Air Brake Calculations etc

ELECTRICITY SUPPLY DEPARTMENT

DRAFT LETTER

Gen. Typing Section
espondence Dept.
ropolitan Branch

Date ..../..../19....

be forwarded :—

Initials.....

Ref. No.....

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g. DATA TRAMWAY BRAKING.

Coefficient of Adhesion wheel to rail.

lean dry rail	.25 to .30	with sand	.35 to .4
lean thoroughly wet rail	.18 to .20	with sand	.22 to .25
reasy and moist rail	.15 to .18	" "	.22 to .25
leet on rail	.15	" "	.20
now on rail	.10	" "	.15
heel skidding	.1		

Coefficient of Friction. Shoe to wheel

Speed 20 m.p.h	Coefficient .192
15	.223
10	.242
7.5	.244
5	.273
1	.351

The abrasion and heating of a brake shoe is such that
he coefficient of friction remains substantially constant
on the major portion of the stop.
e the increased coefficient due to the decreasing
speed is offset by the decreased coefficient due to the
brake shoe heating.

A wheel skidding has only one third the retarding
effort of a wheel revolving.

Signed .....

Clear writing, preferably in ink, will facilitate execution

1.1%.

THT/MR

4th August, 1947.

TRAMWAYS

Air Brake Equipment on Single Truck Trams

Brake Cylinder 8" dia.

Area = $3.1416 \times 4^2 = 50.26$ sq. inches

Brake cylinder pressure at 65 lbs. per sq. in. = 3,266 lbs.

" " " " 75 lbs. " " " = 3,769 lbs.

Permissable Force at each brake shoe using Co-efficient of friction 0.20 and Co-efficient of adhesion 0.25.

Weight of empty tram = 11 tons = 24,640 lbs.

" " loaded " = 15 " = 33,600 lbs.

(Empty tram) Weight per wheel $= \frac{11 \times 2240}{4} = 6,160$ lbs.

Adhesive force $= 6160 \times .25 = 1,540$ lbs.

Permissable force per shoe $= \frac{1540}{.2} = \underline{7,700}$ lbs.

(Loaded tram) Weight per wheel $= \frac{15 \times 2240}{4} = 8,400$ lbs.

Adhesive force $= 8,400 \times .25 = 2,100$ lbs.

Permissable force per shoe $= \frac{2,100}{.2} = 10,500$ lbs.

Brake cylinder lever ratis = 19.5" : 42".

Brake cylinder lever force at 65 lbs. per sq. inch

$= \frac{3266 \times 19.5}{42} = 1,516$ lbs.

Force at end of brake lever $= \frac{21}{2\frac{1}{2}} \times 1516 = 12,734$ lbs.

Force at equaliser beam $= \frac{23\frac{1}{2}}{2\frac{1}{2}} \times 1516 = 14,250$ lbs.

Force per shoe (average) $= \frac{12,734 + 14250}{4} = 6,746$ lbs.

Permissable force = 7,700 lbs. : 6,746 = 87.6%

Brake cylinder lever force at 75 lbs. per sq. inch

$= \frac{3769 \times 19.5}{42} = 1749$ lbs.

Force at end of brake lever $= \frac{21 \times 1749}{2\frac{1}{2}} = 14690$ lbs.

Force at equaliser brake lever $= \frac{23\frac{1}{2} \times 1749}{2\frac{1}{2}} = 16,440$ lbs.

Force per shoe (average) $= \frac{14,690 + 16,440}{4} = 7,782$ lbs.

Permissable force = 7,700 lbs. : 7,782 = 101.1%.

W. H. brake cylinder lever ratis = $17\frac{1}{4}$" : $41\frac{3}{4}$"

Brake cylinder lever force at 65 lbs.

$= \frac{3266 \times 17\frac{1}{4}}{41\frac{3}{4}} = 1349$ lbs.

Force at end of brake lever $= \frac{21}{2\frac{1}{2}} \times \frac{1349}{} = 11,331$ lbs.

Force at equaliser beam $= \frac{23\frac{1}{2}}{2\frac{1}{2}} \times 1349 = 12,680$ lbs.

Force per shoe (average) $\frac{11,331 + 12,680}{4} = 6,002$ lbs.

Permissable force = 7,700 lbs. : 6,002 = 77.9%

Brake cylinder force at 75 lbs.

$= \frac{3769 \times 17\frac{1}{4}}{41\frac{3}{4}} = 1557$ lbs.

Force at end of brake lever $= \frac{21}{2\frac{1}{2}} \times \frac{1557}{} = 13,078$ lbs.

