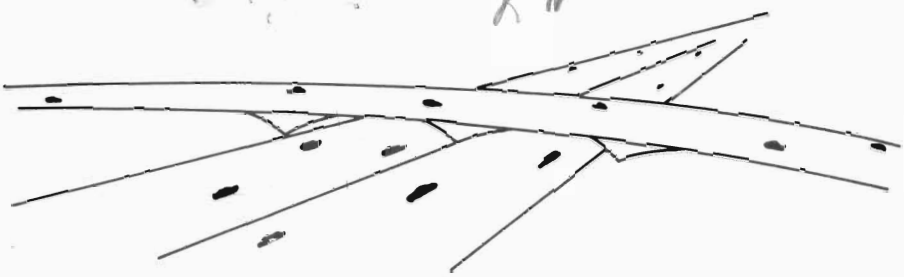

DEPARTMENTAL RESEARCH

Report Number SS 11.8

THIRD CALIBRATION OF THE SKID TEST TRAILERS

TEXAS HIGHWAY DEPARTMENT

THIRD CALIBRATION OF THE SKID TEST TRAILERS

BY

Kenneth D. Hankins
Bob Hart
Bill Teel
Billy Braddock

Texas Highway Department

Research Report SS 11.8

March 1970

THIRD CALIBRATION OF THE SKID TEST TRAILERS

The Maintenance Skid test trailers were calibrated the third time during the week of November 10, 1969. Calibrations were performed on the following items.

1. Proving Rings - Each unit contains two proving rings used to calibrate the force measuring system (usually twice a day while testing). On November 12, 1969, each ring was tested to determine if large variation existed between the rings in each unit.
2. Friction Force - Skid tests were performed on thirty test sections, testing one trailer behind the other. Attempts were made to skid each trailer in the path of the preceeding trailer. It should be noted that the thirty sections used were the same sections used in the second calibration. A list of test sections is attached. It should also be noted that some of the test sections have been sealed or overlayed since the second calibration.
3. The water calibration was not performed during the third calibration because of the short time period available. (The trailers were tested or correlated with the Oklahoma and Louisiana trailers on Friday, November 14, 1969.)

Proving Rings

Each proving ring was calibrated using a common ring as the basis of comparison. That is, the Research Trailer recorded was calibrated using the common ring, then each of the other rings were checked to determine if they resulted in the same reading. This type of calibration is not accurate, however, the force strip chart can only be read to the closest 10 lbs. and no variation in rings was found greater than 10 lbs. with the exception of Unit 42 in which one ring was found to be 15 lbs. This ring was sent to D-9 for accurate calibration.

There is the possibility that all rings could be reading high or low but this possibility was considered to be remote since a total of 8 rings are involved. Rather than flood D-9 with 8 rings to be calibrated at one time the above procedure was used.

Friction Force Calibration

The values found at each test section were analysed with the following results:

A. Unit 41-(Lubbock)-See plot on Figure 1.
   The relation of Unit 41 as compared to the Research Unit is:
   Friction Force (4162) = 18.84 + 0.967 x Frict. Force of Unit 41
B. Unit 42 - (Tyler) - See plot on Figure 2.
   The relation of Unit 42 as compared to the Research Unit is:
   Friction Force (4162) = 61.05 + 0.813 x Frict. Force of Unit 42
C. Unit 43 - (San Antonio) - See plot on Figure 3.
   The relation of Unit 43 as compared to the Research Unit is:
   Friction Force - (4162) = 39.07 + 0.938 x Frict. Force of Unit 43

The values found during testing are given in Table I.

Operator Comments

The following comments were offered by the operator of Unit 41 (Mr. Bob Hart):

1. Brake System
   There has been problems with the brake shoes. There appears to be a problem with the shoes not "seating in" correctly. Approximately ever third

