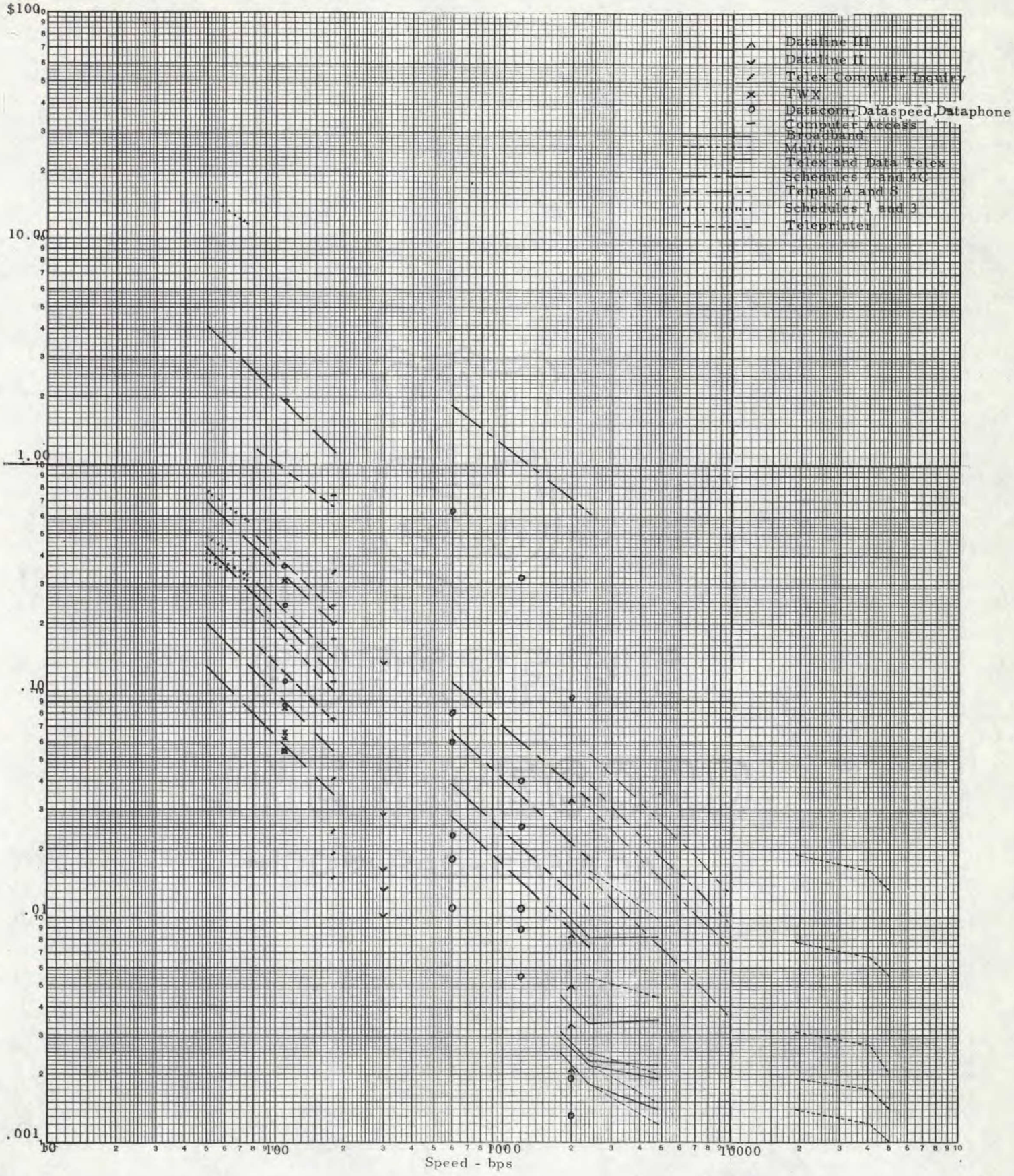
GRAPH 78

Channel Deriving Arrangements
Teleprinter and Computer Access $/Mile/$10^6$ bits



Dollars All Services $/Mile/$10^6$ bits

GRAPH 79



# APPENDIX D

# AN EXAMINATION OF CARRIERS' COSTS OF PROVIDING DATA TRANSMISSION SERVICES

# THE ELEMENTS OF COST

## Introduction

The existing networks do not provide a digital data transmission service but rather a transmission service for digital data. This is because all the Canadian networks are designed primarily to transmit in analogue waveforms. The digital data signals, therefore, must be transformed into analogue waveforms before entering the network at the sending end by the use of a modulator-demodulator unit (better known as a modem). Another modem at the receiving end restores the data to its original digital form. The carriers in fact are operating a total telecommunications network which provides transmission services for several forms of communications including digital data. Because the transmission facilities are integrated, it is necessary to examine the integrated costs of the system to determine their applicability to the digital data transmission services.

The basic element of cost in a communications system is the investment in plant required to provide the service. The operating costs are largely related to investment. The investment costs are those expenditures associated with acquiring property, plant and equipment which have substantial worth and relatively long life expectancy. Investment costs may be financed through the issue of shares or debt, in which case an annual general charge will be imposed for the use of the money and recovery of the investment. The amount of this annual charge is dependent mainly upon the current interest rates, the level of yield expected, the service life of the plant, and the opportunities for salvage.

Operating expense is generated by the existence and the use of the communications system. These are continuing costs, associated with operating, maintaining and administering the system and providing for depreciation. The costs are dependent upon the amount and type of plant in service, its location and configuration, how it is used and maintained, the policies and operating practices of the company as well as the influences exerted by the public and government.

The operating costs of Canadian carriers in terms of dollars expended per $1000 of gross plant investment proves to be quite stable over a period of years. The total costs (less dividends) for the telephone industry as shown in Table 1 have varied only slightly from an annual rate of 20% of the total plant investment. There is, however, a small downward trend until 1964 which increases thereafter.

TABLE 1

## ANNUAL EXPENDITURES PER $1000 OF PLANT INVESTMENT IN THE CANADIAN TELEPHONE INDUSTRY

| Year | Cost of Plant (millions of dollars) | Expenditures[1] (millions of dollars) | Expenditures Per $1000 of Gross Plant (dollars) |
|---|---|---|---|
| 1960 | $2692.2 | $549.0 | $204 |
| 1961 | 2926.5 | 590.4 | 202 |
| 1962 | 3192.2 | 636.5 | 200 |
| 1963 | 3510.5 | 687.3 | 196 |
| 1964 | 3808.5 | 746.5 | 196 |
| 1965 | 4127.4 | 821.2 | 199 |
| 1966 | 4544.5 | 912.5 | 201 |
| 1967 | 5011.0 | 1006.5 | 201 |
| 1968 | 5467.3 | 1095.8 | 200 |
| 1969 | 5988.2 | 1227.4 | 205 |

1. Includes taxes, interest and all operating expenses, but excludes divident payments

Source: Telephone Statistics 1969, Statistics Canada Catalogue 56-203, November 1970

There are three major classifications of carriers' costs:

* operating expense

* taxes

* cost of money

Operating expense is the combination of the costs associated with depreciation, maintenance, operations and the general expense of doing business. Tax components include all forms of taxation whether based on property, sales or income. The cost of money includes interest paid, amortization of discount and premium on long term debt and dividend payments where applicable.

## Cost Patterns Among the Carriers

Although the overall costs of conducting business, as measured against total plant investment, are relatively the same for both the telephone and the telegraph industries there are a number of differences in their distribution. Table 2 reveals that costs attributable to depreciation are comparable but other cost categories differ appreciably. The operations and maintenance expenses paid by the telephone companies are significantly lower, but this is offset by higher costs for general expenses, for taxes and interest payments. Data concerning dividend payments was available only for the telephone companies. The operations and general expense categories of the two types of carriers are not directly comparable but together the categories include the same expenses. The costs of operations are generally those directly associated with the handling of daily traffic on the network. These include the wages and salaries of the operators, clerks and supervisors engaged in traffic activities. The general expenses normally include the salaries of the officers and general office employees of the companies, the costs of commercial and marketing activity, insurance and legal aid, office supplies and other business expenses. It is significant that the two categories combined approximate an expenditure of $60 per $1000 of plant for both the telephone and the telegraph segments of the carrier industry.

