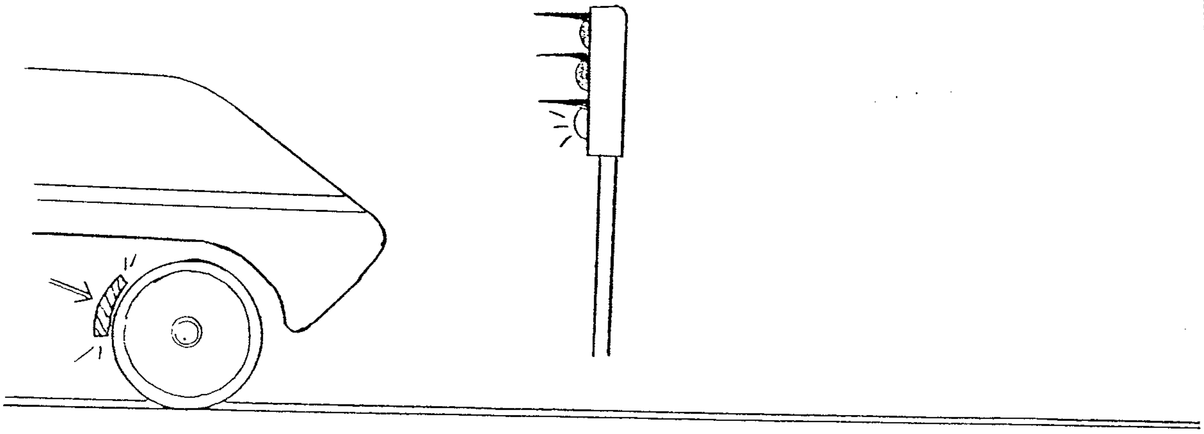
DIRECTOR OF S & T ENGINEERING.
WEST MIDLANDS PROJECTS GROUP.

CALCULATION OF "SERVICE BRAKING DISTANCE"



SERVICE BRAKING DISTANCE

SECTION	DISTANCE IN YARDS	GRADIENT	RISE(YDS) (DIST X GRAD)	FALL(YDS). (DIST X GRAD)
X - A	100	$\frac{1}{500}$	-	0.20
A - B	400	$\frac{1}{350}$	-	1.14
B - C	300	$\frac{1}{280}$	1.07	-
C - D	350	L	-	-
D - Y	450	$\frac{1}{190}$	-	2.37
TOTALS	1600		1.07	3.71

3.71 - 1.07 = 2.64YDS FALL IN 1600YDS

THEREFORE $\frac{1600}{2.64}$ = 605

1420 yards + 142 yards (10%) = <u>1562 yards</u>

AVERAGE GRADIENT = $\frac{1}{606}$ FALLING

CALCULATION OF SERVICE BRAKING DISTANCE

The purpose of calculating the Average Gradient is to enable us then to use the Average Gradient figure to deduce:-

a) Whether there is sufficient Service Braking Distance (SBD) between existing signals. ie. Checking an existing Braking Distance.

or

b) To determine where the positions of new signals that perform a SERVICE BRAKING DISTANCE function should be sited.

SERVICE BRAKING DISTANCE is the distance to stop a train, travelling at the maximum permissible speed of the line, at such a rate of deceleration that will not discomfort or alarm the passengers.

The Standard Signalling Principle (SSP) that covers this area is SSP 34. Included in this SSP are two Graphs Appendix 1 and Appendix 2, see FIGURES 1 & 2 respectively. From the Graphs it can be seen to find a Service Braking Distance you require two pieces of information namely:-

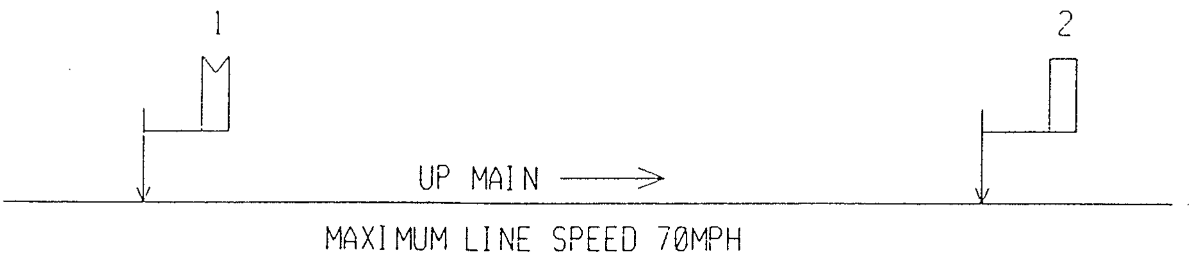
1) The average gradient between the signals concerned.