NO. 650-10R
10 DIVISIONS PER INCH BOTH WAYS
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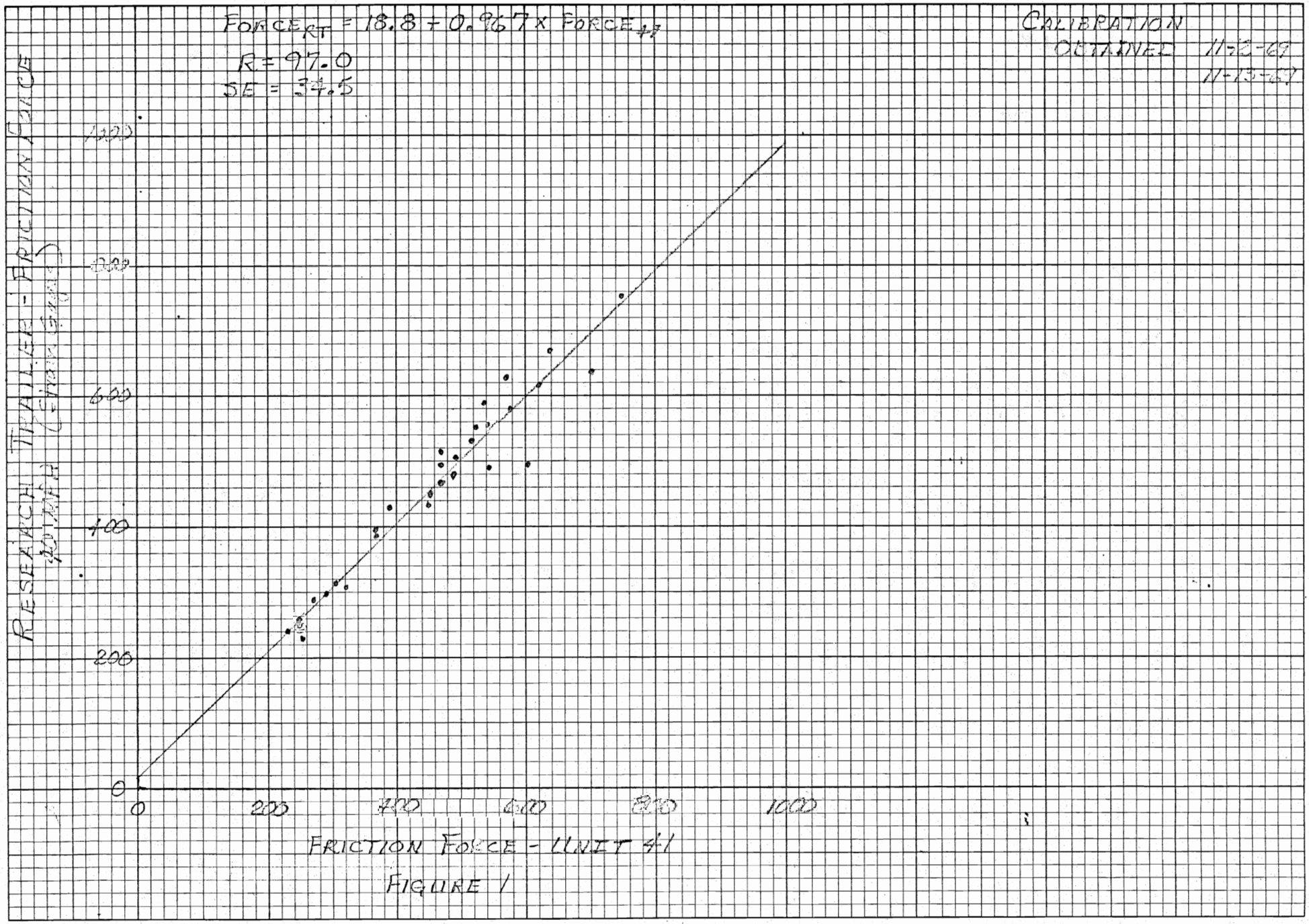