Significant variations can also be found from company to company. Data available for the calendar year 1968 pertaining to the largest telegraph and telephone firms are presented in Table 3. Together these companies

TABLE 2

## EXPENDITURES OF TELECOMMUNICATIONS CARRIERS PER $1000 OF GROSS PLANT INVESTMENT

| | Telephone Companies (dollars) | | Telegraph and Cable Companies (dollars) | |
|---|---|---|---|---|
| OPERATING EXPENSE | | $148 | | $175 |
| Maintenance | $40 | | $71 | |
| Depreciation | 48 | | 45 | |
| Operations | 16 | | 32 | |
| General | 44 | | 27 | |
| TAXES | | $ 33 | | $ 22 |
| Income | $23 | | $17 | |
| Other | 10 | | 5 | |
| COST OF MONEY | | $ 45 | | $ 3 |
| Interest | $24 | | $ 3 | |
| Dividends | 21 | | Not available | |
| COSTS, LESS DIVIDENDS | | $205 | | $200 |

Source: Derived from the tables of Statistics Canada Catalogues 56-201, October 1971 and 56-203, November 1970

TABLE 3

## COMPARATIVE STATISTICS OF SELECTED TELECOMMUNICATIONS CARRIERS (1968)

| | BC Tel | Bell | CNT | CPR | COTC |
|---|---|---|---|---|---|
| | (millions of dollars) | | | | |
| 1. Gross Plant Investment | $613.3 | $3279.3 | $277.8 | $122.7 | $106.5 |
| | (Costs in $ Per $1000 of Gross Plant) | | | | |
| 2. Operating Expense | | | | | |
| Maintenance | $ 45 | $ 41 | $ 82 | $ 57 | $ 44 |
| Depreciation | 47 | 46 | 39 | 32 | 64 |
| Operations | 20 | 16 | 9 | 78 | 32 |
| General | 32 | 39 | 33 | 19 | 10 |
| Totals | 144 | 142 | 163 | 186 | 150 |
| 3. Taxes | | | | | |
| Income | 26 | 22 | - | 21 | 58 |
| Other | 9 | 21 | 5 | 7 | - |
| Totals | 35 | 43 | 5 | 28 | 58 |
| 4. Interest | 23 | 19 | - | - | 24 |
| 5. Totals, Items 2, 3, 4 | 202 | 204 | 168 | 214 | 232 |
| 6. Dividend Payments | 18 | 27 | - | - | - |
| 7. Income, After Taxes, Before Dividends | 29 | 35 | 31 | 19 | 54 |

Source: Statistics Canada Catalogues 56-201 and 56-202, transcripts and exhibits of the Canada Transport Commission during the 1969 rate hearings for BC Telephone and Bell Canada. The costs per $1000 of plant were developed by the consultants.

represent two-thirds of the Canadian investment in carrier plant. In each of the cost categories, variations of 100% or more can be discovered. It is clearly evident from the table that some carriers are able to avoid completely the payment of property or income taxes, or interest on investment capital. Some government sponsored enterprises do not face the requirement to provide a return on investment in the form of dividend payments. Others, such as the railroad companies, combine their telecommunications operations with their railway operations, assigning more or less of the total expenses to the railway operation. For example, in 1968 the CNT assigned 3% of the maintenance and depreciation costs, and 80% of the operations costs to the railway, but none of the general costs. The corresponding figures for 1970 are 4%, 95% and zero respectively. The CPR attributed 32% of the maintenance and depreciation costs to railway operations. The corresponding figures for 1970 are 24%, 22% and 11% respectively.[1]

In 1969 expenditures by members of the Trans-Canada Telephone System averaged $221 per $1000 of plant to cover all costs including dividends. The costs for each member ranged between a low of $181 to a high of $234 per $1000 of investment. The details are given in Table 4.

For the CN-CP Telecommunications network in 1970, the total costs less dividends averaged $182 per $1000 of investment. The details are shown in Table 5.

One must conclude from the nature of the existing variables in the Canadian telecommunications environment that the pattern of costs for each of the carriers is a unique blend determined by the type of operation required to satisfy the demands made upon the companies, their opportunities for acquiring capital, their organization framework and the tax structure of the society in which they operate.

## Maintenance Expense

Maintenance and depreciation account for the major portion of the operating expenses. Maintenance costs include the labour and material required for the upkeep of the plant. Up to one-third of all employee expense is related to the need for equipment maintenance. Currently the major portion of maintenance expense is generated by

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1. Source: Statistics Canada, Telegraph and Cable Statistics, Catalogue 56-201, 1970

TABLE 4

ANNUAL COSTS
TRANS-CANADA TELEPHONE SYSTEM, 1969

| | Total Plant (millions of dollars) | Operating Expenses & Other Taxes | Income Taxes & Interest | Costs less Dividends | Dividends | Total Costs |
|---|---|---|---|---|---|---|
| | | | (dollars per $1000) | | | |
| BC Tel | $ 645.1 | $150 | $57 | $207 | $20 | $227 |
| AGT | 476.4 | 154 | 39 | 193 | 21 | 214 |
| Sask Tel | 217.7 | 139 | 28 | 167 | 25 | 192 |
| MTS | 278.5 | 144 | 37 | 181 | 0 | 181 |
| Bell | 3593.4 | 148 | 55 | 203 | 25 | 228 |
| NBTel | 159.1 | 144 | 50 | 194 | 22 | 216 |
| MT&T | 172.1 | 140 | 65 | 205 | 25 | 230 |
| Nfld Tel | 55.4 | 173 | 31 | 204 | 30 | 234 |
| TCTS Total | $5597.7 | $148 | $52 | $200 | $21 | $221 |

Source: Statistics Canada Catalogue 56-202, July 1970

TABLE 5

## OPERATING COSTS OF CARRIERS FORMING CN-CP TELECOMMUNICATIONS (1970)

| Item | CNT | CPR | Combined |
|---|---|---|---|
| | (millions of dollars) | | |
| 1. Gross Plant Investment | $303.9 | $131.3 | $435.2 |
| | (dollars per $1000 per plant) | | |
| 2. Operating Expenses | | | |
| Maintenance | $ 87 | $ 70 | $ 82 |
| Depreciation | 40 | 37 | 39 |
| Operations | 2 | 76 | 24 |
| General | 34 | 24 | 31 |
| Totals | 163 | 207 | 176 |
| 3. Taxes | | | |
| Income | - | 26 | 8 |
| Other | 5 | 10 | 7 |
| Totals | 5 | 36 | 15 |
| 4. Interest | - | 2 | 1 |
| 5. Total Items 2, 3, 4 | $168 | $245 | $182 |

Source: Statistics Canada Catalogue 56-201, October 1971

the switching and associated equipments which are located in the central offices employed in both local and long distance transmission. However, the maintenance of equipment located on subscribers' premises is also costly. The equipment configuration, use and location are important elements among the factors affecting maintenance costs.

The experience of Bell Canada in 1968 is illustrated in Table 6. The first column indicates the cost of maintenance per $1000 of plant in the particular category of equipment being maintained. For every $1000 invested in central office equipment, $48 was spent for its maintenance, and for each $1000 invested in station equipment located on subscriber's premises, $70 was spent for its upkeep. The second column permits a further comparison of the maintenance effort based on the company's total investment. Bell Canada expenditure for maintenance in 1968 was $41 per $1000 of plant, of which $17, or 41%, was spent on central office equipment and $15, or 37%, on subscriber station equipment. Data for other companies was not available in the same detail, so that intercompany comparisons could not be made at this level.