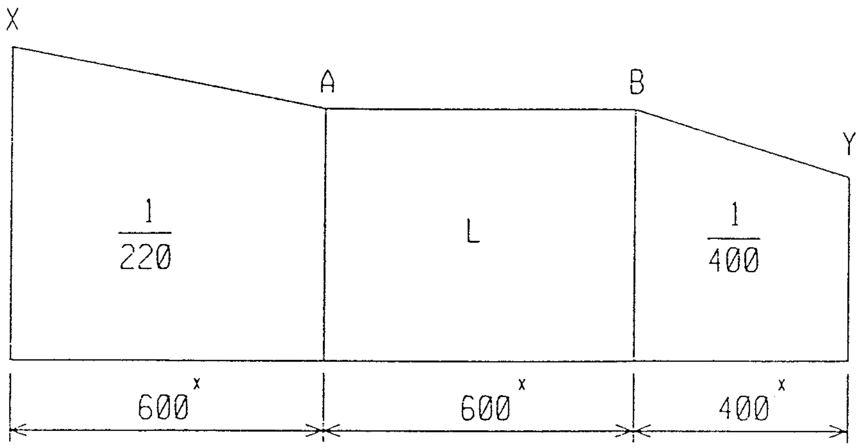
2) The maximum speed of the line.

continued

CALCULATION OF SERVICE BRAKING DISTANCE

Look at the following example of a typical layout showing a semaphore Distant Signal and a semaphore Home Signal.





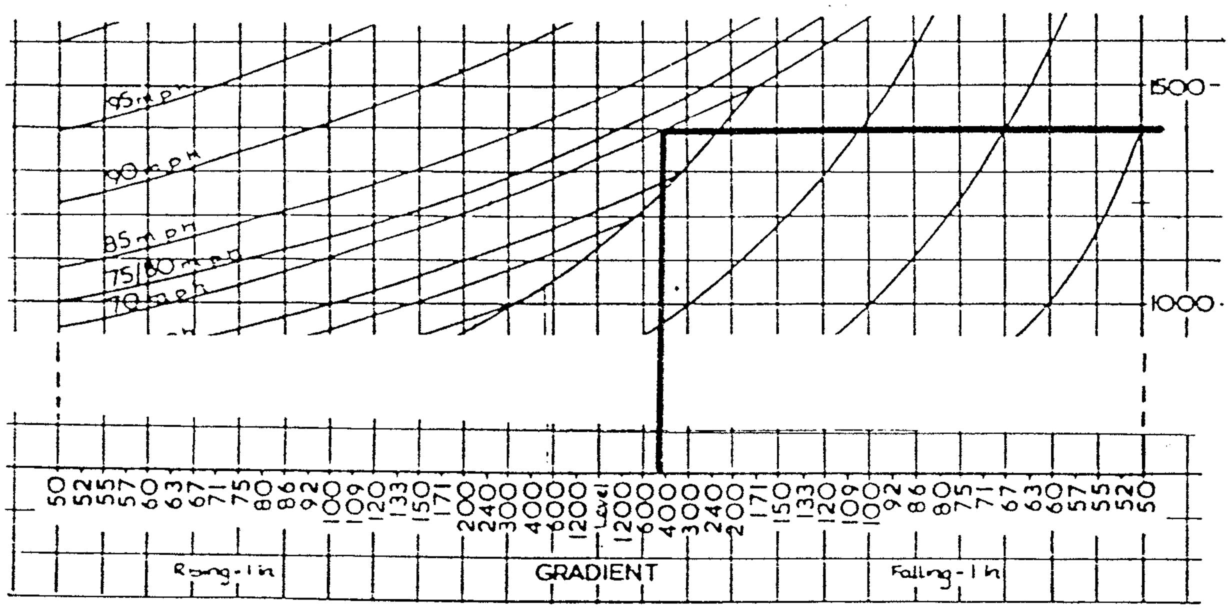
SECTION	DISTANCE IN YARDS	GRADIENT	RISE(YDS) (DIST X GRAD)	FALL(YDS) (DIST X GRAD)
X - A	600	1/220	-	2.73
A - B	600	L	-	-
B - Y	400	1/400	-	1.00
TOTALS	1600			3.73

$\frac{1600}{3.73} = 428.95$ THEREFORE AVERAGE GRADIENT = $\frac{1}{429}$ FALLING

continued

CALCULATION OF SERVICE BRAKING DISTANCE

With the average gradient of 1/429 FALLING and consulting the Composite Graph (Appendix 1) you can see the Minimum Service Braking Distance allowed is approximately 1400 yards, therefore if Signal 1 displays a cautionary signal it is adequately spaced to give sufficient SBD to Signal 2.