Force at equaliser beam $= \frac{23\frac{1}{2}}{2\frac{1}{2}} \times 1557 = 14,636$ lbs.

Force per shoe (average) $\frac{13,078 + 14,636}{4} = 6,928$ lbs.

Permissable force 7,700 lbs. : 6,928 = 89.9%

Summary of the four calculations

ment	Air Pressure	Brake Lever Ratio	Brake Cylinder Lever Force	Gross Weight of Tram	Average Force in lbs. per Brake Shoe	Percentage Efficiency
l tric	65 lbs. sq. inch	19.5":42"	1516 lbs.	11 tons	6746	87.6
	75 lbs. " "	"	1749 "	11 "	7870	101
	65 " " "	"	1516 "	15 "	7782	64.2
	75 " " "	"	1749 "	15 "	7782	74.1
ng- use	65 " " "	$17\frac{1}{4}$":$41\frac{3}{4}$"	1349 "	11 "	6002	77.9
	75 " " "	"	1557 "	11 "	6928	89.9
	65 " " "	"	1349 "	15 "	6002	57.1
	75 " " "	"	1557 "	15 "	6928	65.9

25th June, 1947. W.M.

State Electricity Commission of Victoria
ELECTRICITY SUPPLY DEPARTMENT
BALLARAT BRANCH

TRAMWAY BRAKING - SUMMARY OF VARIABLE FACTORS.

DETAILS		GENERAL ELECTRIC EQUIPMENT		WESTINGHOUSE EQUIPMENT		% BELOW MAXIMUM			
						Heavy Load Permissible		Normal Load Practicable	
		Heavy Load	Normal	Heavy Load	Normal	G.E.	W.H.	G.E.	W.H.
Weight of Tram (approx.)	lbs.	33,600	24,640	33,600	24,640				
Permissible Maximum Brake Force (Av.) per Wheel	lbs.	10,000	7,250	10,000	7,250				
Practicable Maximum Brake Force (Av.) per Wheel 33"	lbs.	7,250	7,250	7,250	7,250	27.5	27.5		
Existing Maximum Brake Force (Av.) per Wheel 33"	lbs.	7,250	7,250	6,470	6,470	27.5	35.3	-	10.7
" " 29½"	lbs.	6,480	6,480	5,780	5,780	35.2	42.2	10.6	20.2
Existing Minimum Brake Force (Av.) per Wheel 33"	lbs.	6,210	6,210	5,550	5,550	37.9	44.5	14.3	23.4
" " 29½"	lbs.	5,550	5,550	4,960	4,960	45.5	50.4	23.4	31.5

4th August, 1947.

THT/MR

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Brake cylinder lever ratio = 19.5" : 42"

Brake cylinder lever force at 65 lbs. per sq. inch

$= \frac{3266 \times 19.5}{42} = 1,516$ lbs.

Force at end of brake lever $= \frac{21}{2\frac{1}{2}} \times 1516 = 12,734$ lbs.

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Force per shoe (average) $= \frac{14,690 + 16,440}{4} = 7,782$ lbs.

Permissable force = 7,700 lbs. : 7,782 = 101.1%.

W. H. brake cylinder lever ratio = 17¼" : 41¾"

Brake cylinder lever force at 65 lbs.

$= \frac{3266 \times 17\frac{1}{4}}{41\frac{3}{4}} = 1349$ lbs.

Force at end of brake lever $= \frac{21}{2\frac{1}{2}} \times 1349 = 11{,}331$ lbs.

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Force per shoe (average) $\frac{11{,}331 + 12{,}680}{4} = 6{,}002$ lbs.

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Force per shoe (average) $\frac{13{,}078 + 14{,}636}{4} = 6{,}928$ lbs.