## Depreciation Expense

Depreciation expense has been a greater proportion of the operating expense in recent years. The size of the annual depreciation charge depends on the life of the equipment and the current cost of money. Electronic systems are deemed to have a life span of 20 years. Experience has shown that the electronic equipment within the system has an average life of 10 years, while that for station connections is as low as 7 years, and for buildings is over 30 years. In addition to simple wear, telecommunications systems are prone to early obsolescence to the extent that equipment is no longer satisfactory when newer equipment and techniques yield technically superior performance or more economical operation. A comprehensive list of the depreciation rates applied to categories of telephone plant by Bell Canada is given in Table 7. Equipments such as vehicles, tools and work equipment depreciate more rapidly, but these represent a very small proportion of the total. The investment in station equipment, however, depreciates over 11 years, and this category represents about one-fifth of the total book cost. This has some important implications for the costs associated with data networks since the cost of station equipment is higher for data transmission services, with the result that station equipment costs could be a relatively high proportion of the

TABLE 6

BELL CANADA, 1968

MAINTENANCE EXPENSES BY EQUIPMENT CATEGORY

| | Maintenance Expense Per $1000 of Equipment Category | Maintenance Expense Per $1000 of Total Telephone Plant |
|---|---|---|
| LAND AND BUILDINGS | $13 | $ 1 |
| CENTRAL OFFICE EQUIPMENT | 48 | 17 |
| STATION EQUIPMENT | 70 | 15 |
| OUTSIDE PLANT | 22 | 7 |
| OTHER | 17 | 1 |
| | | $41 |

Source: Derived from CTC hearings, 1969, Item No. 5, Information Requested by Attorney General for Ontario

total investment in a purely data transmission network. Table 7 was developed through studies made within Bell Canada. Although they are representative of the telecommunications industry as a whole, they are not necessarily transferable to the operations of other companies.

## THE ELEMENTS OF INVESTMENT

### Introduction

In order to examine the investment in various classes of equipment that are required for data transmission systems, it is useful to establish five major categories. These are:

* station equipment (located at the customer's site)
* local loops (linking the station to the network)
* switching equipment
* inter-office transmission facilities; and
* support facilities (buildings, vehicles, tools, etc.)

These categories of equipment form the building blocks of the systems. In each category there are a wide variety of equipments and techniques which are in turn the components of these building blocks. Each component provides certain performance characteristics that may or may not be advantageous in particular situations. The choice of equipment normally is based on an assessment of the alternatives available, selecting the one which maximizes performance at least cost.

In the continually expanding and technologically advancing communications industry, selection criteria must continue to include consideration of the rate of growth that can be expected, the expansion capability of the equipment, its service lifetime, the probability of obsolescence and the need for compatibility with other equipment already in the system. A further choice is offered to the carrier operating a distribution network employing alternative routing, because a trade-off between categories of equipment may be possible. The fundamental conclusion is that the

TABLE 7

BELL CANADA
DEPRECIATION RATES - 1968 AND 1969

| Account Number | Title | 1968 Rate | 1969 Provisional Rate | 1968 % of Plant |
|---|---|---|---|---|
| 212 | Buildings | 2.7 | 2.7 | 7.9 |
| 221.1 | *C.O.E. - Manual | 6.0 | 6.0 | |
| 221.3 | C.O.E. - Step-by-Step | 4.3 | 5.4 | |
| 221.4 | C.O.E. - Crossbar | 3.5 | 3.6 | |
| 221.5 | C.O.E. - Circuit | 5.2 | 5.2 | |
| 221.6 | C.O.E. - Radio | 6.9 | 6.9 | |
| 221.7-170 | C.O.E. - Electronic - MSD | 20.0 | 20.0 | |
| 221.7-270 | C.O.E -- Electronic - CSN | 7.6 | 7.6 | |
| 221.7-970 | C.O.E. - Electronic - ESS | 3.1 | 3.1 | |
| | C.O.E. Composite | 4.6 | - | 35.4 |
| 231 | Station Apparatus | 7.4 | 7.4 | |
| 232 | Station Connections | 13.0 | 13.0 | |
| 234 | Private Branch Exchanges | 6.1 | 6.1 | |
| | Station Composite | 9.2 | - | 21.8 |
| 241 | Pole Lines | 4.4 | 4.4 | |
| 242.1-110 | Aerial Cable - Exchange | 3.6 | 3.6 | |
| 242-1-210 | Aerial Cable - Toll | 2.7 | 2.7 | |
| 242.2-120 | U.G. Cable - Exchange | 2.3 | 2.3 | |
| 242.2-220 | U.G. Cable - Toll | 2.7 | 2.7 | |
| 242.3-130 | Buried Cable - Exchange | 3.3 | 3.3 | |
| 242.3-230 | Buried Cable - Toll | 2.6 | 2.6 | |
| 242.4 | Submarine Cable | 3.4 | 3.4 | |
| 243.1 | Aerial Wire - Exchange | 13.9 | 14.0 | |
| 243.2 | Aerial Wire - Toll | 4.0 | 4.0 | |
| 244 | U.G. Conduit | 1.7 | 1.7 | |
| | Outside Plant Composite | 3.4 | - | 32.8 |
| 261 | Furniture & Office Equipment | 4.6 | 4.6 | 0.8 |
| 264.1 | Motor Vehicles | 13.9 | 13.9 | |
| 264.2 | Garage & MV Shop Equipment | 6.0 | 6.0 | |
| 264.3 | Tractors, Trenchers & Associated Cable-Laying Equipment | 9.7 | 9.7 | |
| 264.5 | Other Tools & Work Equipment | 8.6 | 8.6 | |
| | Vehicles, Tools Composite | 12.2 | - | 1.3 |
| | Composite Rate - All Depreciable Property | 5.169 | 5.266 | |

*C.O.E. - Central Office Equipment

Source: CTC hearings re Bell Canada application, 1969, Exhibit B-87

relationship between performance and cost for any segment of a communications system cannot be considered in isolation, but must be reviewed in the light of the basis on which investment decisions were made, namely, the requirements for the system as a whole, whether existing or planned.

A large proportion of the data appearing in this section pertains to the investments made by the telephone companies. The principal sources of these data are the Telecommunications Studies, documents relating to hearings held by the Canadian Transport Commission, and the annual reports of the carriers. Data in similar detail concerning the telegraph and cable carriers were not available from similar sources.

According to the very recent Trans-Canada Telephone publication "Communications, Computers and Canada", the telephone networks carry approximately two-thirds of the low speed data traffic and three-quarters of the medium and high speed data transmitted on the Canadian switched networks. Their investments can thus be taken as indicative of the nature of equipment necessary to meet the user-to-user needs for data communications on a switched basis. Table 8 indicates the telephone investment by categories which are similar to those described earlier in this section. Each of these investment categories will be examined in detail in the following paragraphs.

Station Equipment

Four principal types of equipment are provided at the subscriber's station:

* terminals

* data sets or modems

  (The term data set is more general than modem. Modems modulate and demodulate data signals. Some data sets do not contain a modem.)

* multiplexers

* telephone handsets

The greater proportion of terminal devices in use today are the teletypewriter or keyboard-type devices, employed in user-to-user and

TABLE 8

## TCTS INVESTMENT BY EQUIPMENT CATEGORY (DECEMBER 1970)

| | Investment (millions) | Investment % |
|---|---|---|
| STATION EQUIPMENT | $1,217 | 20.6 |
| OUTSIDE PLANT | 1,830 | 31.0 |
| SWITCHING EQUIPMENT | 1,421 | 24.1 |
| TRANSMISSION FACILITIES | 809 | 13.7 |
| OTHER INVESTMENT (Land, Buildings, Vehicles, Tools, etc.) | 624 | 10.6 |
| TOTALS | $5,901 | 100.0 |

Source: TCTS Member Company Investment Data, 1970 submitted to the Telecommission

user-to-computer services. Unit prices range from $500 to $3,500 for teleprinters operating up to 100 words per minute (wpm) between $2,200 and $5,000 for speeds up to 150 wpm, and from $5,000 to $8,000 for speeds up to 1200 wpm.[1] Machines which only receive are 10% to 20% less expensive in each of the speed ranges. In the low speed range, that is 100 wpm or less, heavy duty teleprinters are two to four times the cost of light duty machines. Teleprinters fitted with tape punch/readers increase costs by 25% to 50%. Telespeed/Dataspeed receivers are 30% more expensive than the corresponding sending sets. In 1958 Bell Canada reported that the 90 Dataspeed units in service represented an investment of $670,000, averaging $7,444 per unit. A list of representative equipments, their capabilities and costs are presented in Table 9.

Data sets convert digital signals to analogue at the sending end and at the receiving end restore the signal to digital form. Costs generally increase with:

* increased speeds of transmission
* increased sophistication of the data sets
* the numbers of optional features provided
* adaptability for use with the switched network

The effect of requiring increased tranmission speeds is shown in Table 10.