Theoretically Signal 1 could be placed closer to Signal 2 but in practice it has been suggested to aim to place the Distant Signal between 1.1xSBD and 1.5xSBD. This flexibility of measurement can have benefits when taking site considerations into account.
ie. accommodating existing signals, actually siting the signal because of Signal Sighting Committee recommendations and signal adjustment to a preferred “Headway” pattern.

The maximum distance from the first Cautionary Signal to the Stop Signal should be less than 1.5xSBD, a separation of greater than 1.5xSBD would cause the driver of a train to brake unreasonably early.

We have studied the case of the existing signals and how to “check” that they are correctly positioned to obtain adequate SBD, now let us examine the actual placement of a new Distant Signal to an existing Home Signal.

continued

CALCULATION OF SERVICE BRAKING DISTANCE

The contents of SSP 34 we should now familiarise ourselves with before actually placing any Signals on the Scheme Plan.

Text contained within SSP 34:-

BRITISH RAILWAYS BOARD

STANDARD SIGNALLING PRINCIPLE NO. 34

Director of S & T Engineering
Ref: 206-66-38

Director of Operations
Ref: MM/S/3/34

BRAKING DISTANCES

FOREWORD

This principle establishes the minimum service braking distances to be provided in all signalling new works and renewals. The accompanying graphs which incorporate appropriate safety margins, are in substitution of all existing Regional graphs and/or tables.

PROVISIONS

1. The distances shown in the Appendices are minimum post-to-post distances and must not be reduced. Sighting distance is additional to these and should be not less than 200 yards unless speeds are low or there are exceptional circumstances.

2. Unless there are special circumstances, the composite graph in Appendix "I" is to be used. This enables braking distances to be read off on the basis of the train requiring the longest braking distance under the given conditions of the line speed and gradient.

3. Exceptionally, on lines carrying a preponderance of passenger trains, the graph in Appendix "II" may be used in order to meet headway requirements provided that special arrangements (eg. speed restrictions) are made for other types of train requiring longer braking distances.

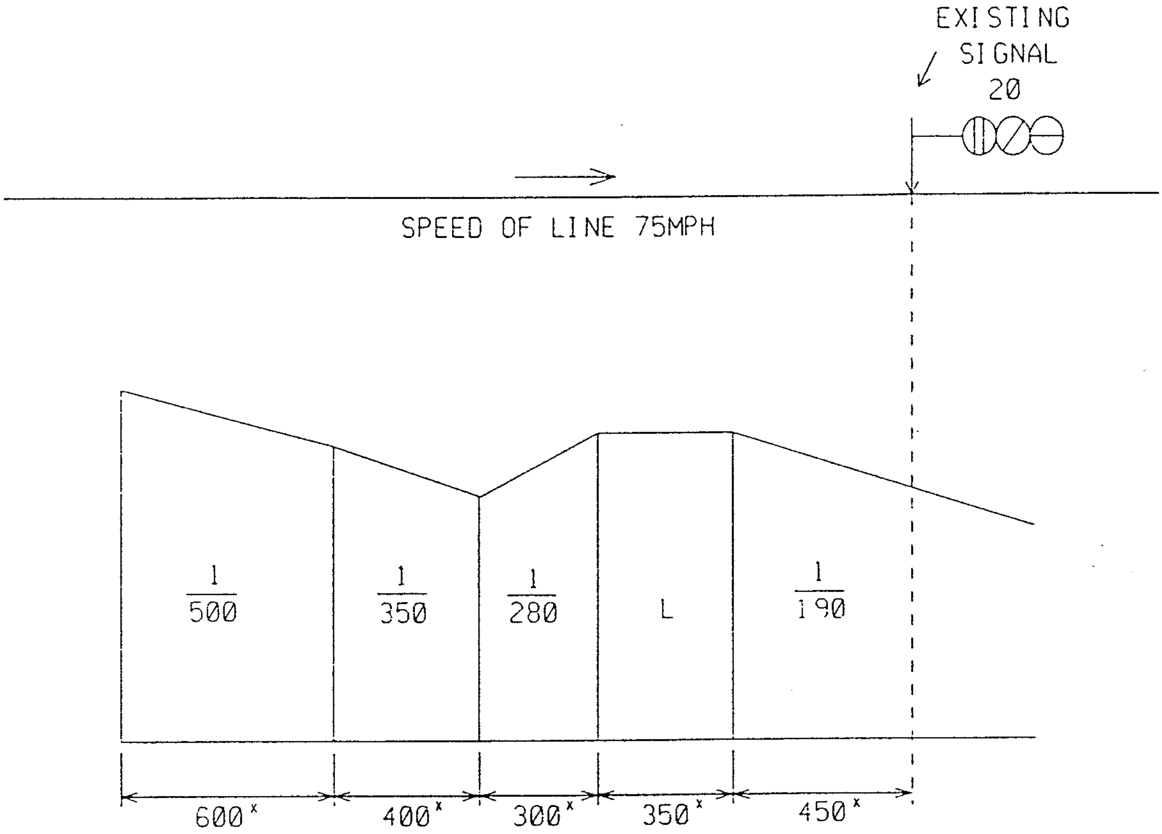
4. On low speed lines where the braking distances shown in Appendix "I" are considered to be insufficient to cater for Classes 8 and 9 freight trains at line speed, the minimum distance to be allowed shall be that shown for 40 mph in Appendix "I".