Permissable force 7,700 lbs. : 6,928 = 89.9%

Summary of the four calculations and percentages

ment	Air Pressure	Brake Lever Ratio	Brake Cylinder Lever Force	Gross Weight of Tram	Average Force in lbs. per Brake Shoe	Percentage Efficiency
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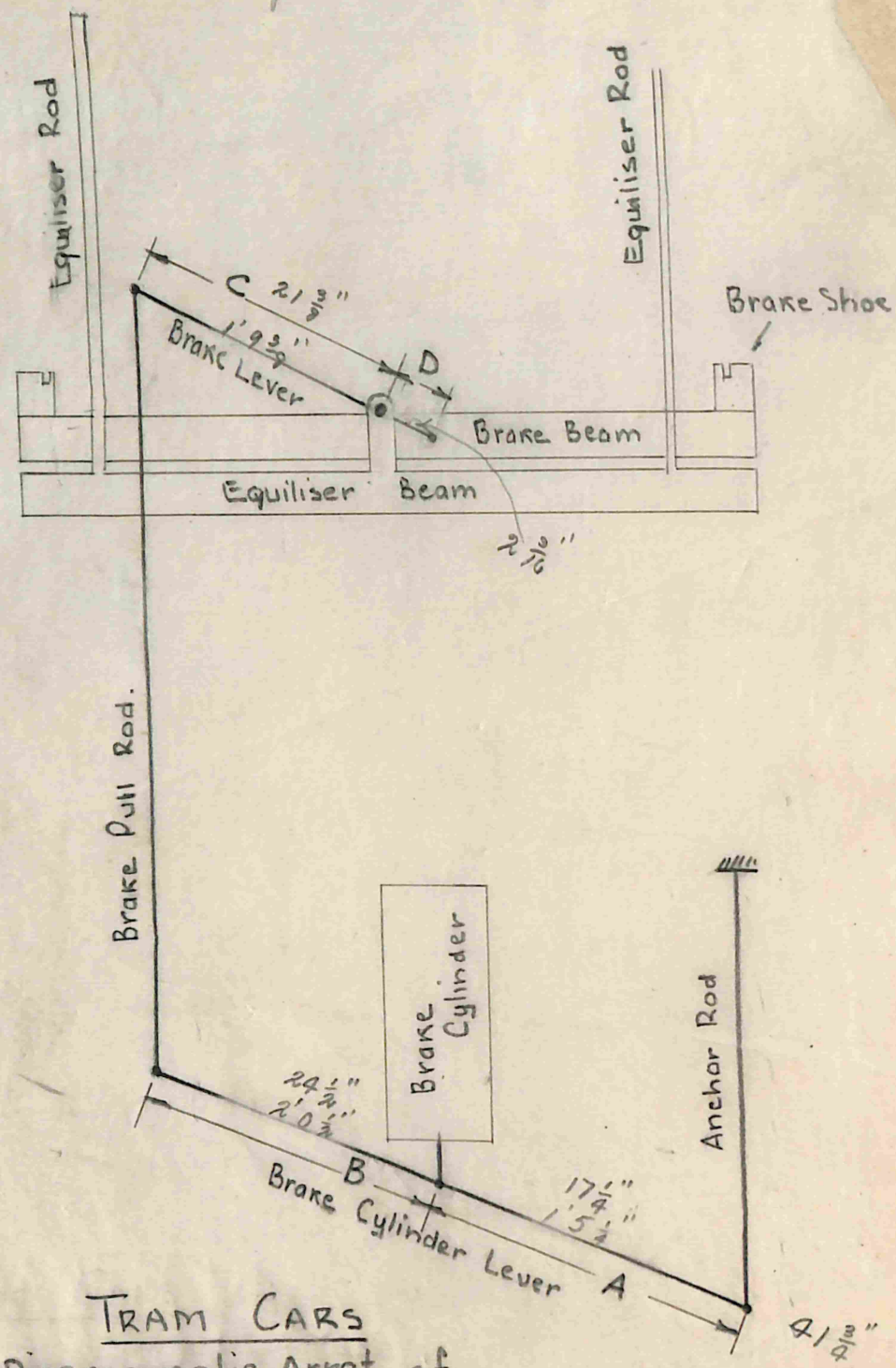
	75 lbs. " "	"	1749 "	11 "	7782	101.1
	65 " " "	"	1516 "	15 "	6746	64.2
	75 " " "	"	1749 "	15 "	7782	74.1
ing-ouse	65 " " "	17¼":41¾"	1349 "	11 "	6002	77.9
"	75 " " "	"	1557 "	11 "	6928	89.9
"	65 " " "	"	1349 "	15 "	6002	57.1
"	75 " " "	"	1557 "	15 "	6928	65.9

Bendigo standard as shown below for single truck trams



TRAM CARS
Diagrammatic Arrgt. of Brake Mechanism

G.E. Brake Rigging

19.5 : 42 = x : 3769

Brake Cyl Lever at 75 lbs = $\frac{3769 \times 19.5}{42}$ = 1749 lbs

Brake Cyl Lever @ 65 lbs = $\frac{3266 \times 19.5}{42}$ = 1516 lbs

Brake Lever at A (75 lbs) $\frac{21}{2\frac{1}{2}} \times 1749$ = 14,691 lbs

Brake Lever at B (75 lbs) = $\frac{23\frac{1}{2}}{2\frac{1}{2}} \times 1749$ = 16,440 lbs

Force per shoe = $\frac{14691 + 16440}{4}$ = 7,782 lbs.