There are a multitude of variations in data sets, each of which affect the purchase price. Some data sets do not contain an integral telephone set, but can accommodate a separate telephone. Some data sets can accommodate several telephones. Some can operate unattended. Others have reverse channel capability for requesting transmission. Still others have capability for providing both voice and data facilities, error correction, and compensation for distortion created by the communications line. The modem furnished by the carrier is usually selected to meet the requirements of a particular class of user.

Material costs of station equipment for data communications provided by Bell Canada on customers' premises are given in Table 11.

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1. Auerbach Computer Technology Reports, Philadelphia, 1971

TABLE 9
Page 1

## TELETYPE EQUIPMENT

| TRADE NAME OR MODEL | FUNCTION | SPEED WPM | PURCHASE PRICE $U.S. |
|---|---|---|---|
| Model 28 Equipment | | 60-100 | |
| KSR | Send/receive | | 1,440-1,730 |
| ASR | Send/receive with tape punch/ reader | | 2,425-3,000 |
| R/O | Receive only | | 1,275-1,470 |
| Model 32 Equipment | | 60-100 | |
| KSR | Send/receive | | 500-400 |
| ASR | Send/receive with tape punch/ reader | | 750-825 |
| R/O | Receive only | | 500-550 |
| Model 33 Equipment | | 100 | |
| KSR | Send/receive | | 800-725 |
| ASR | Send/receive with tape punch/ reader | | 800-975 |
| R/O | Receive only | | 550-650 |
| ASR | Send/receive with tape punch/ reader; equipped with numeric keyboard | | 900-1,000 |
| Remote Keyboard | Send only | | 150 |
| Model 35 Equipment | | 100 | |
| KSR | Send/receive | | 1,700-2,210 |
| ASR | Send/receive with tape punch/ reader | | 2,850-3,250 |
| R/O | Receive only | | 1,424-1,550 |
| ACS | Send/receive with tape punch/ 2 readers; extensive format control | | 4,725 up |

Source: Auerbach Computer Technology Reports, Philadelphia 1971

TABLE 9
Page 2

## TELETYPE EQUIPMENT

| TRADE NAME OR MODEL | FUNCTION | SPEED WPM | PURCHASE PRICE $U.S. |
|---|---|---|---|
| Model 37 Equipment | | 150 | |
| KSR | Send/receive; parity check | | 2,450-2,850 |
| ASR | Send/receive with tape punch/ reader | | 4,050-4,650 |
| R/O | Receive only | | 2,125-2,550 |
| Telespeed Equipment | | | |
| 750 - Send Set | Send only | 750 | 1,000 (table-top) 1,550 (cabinet) |
| 750 - Receive Set | Receive only | 750 | 2,850 |
| 1050 - Send Set | Send only | 1050 | 2,350 |
| 1050 - Receive Set | Receive only | 1050 | 3,100 |
| 1200 EDC - Send Set | Send only | 1050 or 2100 | 4,819 |
| 1200 EDC - Receive Set | Receive only; performs read-after-write check | 1050 or 2100 | 6,226 |

Source: Auerbach Computer Technology Reports, Philadelphia 1971

TABLE 10

## EFFECTS OF TRANSMISSION SPEEDS ON COSTS OF DATA SETS

| Speed in bps | Network | Approximate Unit Cost |
|---|---|---|
| 300 | Public Switched | $ 400 |
| 1200 | Public Switched | 800 |
| 2400 | Private Line | 1,800 |
| 2400 | Public Switched | 2,200 |
| 4800 | Private Line | 5,600 |
| 4800 | Public Switched | 12,000 |

Sources: Derived from:

Auerbach Computer Technology Reports, Philadelphia, 1971

Datapro '70 Communications, Datapro Research Corporation, Philadelphia, 1971

Specialized Communications Carrier Market, Frost & Sullivan, Inc., New York, 1971

TABLE 11

## MATERIAL COST OF STATION EQUIPMENT
Bell Canada as at December 31, 1968

| | Units Installed | Book Costs | Average Cost Per Unit |
|---|---|---|---|
| DATA-PHONE DATA SETS (including Private Line connected sets) | 1491 | $1,900,000 | 1274 |
| DATA-SPEED UNITS | 90 | 670,000 | 7444 |
| TELETYPEWRITER EXCHANGE SERVICE (TWX) (includes Data Set and Teletypewriter) | 2136 | 5,500,000 | 2575 |
| DATACOM SERVICE (includes Data Set and Teletypewriter) | 296 | 800,000 | 2702 |
| PRIVATE LINE DATA TELETYPEWRITER | 189 | 930,000 | 4921 |

Source: CTC Hearings 1969, re Bell Canada application, Exhibits B-335 and B-336

Multiplexers are used to combine several low speed data signals into a composite high speed signal in order to transmit them into a single channel to the receiving station where the original low speed signals are then recovered. The equipment is offered to the user with large telecommunications requirements to reduce his overall costs for service. In this environment, multiplexers are an element of station equipment as distinct from their general use by the carriers. Two forms of multiplexing exist. One, frequency division multiplexing (FDM) divides the capacity of a communications voice band channel into a number of low speed data channels with specified frequency allocations. Time division multiplexing (TDM) interleaves data streams in time from a number of low speed channels to form a high speed data stream. FDM equipment has been more generally used because of the higher costs of TDM sets. However, this cost disparity is disappearing and in some cases the production of highly reliable TDM equipment requiring little maintenance has reversed the advantage. Multiplexers are constructed to provide an extremely wide range of options with respect to the characteristics of input data, transmission rates, mixing patterns, number of channels, status and diagnostic indicators and error control. Carrier costs per data channel when used at full capacity range from about $350 to $775.[1]

Sophistication rather than the speed of transmission is the principal cost factor. Some manufacturers build in greater flexibility at higher cost; others provide a wide range of optional features. Some multiplexers offer a voice plus data capability, accepting both simultaneously by accommodating some low-speed data channels on the upper portion of the same voiceband channel. Some equipments may be fitted with plug-in filters for changing channel speeds, or with crystal controlled oscillators for improved frequency control. Other multiplexers incorporate a capability allowing local control of remote digital signals for testing purposes. Carriers' costs increase with the number and sophistication of the features that are provided. Otherwise, the carrier's cost per data channel decreases with increasing channel handling capacity.

The ordinary telephone handset can be used for data transmission. Portable terminals with acoustic couplers accommodate the handsets in specially designed cradles. The data which is already in analogue form when presented to the handset is transmitted via the public switched network. Ordinary handsets range from $18 to $23 depending upon type. The 1968 unit cost of an installed touchtone telephone was $33.[2] Bell Canada reported that the cost of an installed

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1. Auerbach Computer Technology Reports: Multiple ers, Philadelphia, 1971

2. CTC Hearings re BC Tel Rate Application 1970, Exhibit BCT-9 and Bell Canada Rate Application 1969, Transcript of Evidence Vols. 44 and 47.

telephone was between $96 and $120.[1] The telephone and wiring at the customer's location cost $60, with the remainder of the cost attributable to the directly associated equipment at the central office, including switching equipment. Acoustic couplers to accommodate speeds up to 300 bps, and which the subscriber himself may supply, are available in the United States from $250 to $600 with the majority near the $400 level. Couplers for use at 1200 bps cost between $700 and $1100.[2] Differences in cost are in some cases attributable to built-in optional features such as automatic answer, reverse channel, carrier detection indicator and loop-back features. The cost for the most expensive telephone does not begin to approach the costs for acoustic couplers, data sets, modems or multiplexers. For example, the cost of a private line teleprinter is 150 times that of the ordinary telephone handset, and the Dataspeed units are 225 times that of a touch-tone telephone. Increased utilization of the network for data traffic will enlarge the total investment in station equipment. Users supplying their own terminal facilities help to absorb this cost and reduce the investment requirements for the carrier.

Local Loops

The local loop is the circuit that connects the station equipment to the local central office or exchange. Each local or subscriber loop is associated with a particular subscriber station, often with a specific piece of station equipment at the subscriber's premises. At the exchange, two situations arise. If the subscriber has selected the switched network for data transmission, the loop is connected to the switching equipment which permits access to the network. If he uses a private line, the loop is connected to the circuit leading to the other station or stations forming the private system.