continued

CALCULATION OF SERVICE BRAKING DISTANCE

5. Graphs for speeds in excess of 100 mph have not been produced and it has been established that rolling stock which will run at speeds between 100 mph and 125 mph will be fitted with improved braking to ensure stopping from their maximum speed within the distances shown on the "W" curve for 100 mph.

Shown below is an example of a situation where we need to site a 3 aspect colour light signal in rear of an existing colour light signal.



When the new signal in rear of 20 is showing a yellow aspect this signal must be placed at SBD plus the parameters previously quoted (between 1.1 & 1.5xSBD) must be taken into account.

To determine where to place the new signal follow this procedure:-

Find the maximum speed of the line (in our case 75 mph).

From the Braking Curves estimate the distance over which the Average Gradient will have to be calculated whilst simultaneously estimating the average gradient.

continued

CALCULATION OF SERVICE BRAKING DISTANCE

LEVEL AT 75 mph IS 1380 yards (APPENDIX 1)

If we were to place the signal at 1380 yards plus 10% it would be placed 1518 yards in rear of signal 20, but at this point we can see that the average gradient is FALLING so we will have to take into account more of the gradient profile.

As a guess I would say that the average gradient is about 1/500 FALLING (always estimate to the safe side) looking at the graph we need at least 1430 yards + 10% = 1573 yards. This figure gives us a guide as to the distance to take the average gradient, round the figure up to 1600 yards.

SECTION	DISTANCE IN YARDS	GRADIENT	RISE(YDS) (DIST X GRAD)	FALL(YDS) (DIST X GRAD)
X - A	100	$\frac{1}{500}$	-	0.20
A - B	400	$\frac{1}{350}$	-	1.14
B - C	300	$\frac{1}{280}$	1.07	-
C - D	350	L	-	-
D - Y	450	$\frac{1}{190}$	-	2.37
TOTALS	1600		1.07	3.71

3.71 - 1.07 = 2.64YDS FALL IN 1600YDS

THEREFORE $\frac{1600}{2.64} = 606$

AVERAGE GRADIENT = $\frac{1}{606}$ FALLING

From the Composite Graph read the actual Minimum SBD required.