FIGURE 1

NO. 650-10R
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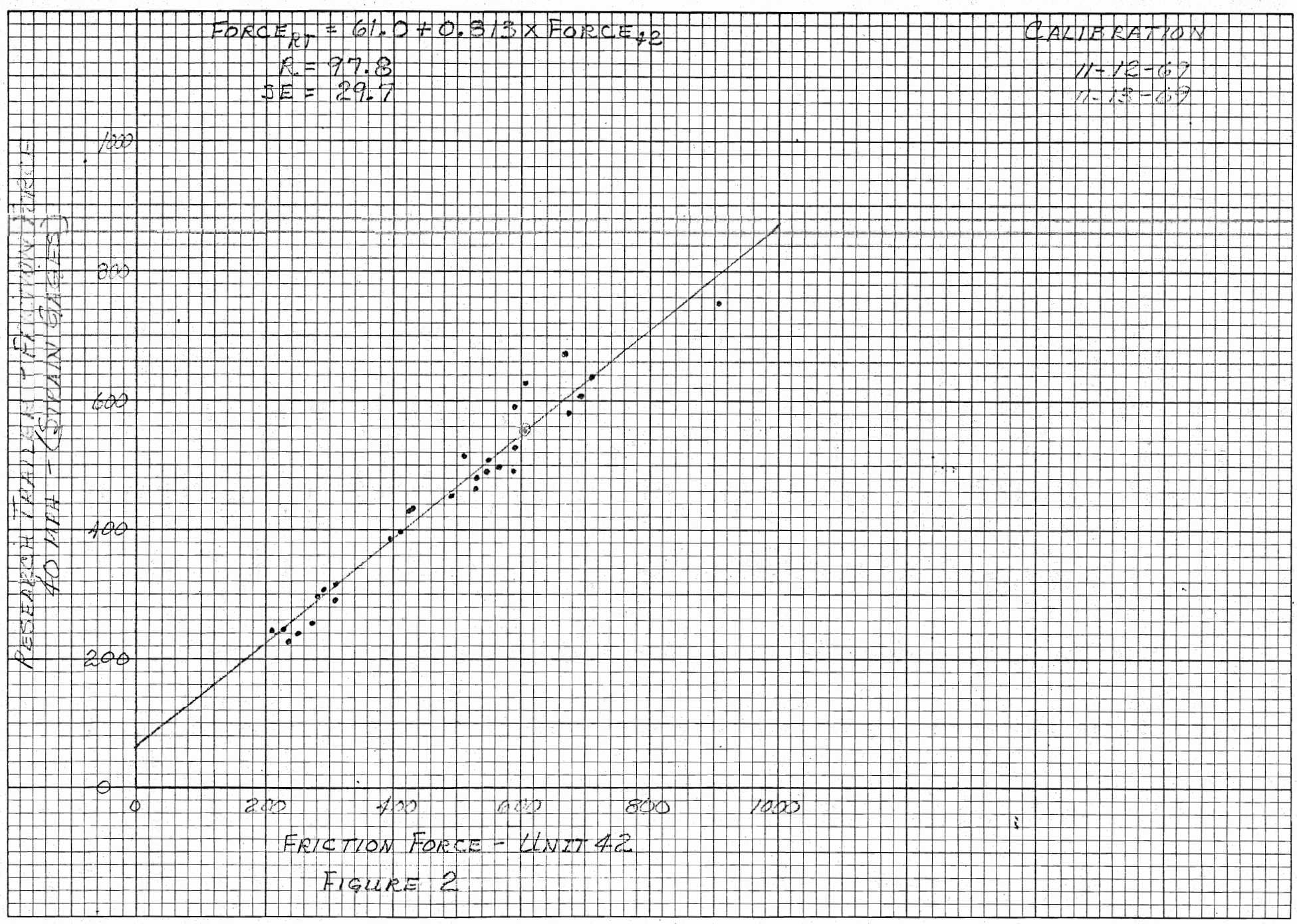