Because there are a number of subscriber stations connected to it, each central office is, in effect the hub of a rimless wheel and the subscriber loops are the spokes connected to the centre. The circuits, being concentrated at the hub, generally leave the exchange in large feeder cables. As the distance from the central office increases, the circuits cascade through a number of smaller distribution cables, eventually reaching a terminal from which one or more pairs of wires connect to the subscriber's premises. The cable routes may change from time to time because of changes in the total demand for services

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1. Telecommission Study 4(a)

2. Auerbach Computer Technology Reports, Philadelphia, 1971

in the community. Typically, the loop is physically rearranged at some point every two years and 9 or 10 splice points are not uncommon.

The significant factors affecting the cost of the loops in an exchange are:

* length of the loops;
* type of transmission line employed;
* the density and distribution of stations within the exchange area

Local loops typically are pairs of copper wires accumulated into cables and strung on poles or buried underground. Loops may also be open wire pairs mounted on poles. They vary in the gauge of wire used. Since they are the single most expensive items associated with a particular subscriber station, finer gauges are used where possible to reduce costs of service. More sensitive station equipment and exchange equipment that can compensate for the changes in the electrical characteristics of the loop permit the use of finer wires. System planners determine the economic trade-off. Current investment of the telephone companies for local loops is approaching 30% of total plant.[1] Equivalent data for telegraph carriers were not available.

Local loop lengths are a major cost factor. In Bell Canada, the average installed cost of a 2-mile loop is reported to be $200 and for a 4-mile loop more than $500.[2] These costs are based on existing plant, much of which was installed years ago with a life expectancy of nearly 30 years. Current costs for a 2-mile loop are as high as $350. Open wire subscriber loops mounted on pole lines are extremely costly. The British Columbia Telephone Company reports exchange loop costs per mile to be $118 for aerial wire as opposed to $31 for aerial cable.[3]

The use of cable carrier systems on the exchange distribution plant can provide better utilization of the cable pairs and eliminate or

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1. TCTS, Member Company Investment Data, 1970, submitted to The Telecommission
2. Telecommission Report 8(b)(ii), Appendix E
3. CTC hearings of BC Tel rate application 1971 Exhibit AG-12

postpone the need for additional outside plant. Costs range from $200 to $700 per channel,[1] depending on the equipment characteristics that are required. Economies of scale can be exploited in construction of exchange distribution systems. The experience of the New Brunswick Telephone Company[2] indicates that a 400-pair cable installed in underground conduit in a semi-metro area costs $75 per circuit mile. A 100-pair buried cable installed in a rural distribution system costs $83 per circuit mile. In Alberta, on the other hand, a program aimed at extending service to 48,000 rural applicants through installation of buried cable has cost $1060 per circuit for an average circuit length of just under one mile.[3]

Local loop plant accommodates low transmission speeds without "conditioning". This channel capacity is equivalent to the voice grade circuits in the telephone network. When the data transmission characteristics of the local loop do not meet the subscriber's needs, "conditioning" is accomplished to overcome the loss characteristics of the circuit. Higher data transfer rates then are possible without increasing error rates. Acceptable quality in telephone service requires a channel frequency spectrum whose range is 300 to 3400 Hz. Teleprinter signals on the other hand may be transmitted within a channel frequency band of 120 Hz for 75 bps speeds and 480 Hz for speeds of 300 bps. Since a number of 120 or 480 Hz bands can be derived from the spectrum between 300 and 3400 Hz, as shown in Table 12, there are obvious cost advantages available per teleprinter circuit when a number of teleprinter channels originate from one subscriber's location, or even from one building. With the aid of separation filters, a single 2-wire circuit could connect many subscribers to the teletypewriter exchange. Where this is not possible, each subscriber would utilize one pair of wires.

Conditioning provides a flatter frequency response over the bandwidth of the channel, thus effectively extending its usable range and materially improving the capacity of the channel to perform at higher speeds. Cost data pertaining to Canadian carriers are lacking in this area, but the average book costs reported for similar facilities in one company in the United States are shown in Table 13. The conditioning

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1. Crownfield, William R. Experience with Station Carrier Applied to Loop Plant, Proceedings of the National Electronics Conference, Inc., Oak Brook, Illinois, 1970, Appendix 1, pp. 919-920
2. Telecommission Report 2(d)
3. Alberta Government Telephones, Annual Reports, 1969, 1970

TABLE 12

NUMBER OF TELEPRINTER CHANNELS AVAILABLE THROUGH SUB-DIVISION OF ONE VOICE CHANNEL (NOT CONDITIONED)

| Bit Rate (bps) | Channel Spacing (Hz) | Number of Teleprinter Channels |
|---|---|---|
| 75 | 120 | 17 |
| 110 | 170 | 12 |
| 150 | 240 | 8 |
| 300 | 480 | 4 |

TABLE 13

## EXAMPLES OF CHANNEL CONDITIONING INVESTMENT

| Item | Unit Net Plant |
|---|---|
| Type C1 Conditioning - per location - two point channel not arranged for switching - connects two locations within the same exchange | $152 |
| Type C1 Conditioning - per location - multi-point channel or two point channel arranged for switching | $221 |
| Type C2 Conditioning - per location - two point channel not arranged for switching - connects two locations within the same exchange | $444 |
| Type C2 Conditioning - per location - multi-point channel or two point channel arranged for switching | $655 |
| Type C4 Conditioning - two point channel - connects two locations within the same exchange | $757 |
| Type C4 Conditioning - three point channel - between control point and main station | $852 |
| Type C4 Conditioning - two or three point channel - each additional station to main station | $520 |

Source: Pacific Telephone & Telegraph Company, San Francisco, California, submission to Public Utilities Commission for the State of California, December 1969 in response to Decision 74917

types C1, C2 and C4 are revised designations of Schedules 4A, 4B and 4C conditioning services listed as Canadian tariff items filed with the Canadian Transport Commission.[1] An unconditioned line is expected to meet performance standards up to at least 2500 Hz, with C1 conditioning up to 2700 Hz, with C2 to 2000 Hz, and with C4 to 3200 Hz.[2]

The category of costs generally grouped as local exchange outside plant equipment includes pole lines, wire, cable and conduit used for both local and long distance distribution of telecommunications services. This category includes, therefore, more than pure local loop investment since local and interexchange circuits often share a cable facility. However, in 1969, only 7% of the wire and cable mileage in the telephone industry was not dedicated exclusively to local exchange use.[3] Consequently, one can assume that if 30% of total plant investment is local exchange outside plant, as has been reported, this proportion is approximately correct for pure local loop costs as well. If this figure is taken as representative, the Canadian telephone industry had invested by 1970 approximately $1.76 billion in the local distribution networks, the average cost per loop being about $250.[4] This cost approaches that of the cheapest of the acoustic couplers, but is only one-tenth of the cost of the private line teletypewriter and one-fifth the cost of a Dataphone dataset, thereby reinforcing the relative importance of station equipment as an element of data communication costs.

Switching Equipment

Switching equipment is the means by which the customer can connect to any other subscriber in the system. The geographical allocation of the exchanges in a network and their functional interrelationships depend upon the existing and potential demand for total telecommunications service. Switching offices have been developed to serve both local and long distance calling. They have been arranged and are located to provide alternative routine in case of failure and are designed so that the failure to accommodate a subscriber will occur at less than 1% frequency at peak traffic volumes.

Consider an exchange of 1000 subscribers. For local calling only, a maximum of 500 switch connections would be required to connect each

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1. Auerbach Computer Technology Reports, Report 3200, p.5, 1970

2. Auerbach Computer Technology Reports, Report 4321, p.2, 1971

3. Telephone Statistics 1969, Statistics Canada Catalogue 56-203, November 1970

4. Based on numbers of telephones in service, less number of extensions, and assuming one exchange line per 5 telephones connected to a PBX

of 500 callers to a corresponding number of subscribers, so that all 1000 are connected. The more normal situation is that a smaller number of subscribers desire connection at any one time, so that many fewer than 500 switch connections need be provided.

The number of connectors required in the switching equipment are a function of the number of subscribers and terminating trunks connected to the machine, and the traffic pattern (number, time of placing and duration of the calls). These factors also affect the complexity of the equipment and its cost.