1420 yards + 142 yards (10%) = 1562 yards

Therefore place the signal at 1562 yards in rear of signal 20, you will notice that this distance is within the gradient profile taken which was 1600 yards.

continued

CALCULATION OF SERVICE BRAKING DISTANCE

NOTES.

a) If the Braking Distance when taken from the graph is greater than the distance you calculated the average gradient over, then re-calculate.

b) If the Braking Distance when taken from the graph is less than the distance you calculated the average gradient over, re-calculate only if the difference is significant.

continued

CALCULATION OF SERVICE BRAKING DISTANCE

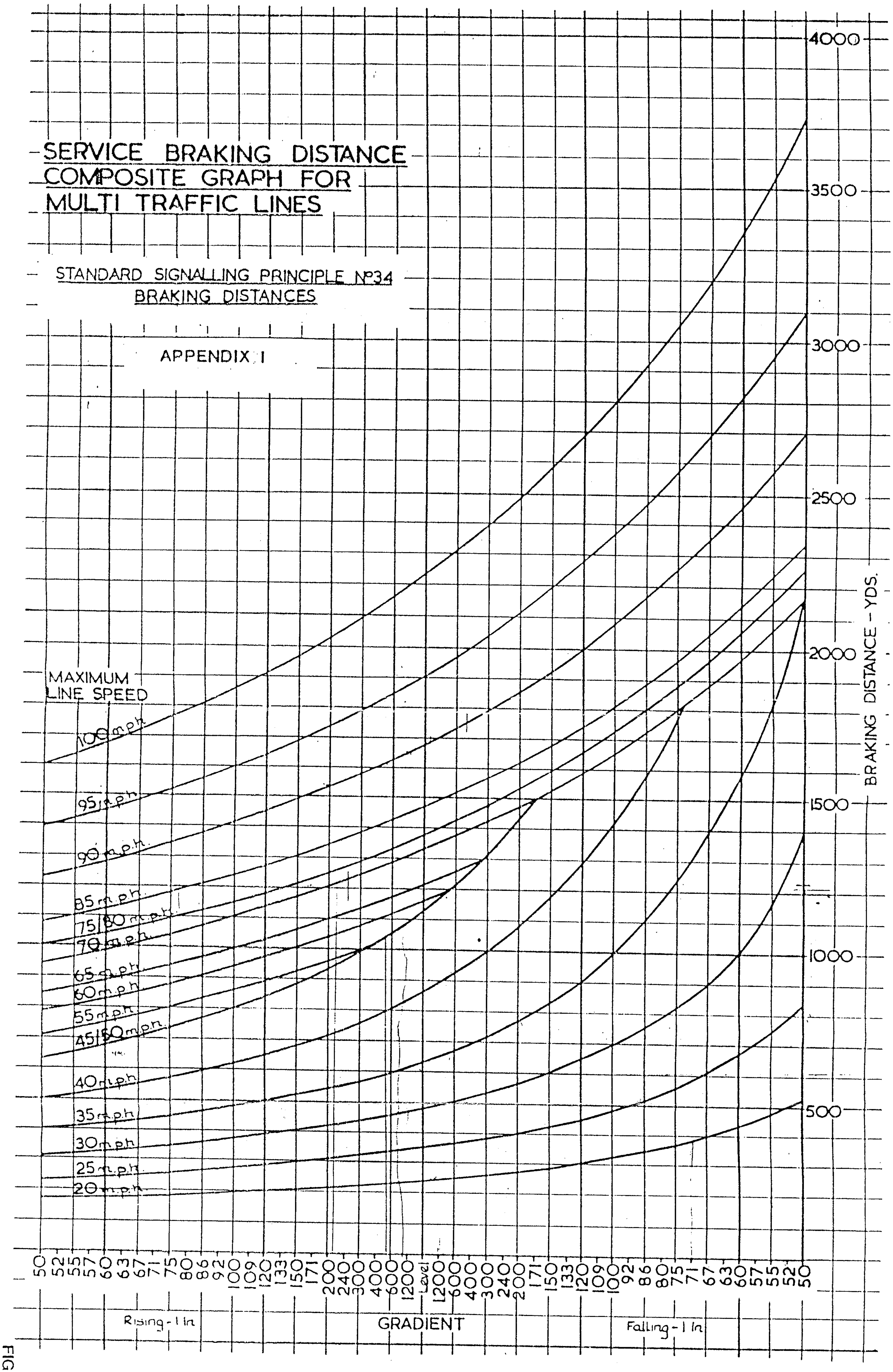
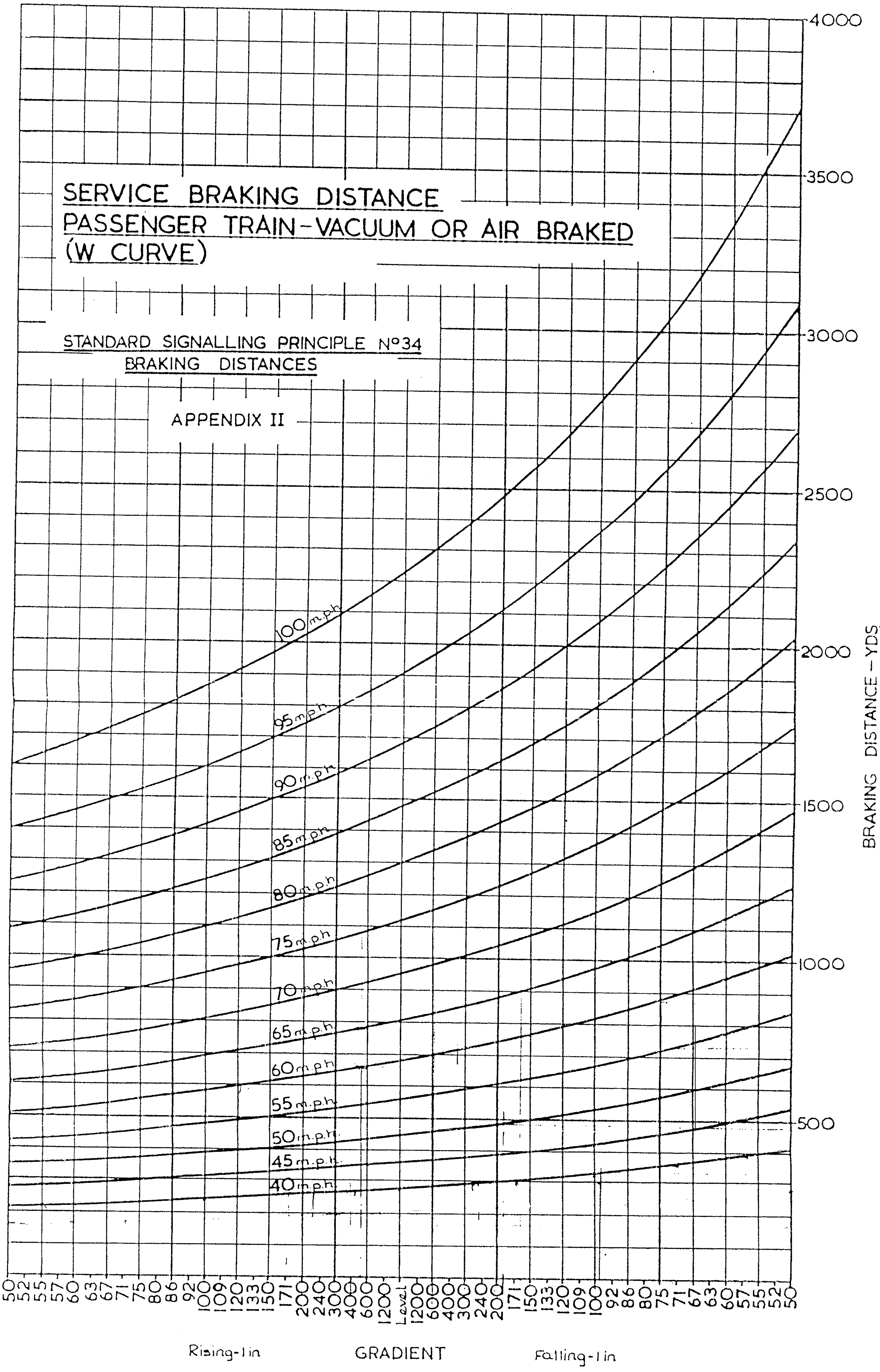


FIGURE 1
continued


SERVICE BRAKING DISTANCE
PASSENGER TRAIN-VACUUM OR AIR BRAKED
(W CURVE)
STANDARD SIGNALLING PRINCIPLE Nº34
BRAKING DISTANCES
APPENDIX II
100 m.p.h
95 m.p.h
90 m.p.h
85 m.p.h
80 m.p.h
75 m.p.h
70 m.p.h
65 m.p.h
60 m.p.h
55 m.p.h
50 m.p.h
45 m.p.h
40 m.p.h
4000
3500
3000
2500
2000
1500
1000
500
BRAKING DISTANCE - YDS
50 52 55 57 60 63 67 71 75 80 86 92 100 109 120 133 150 171 200 240 300 400 600 1200 Level 1200 600 400 300 240 200 171 150 133 120 109 100 92 86 80 75 71 67 63 60 57 55 52 50
Rising-1 in
GRADIENT
Falling-1 in