Permissable Force per shoe

Empty 7700 : 7782 = 101 %

Loaded 10,500 : 7782 = ~~74.1 %~~

G.E. Brake Lever Ratio 19.5 : 42

8.4 to 1 and 9.4 to 1

DMW

22/ 8/45.

TRAMCAR AIR BRAKE TESTS.

No. 8 Tram was involved in a rear-end collision in Pakington Street on the evening of ~~September~~ August 13th, 1945.

No. 9 Tram was taken direct from Depot and known to be in good order.

Air Brake Tests Tram No. 5 taken at Ormond Road from Humble Street loop towards McKillop Street.

Speed	Pressure in lbs.sq. inch.	Distance	Time in sec.	
21 m.p.h.	76 lbs.	126 ft.	7½	14.2.34
19 "	65 "	97 "	7¼	Empty tram
20 "	75 "	100 "	7	Approx. weight 12 tons
19 "	75 "	95 "	6½	
19 "	75 "	81 "	6½	
20 "	75 "	94 "	7	5. 3. 34
19½ "	75 "	94 "	6	Added weight 4526 lbs.
23 "	75 "	150 "	9	
19½ "	75 "	86 "	6	5. 3. 34
20 "	75 "	84 "	5¾	Empty Tram
22 "	75 "	109 "	6¾	

No. 9 Tram -

Speed at Virginia Street = 14 m.p.h.
" " Elizabeth Street = 18 m.p.h.
" " 150' mark = 22 m.p.h.
Distance required to stop =220'

DMW

22/ 8/45.

TRAMCAR AIR BRAKE TESTS.

No. 8 Tram was involved in a rear-end collision in Pakington Street on the evening of ~~September~~ August 13th, 1945.

No. 9 Tram was taken direct from Depot and known to be in good order. Tests were taken on the down grade between Virginia and Skene Streets in Pakington Street, the site of the collision.

... ...

Grade of Track - 1 in 21.
Track conditions - Dry
Dead Load on tram - 2 ton 11 cwt.
Air brake applied at usual traffic position about midway between Virginia and Elizabeth Streets.

Test No. 1 - Normal braking from 15 m.p.h. - Air only.

		No. 8	No. 9
Distance required to stop	=	218'	148'
Distance of front of car from South B.L. Line Skene Street.	=	211'	281'

No skidding of wheels.

Test No.2 - Emergency braking from 15 m.p.h. - Air only.

Distance required to stop	=	108'	115'
Distance of front of car from South B.L. Skene St.	=	321'	314'

No skidding of wheels.

Test No.3 - Normal braking from 20 m.p.h. - Air only.

Distance required to stop	=	257'	246'
Distance of front of car from South B.L. Skene St.	=	172'	183'

No skidding of wheels

Test No.4 - Emergency braking from 20 m.p.h.- Air only.

Distance required to stop	=	210'	225'
Distance of front of car from South B.L. Skene St.	=	219'	204'

Skidding of wheels over last 10' approx. (No. 8)
No skidding of wheels (No. 9)

Test No. 5 - Normal braking from 10 m.p.h. -Air only.

Distance required to stop	=	53'	61'
Distance of front of car from South B.L. Skene St.	=	376'	368'

No skidding of wheels.

Test No. 6. Emergency braking from 10 m.p.h.-Air only.

Distance required to stop	=	27'	36'
Distance of front of car from South B.L.Skene St.	=	402'	393'

Test No. 7- No. 8 Tram
Rolling down hill to maximum speed at a point 150' South of South B.L. Skene Street.

Speed at Virginia Street = 15 m.p.h. (usual traffic speed.)
" " Elizabeth Street = 17 m.p.h.
Speed at point 150' South of South B.L. Skene St. where emergency air brake was applied = 21 m.p.h.
Distance required to stop = 238'
No skidding of wheels.

No. 9 Tram -
Speed at Virginia Street = 14 m.p.h.
" " Elizabeth Street = 18 m.p.h.
" " 150' mark = 22 m.p.h.
Distance required to stop =220'

7/7/47.

	Piston Travel	
	Loaded	Empty.
No 19 Tramcar.	$2\frac{3}{4}$" (approx 70 passengers)	$2\frac{1}{2}$"
No 4 Tramcar	$2\frac{3}{4}$" approx 60 passengers	$2\frac{5}{8}$"

Increase travel due to load (70 pass) $\frac{1}{2}$ inch

Braking

Bco 22.9.'45 per M. Fussell

air pressure reduced to 65 - 75 lbs

Lever 21": $2\frac{1}{2}$"

$19\frac{1}{2}$": $2\frac{1}{2}$"