In the telephone industry there is an abundance of statistical evidence concerning telephone use.[1] The average holding time to dial a 7-digit number and obtain an answer from the called party is 30 seconds. The average length of talking time is 130 seconds. When the called party does not answer, the average wait before hanging up is 40 seconds. Compared to the residence telephone, business telephones contribute one and one-half times as much traffic and lines from a PBX four times as much. The busy hour traffic peaks occur between 10 and 11 in the morning and 2 and 3 in the afternoon. About 80% or more of the calls made are local as opposed to long distance. These characteristics may be altered somewhat by unique local calling patterns but this generally causes no problem because the engineering of switching facilities and the associated local exchange trunks is based on local circumstances. Measurement techniques are well developed.

However, the same type of information is not available concerning data transmission. With the exception of the Telex exchange network, data transmission history is still too short to assess its characteristics with confidence. In Canada, fewer than 5% of Telex calls are local, the reverse of telephone experience. The use of Telex network is largely confined to business hours, and the traffic is of a "business nature". The relative difference in density of traffic between peaks and lows is considered higher than for the telephone industry. The effect is produced by the number of messages sent rather than the duration of the calling time. As a result, for a given number of subscribers, more switches and connecting paths are required for Telex than for long distance telephone service.[2]

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1. Traffic Engineering Handbook, Telephony Publishing Corporation, Chicago, 1969

2. CN/CP Telecommunications, Manual of Telecommunications Services, Section 3

The switching investment per subscriber line for Telex, all other factors being equal, should therefore be greater. Unfortunately, comparative statistics are not available. Because the vast majority of Telex calls are long distance, the number of outgoing trunk lines that are required would seem also to be relatively greater than one would expect to find in a telephone office. If the characteristics of data transmission on the public switched telephone network appear over time to deviate greatly from the norms established in the telephone industry over the years, increased data traffic may force a redesign of telephone network segments to avoid degradation in the quality of service. Experience with dial-up computer time sharing networks indicates that holding time is in some cases four to five times that of normal toll calling on the telephone network. An increase in the demand for data transmission under these circumstances would require extensive investment in augmentation of switching and trunk facilities.

In 1970, Trans-Canada Telephone System reported that switching equipment represented 24% of members' investment. This figure coincides with Bell Canada's investment for the same year, up one percent from 1968. In 1970, Bell Canada had approximately 630 step-by-step switches, 360 No. 5 crossbar switches and 6 electronic switches serving 3,670,000 lines. Marked differences are apparent in Table 14 with respect to the approximate costs per line served. The book costs quoted in the table relate to the investment at the time of installation. Since much of the step-by-step equipment is nearing retirement age, these costs probably are understated in terms of today's dollars. At 1970 prices, the installed cost per line for No. 5 crossbar equipment is shown in Table 15 to be approximately 22% greater than that for step-by-step switches.

In terms of data transmission there are several advantages gained by installing No. 5 crossbar equipment despite the higher cost per line. First, the annual maintenance costs are said to be reduced by 30%. Next, switching speeds are faster by 32% after the call has been registered in the switch (.75 seconds as opposed to 1.1 seconds).[1] Step equipment is noisier and is therefore susceptible to higher error rates. The No. 5 crossbar offices can supervise longer subscriber loops. Step-by-step offices supervise loops of resistance to 1300 ohms, and No. 5 crossbar switches to 1500 ohms. Assuming the use of 26 gauge wire, the difference of 200 ohms represents a difference of one mile in loop length. Moreover, the crossbar and electronic offices can be equipped readily with a touch-tone receiver which can offer a data

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1. CTC hearings 1970 BC Tel rate application, Exhibit BCT-30

TABLE 14

## INVESTMENT IN SWITCHING EQUIPMENT
## BELL CANADA 1970

| Type | Quantity[1] | No. of Lines[1] | Book Cost[2] | Average Unit Cost | Cost per Line |
|---|---|---|---|---|---|
| SxS | 630 | 2,500,000 | $388,475,104 | $ 616,627 | $155 |
| 5 XBar | 360 | 1,100,000 | - | estimated | $230-$260[3] |
| Elect | 6 | 70,000 | $ 51,694,274 | $8,615,712 | $738 |

1. Source: Telecommission Report 8(b)(ii). Appendix E submitted by TCTS - Values are approximate

2. Source: CTC hearings 1970 Bell Canada rate application, Exhibit 0-70-16

3. Based on data presented in CTC hearings of BC Tel and Bell Canada rate applications in Exhibit BCT-29 of 1970, details of which are in Table 15, in Exhibit B-70-9 of 1969, and Telecommission Report 3(d)

TABLE 15

## COMPARATIVE COSTS
## SWITCH SIZE 4000 LINES, 5000 CONNECTOR TERMINALS

| | SxS | 5 XBar |
|---|---|---|
| | (dollars) | |
| Installed, Book Value | $782,000 | |
| 5 XBar Switch | - | $ 900,000 |
| Frames, Protectors, spare parts, test equipment, etc. | - | 45,000 |
| Sales Tax | - | 32,000 |
| Engineering Overhead | - | 28,000 |
| Installed, 1970 Value: Total | 825,000 | 1,000,000 |
| Annual Maintenance Costs | 12,000 | 8,400 |
| Costs Per Line | | |
| At Book Cost | 196 | 251 |
| At 1970 Value | 206 | 251 |

Source: CTC hearings, BC Tel rate application 1970, Exhibit BCT-29

transmission facility to every telephone user; step-by-step offices would require very costly modification to offer this service. Finally, No. 5 crossbar and electronic machines offer switching speeds more closely approaching those of the computer.

There remain areas in Canada which are still served by manual switchboards. To provide truly effective links in a data network, automatic switching is necessary. The Maritime Telegraph & Telephone Company is undertaking an upgrading program to introduce automatic switching for 25,000 telephones but this will be at a cost of $920 per telephone. Equipment permitting direct dialing for approximately 100,000 telephones will cost an additional $25 per telephone.[1] With direct distance dialing it is imperative that data networks employ Automatic Number Identification (ANI) equipment for billing purposes. The addition of ANI to all exchanges in British Columbia cost an average $9.75 per station. Annual operating costs for ANI equipment are assessed to be 20% of investment in British Columbia.[2]

In 1968, about 14% of Bell Canada's investment in switching equipment was utilized in serving long distance calling. When installed, the 4A crossbar switch located in Montreal served 4474 trunks at an installed cost of approximately $10 million.[3] At the average cost of $2235 per trunk, this office far outstrips the local exchanges with respect to switching costs. A similar switch recently installed in Edmonton cost $6.2 million for the equipment alone[4], and will probably match or exceed the costs of the Montreal installation. The effect of the higher costs of these switching facilities is of direct relevance to data transmission costs.

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1. The Globe and Mail, Toronto, November 3, 1971

2. Canadian Transport Commission, re BC Tel 1971, Exhibit BCT 10-VI

3. Canada's telephone Industry in Perspective, Telephone Association of Canada, 1967

4. Alberta Government Telephones, Annual Report, 1969

In summary, with respect to switching, if we accept the TCTS average of 24.1% to be representative, the telephone companies by 1970 had invested $1413 millions in switching gear. Using the same basis previously employed for calculating local loop costs, the switching investment per subscriber station is calculated to be approximately $205. This of course includes the manual and step-by-step switching equipments which are older, less expensive and of less relevance to data transmission. Data transmission switching investment is therefore likely to be more expensive, approaching a cost of $230 to $260 per line for the No. 5 crossbar machine facility.

## Inter-Office Transmission Facilities

Several choices are possible in the selection of inter-office transmission facilities, ranging from open wire lines to microwave radio. The volume of traffic, the distance between offices and the existing plant configuration are key variables. Alternative methods for satisfying system needs are normally selected on the basis of the technical solution which best achieves orderly expansion at least cost. Transmission facilities may be grouped into five main categories:

* open wire
* cable (symmetric pair)
* wire pair carrier systems
* coaxial cable carrier systems
* radio systems
    - High Frequency (HF) radio
    - Microwave relay
    - Satellite

The investment cost of a transmission system is dictated mainly by type of physical facilities, the system length and the number and rate of growth of the circuits in the cross-section. The distributed networks of the public switched telephone and telegraph companies are a complex composite of all these categories of equipment. In the TCTS network, this represents about 13% of the total investment.

The costs for open wire and cable are usually directly proportional to the distance between the connected offices, although the

need for loading and voice frequency repeaters introduces small variations. On the other hand, the investment costs per channel for wire line carrier systems, whether for open wire or cable, depend upon terminal equipment requirements and the number of intermediate carrier repeaters that are necessary. Investment costs for radio systems rest almost entirely on the costs of the terminal and repeater installations, the costs per channel being a function of the multiplex equipment located at these installations, and the costs per mile a function of the working range of the selected radio equipment. The relative costs of some representative systems are shown in Figure 1.

The high initial investment required for microwave often makes it more economical to use paired cable or open wire over short distances or where traffic volume is low. For example, a recently completed 90-mile open wire system in Alberta cost $300,000.[1] It is estimated that a 300-circuit microwave system would cost two and one-half times that figure. Microwave systems, however, are very attractive for long distance, high density traffic routes, since distance and traffic volume both affect the economies achieved through scale. Current demand for long-haul transmission facilities in Canada has not required immediate installation of the full capacity of large microwave systems. The carriers, however, typically make allowance for future expansion by selecting equipment that is readily augmented. Given adequate building and power capacity, approximately 60% to 70% of the costs of expanding a microwave system are consumed by the multiplexing equipment. The relative costs, based on the experience of the New Brunswick Telephone Company and reported in the Telecommission Report 2(d) entitled "Communications and Regional Development" are reproduced in Table 16.

Current installed costs of microwave systems are quoted as being approximately $12 per voice channel-mile.[2] The recent construction of a 600-mile, 1200-voice channel microwave system following a route from Vancouver to the British Columbia-Alberta border via Squamish, Kamloops, Prince George and Dawson Creek required an expenditure of $8,620,000 or roughly $12 per circuit-mile. However, this does not take into account the need to provide protection channels as well as monitoring and maintenance circuits within the system. Assuming that the proportion of channels assigned to full-time commercial traffic is 75% of the available capacity, the investment cost per working channel is nearer $16.

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1. Alberta Government Telephones, Annual Report 1970

2. Telecommission Report 4(a), Appendix E

## COMPARATIVE INVESTMENT COSTS VERSUS TRANSMISSION METHOD AND NUMBER OF CIRCUITS

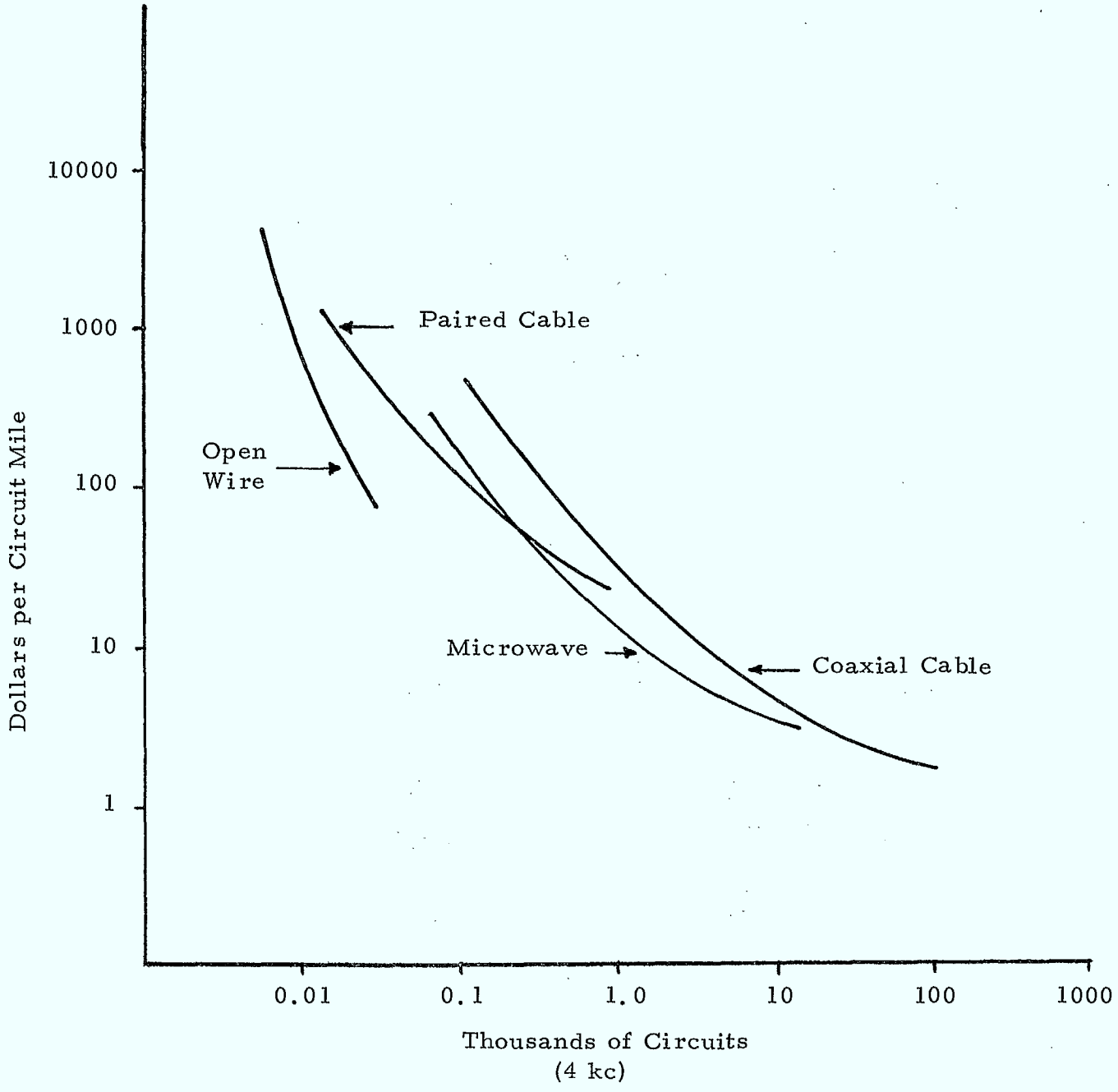


FIGURE 1

Source: Telecommission Study 4(a) Appendix E

CCITT, Economic Studies and Comparisons, 1969, Chapter D. IV

TABLE 16

RELATIVE COSTS OF
MICROWAVE RELAY MULTIPLEXING EQUIPMENT

| No. of Channels | Relative Cost per Channel |
|---|---|
| 1800 | 1.0 |
| 960 | 1.0 |
| 600 | 1.3 |
| 300 | 1.12 |
| 120 | 1.40 |
| 60 | 1.96 |

(Figures are per end and are NOT comparable to per mile)

Source: Telecommission Report 2(d)

Costs of Satellite transmission systems are independent of distance, but the cost per channel is intimately linked to the utilization that can be achieved, which in turn is a function of demand at the prices charged to the user. Cost information for the Canadian environment awaits the launching and operation of a satellite system.

Coaxial cable costs have been decreasing to competitive levels and installations are being made in the Canadian network. The L-4 coaxial cable system is representative of the long distance heavy route cable facilities that are becoming available. Each tube is capable of carrying 1800 circuits with a repeater spacing of two miles. Representative costs at 1967 prices are shown in Table 17. The costs assume placing costs of $4,500 per mile, although this could vary between $3,000 and $20,000 depending on the locality. Without providing protection channels, costs per voice channel range from $7 to $11, but land, buildings and support equipment costs are additional.

For short-haul equipment, existing wire pairs can provide expanded facilities through the use of carrier systems. Because the number of voice channels in a carrier system depends primarily on the capacity of the terminal equipment, costs for additional carrier circuits above certain minimum distances will be less than for additional physical wire or cable circuits. At one time the carrier systems were found only in long-haul transmission activities, but current availability of less expensive, more efficient carrier equipment has moved the cross-over point in costs between physical pairs and carrier facilities to relatively short distances. In 1965 the type T-1, a 24-channel carrier which uses digital transmission, was introduced for short-haul service, being cheaper than baseband transmission at distances greater than 12 to 14 miles. The T-1 is eminently suitable for data transmission up to 50 miles with a full capacity of 1.544 bits per second. U.S. experience prior to 1968 indicates that the installed costs for a T-1 system was approximately $8,400 at each end, yielding a voice equivalent channel cost of $700 using existing wire pairs. [1]

The policy of the carriers in Canada is to provide sufficient switching and trunking facilities to meet all but 1% of the traffic demand during the busy hour. What is the effect on investment costs? There are no data available relating solely to data transmission, but using the

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1. D.A. Dunn et al. Report 7379B of the Stanford Research Institute, available from U.S. Department of Commerce, Clearinghouse for Scientific and Technical Information, Springfield, Va.

TABLE 17

## INSTALLED COSTS OF L-4 COAXIAL CABLE SYSTEM[1] (1967 PRICES)

| Equipment | 2-Tube | 6-Tube | 10-Tube |
|---|---|---|---|
| | (in thousands of dollars) | | |
| Line Haul Costs (for 120-mile section) | | | |
| Repeaters | 616 | 1,767 | 2,918 |
| Cable | 1300 | 2,123 | 3,918 |
| Total | 1,916 | 3,890 | 5,992 |
| Terminal Costs (each end) | 230 | 610 | 990 |
| Number of Voice Channels | 1,800 | 5,400 | 9,000 |
| Costs per Voice Channel at Full Capacity | | (in dollars) | |
| Line Haul per 120 Mile Section | 1,064 | 720 | 666 |
| Terminals | 256 | 226 | 220 |

1. Derived from data presented by CCITT, Economic Studies and Comparisons, 1969, Chapter D.IV; Rostow, Eugen V., President's Task Force on Communications Policy, Washington, D.C., Staff Paper One; Gunn, J.F. Weller, D.C., A Digital Mastergroup Channel for Modern Coaxial Carrier Systems, International Conference on Communications, San Francisco, June 1970; Meckling, William H. Communications Satellites, RM-2709-NASA and supplemental information, The Rand Corporation, Santa Monica, California, 1960; Telesat, Interaction of the Terrestial and Satellite System, Department of Communications, 1970; D.A. Dunn et al. Report 7379B of the Stanford Research Institute, available from U.S. Department of Commerce, Clearinghouse for Scientific and Technical Information, Springfield, Va.; Manufacturers prices based on large volume production of cable type PD-375 (with lead sheaths)

NOTE: Costs quoted refer to transmission equipment only. They do NOT include land, buildings, access roads, test equipment or other maintenance and support equipment.

statistics compiled by the U.S. telephone industry[1] one may obtain an appreciation of the impact that quality of service has on investment costs regarding trunk lines.

Consider the busy hour demand to be 100,000 call seconds for an inter-exchange facility consisting of 38 trunks. This amount of traffic would result in 73% utilization of the lines and 4% of the callers would encounter an all-equipment-busy condition in the group. The addition of one trunk would reduce utilization but would still present a busy signal to 3% of the callers. Adding another trunk to provide 40 in all would still leave 2% of the callers without a connection. To get to the 1% grade of service, a further two trunks would be required, bringing the total in all to 42. At this level, therefore, a 10% increase in trunk facilities is required to obtain a 3% increase in service level. Following similar logic, one discovers that a traffic demand of 27,000 call seconds made on a 3-trunk group would result in 4% of the callers encountering busy equipment. Three additional trunks, a 100% increase, would be required to improve the service level to the current standard.

In summary, the existing networks operated by the carriers contain a compendium of transmission media. The embedded investment is a strong reflection of the nature of the industry, the type and number of demands for telecommunication services made in the past, and the relative time periods in which the demands were made. Among the telegraph companies three-quarters of the wire mileage is found in overhead wires, not cables.[2] The telephone companies on the other hand maintain only 5% of the wire mileage in aerial wire, most of it in the toll function, the remainder in cables.[3] One-seventh of the TCTS member's investment is accounted for by transmission facilities, both long and short haul. The average cost per voice channel mile is less than that for local loop construction because of the economies of scale generated by microwave and carrier systems. Nevertheless, individual routes for short-haul service may not differ greatly from the investment required to install the local distribution system.

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1. Traffic Engineering Handbook, Telephony Publishing Corporation, Chicago, 1969

2. Source: Statistics Canada, Telegraph and Cable Statistics, Catalogue 56-201, 1970

3. Source: Statistics Canada, Telephone Statistics, Catalogue 56-203, 1969

## Support Facilities

Investment in support facilities for the carrier's operations includes the land and buildings required to house the equipment, tools, work equipment and vehicles of all types, furniture and office equipment. Data relating to the members of the Trans-Canada Telephone System reveals that the facilities represented almost 11% of the total investment. Reference to Table 7 shows that except for land and buildings the depreciation rates for the equipment in this category are generally higher than that for most categories of communications equipment. On the other hand, maintenance costs as a proportion of the investment are smaller. These facilities form an investment pool common to all the services provided on the integrated network and their annual costs are a charge against each of the offerings whether data, voice, television, radio or facsimile.

## CONCLUSIONS

The fundamental cost associated with digital data transmission is the investment required to construct the transmission facility. Essentially the facility consists of four operating components (the station equipment, the local loop, the central office equipment and the inter-office transmission lines) and the support component necessary to maintain and operate the network. Each component itself can be constructed with a wide variety of equipments and techniques. Equipment selection is based on the user's current requirements, the potential for expansion, the need for inter-equipment and inter-service and, when alternatives are possible, the least cost. Eventually, the quantity and location of the subscribers and the amount, type and timing of the traffic generated become the principal determinants of the mix of hardware deployed by the carriers. For any company, the investment costs are a function of the mix of hardware required to carry the load and mix of traffic presented.

The telecommunications carriers conduct annual reviews of operations in order to meet the demand for service, to control expense and to develop satisfactory earnings. Because basic estimates of the incremental demand for various service offerings determine the additional equipment requirements, the annual review is prepared "upwards" by the managers who have intimate knowledge of the local operation for which they are responsible. The locally prepared estimates are assembled and reviewed by succeeding levels of the company organization, eventually being scrutinized and analyzed by the headquarters

staff before being incorporated into the overall plan. The plan will include an estimate of the revenues, expenses and the necessary construction expenditures from which financing plans are developed.

Planning of the construction program itself requires consideration of priorities, alternatives and timing. Financial planning includes a review of the financial resources and the general financial situation, anticipated earnings levels, and opportunities for improvements in the carrier's operations. These considerations may lead to decisions to reduce the construction program and to seek improvements in the expense picture or in the utilization of the carrier's facilities. Once the company plan is approved, each unit of the company down to the smallest is expected to carry out the agreed objectives.

The number of combinations and permutations of alternatives possible result in each locality exhibiting a unique mixture of hardware appropriate to the local needs. The different equipment and operating patterns, therefore, yield different cost patterns, not only from company to company, but also from location to location within the same company. In addition, the date of the investment influences the legitimacy of book cost values. Company-wide cost averages, therefore, are representative of the total mix taken across a lengthy time frame and are not suitable for purposes of planning or comparison. The carriers themselves are more interested in current unit costs for planning purposes than they are in unitizing historical embedded costs.

Several factors affect the initial and annual costs of the building blocks of the system. First, investment costs are related to the geographical location of the facility, the amount and type of traffic to be handled and the volume of the peak loads. The annual operating costs derive mainly from depreciation, maintenance, traffic and business operations expenses. Taxes and the cost of money are important costs to some carriers but have a lesser impact on others.

Economies in the communications network are achieved through large scale operations. The network favoured with heavy traffic across large cross-sections will achieve the greatest economy. Here trade-offs between switching and transmission arrangements are possible. High volume direct transmission routes bypassing the switching centres become economic. Alternate routing schemes on low or medium traffic routes rely on switching centres to provide flexibility, reliability and high utilization of transmission channels. The accommodation of data transmissions on facilities that are relatively interchangeable among telephone, radio, television and facsimile services lead to further economies of scale.

Data transmission speeds are a prominent factor in determining the costs of station terminals. Higher speeds require wider channel bandwidths and increase both line and switching costs. Call holding times are a significant factor in determining investment costs for switching and trunking facilities on the switched networks. Increases in the rate of calling can demonstrate similar effects. Distance between user stations is an important factor. Non-carrier transmission systems show a direct relationship between cost and distance, but in carrier systems terminal costs are relatively independent of distance. Microwave and coaxial repeatered facilities yield incremental reductions in cost with distance.

Reliability and grade of service constraints imposed on the carrier increases his costs through the necessity of providing protection (standby) channels and additional switching and trunking facilities. The requirement to minimize delays in data transmissions necessitates fast and costly signalling and switching service.

Finally, data transmission requires costlier subscriber terminals than does voice communications. The station equipment for data transmission thus can be the most expensive individual item in the transmission link.