FIGURE 2

NO. 650-10R
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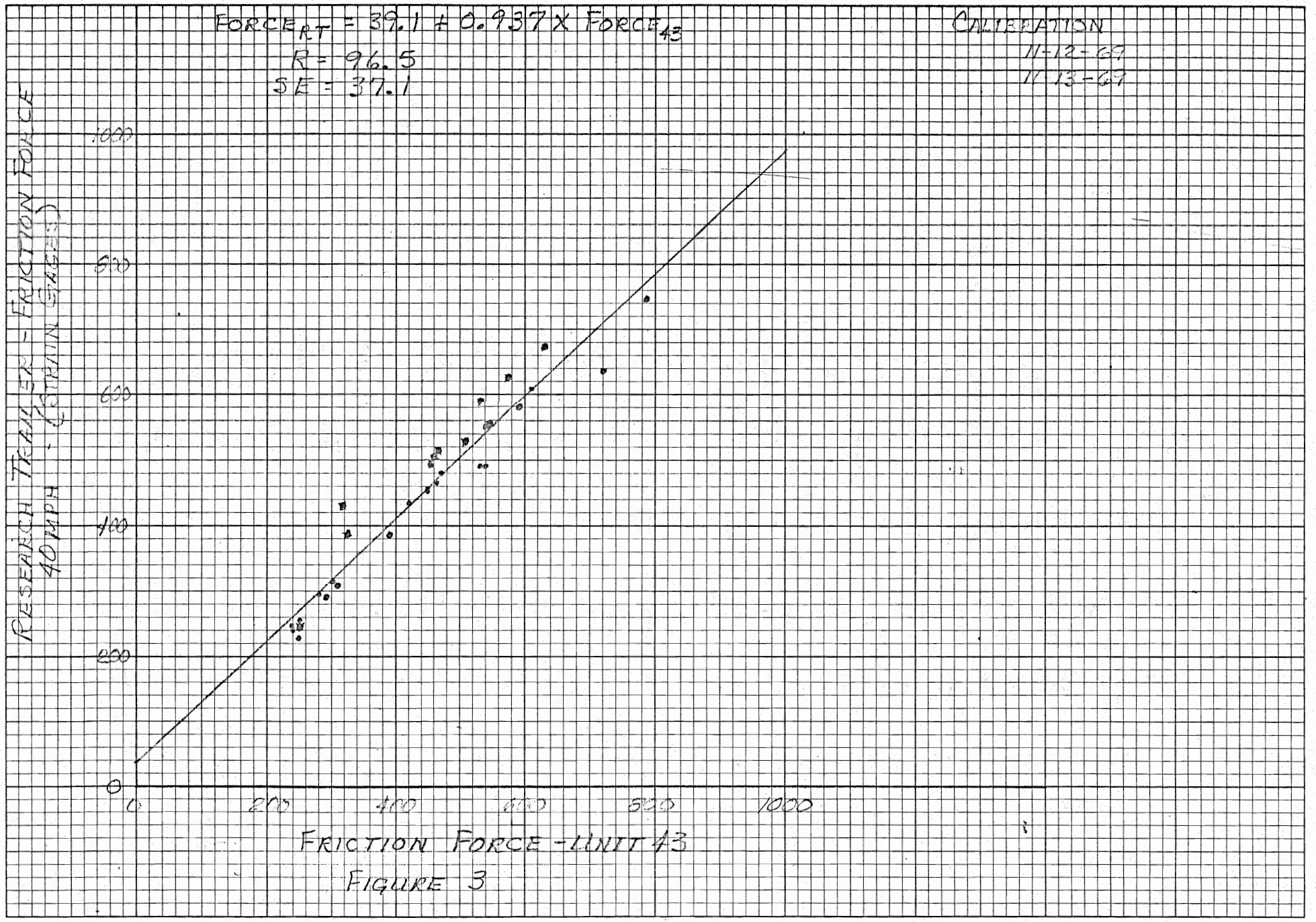

FIGURE 3

TABLE I
SKID TEST TRAILER
CALIBRATION TESTS
NOVEMBER 12 and 13, 1969

Section No.	Unit 4162 Research LVDT	Unit 4162 Research St. Gage	Unit 41 Dist. 5	Unit 42 Dist. 10	Unit 43 Dist. 15
1	332	308	320	290	308
2	712	638	701	710	720
3	522	492	607	584	530
4	450	436	450	430	419
5	317	315	301	305	300
6	542	490	542	545	542
7	600	556	543	602	540
8	250	258	248	274	252
9	294	292	272	308	292
10	290	298	289	280	280
11	500	462	468	534	462
12	232	240	229	252	240
13	412	386	373	398	390
14	704	608	610	696	608
15	254	226	255	238	249
13A	624	580	578	678	594
16	250	246	250	208	238
17	488	456	455	492	452
18	842	754	749	904	784
19	524	480	490	533	469
20	442	398	366	410	322
21	488	430	390	426	316
22	594	528	518	590	508
23	664	590	538	588	532
24	756	676	638	672	632
25	730	628	570	602	574
26	272	244	254	226	256
27	640	554	522	605	543
28	574	516	468	510	465
29	564	496	474	562	456
30	570	506	494	548	460

Sections 1-19 tested Nov. 12, 1969
Sections 20-30 tested Nov. 13, 1969

set disintegrates. The shoes when replaced are only riveted (as v.s. both riveted and bonded. There is no brake cooling system on the trailer (as opposed to a water cooling system on the other 3 trailers).
There have been no problems with the brake backing plate since it has been reinforced.

2. Drag Link
This unit has broken one aluminum drag link and bent two others in the past year of operation. The first drag link installed after the broken link had approximately 1200 skids before bending, the second had approximately 3000 skids the the present drag link has approximately 4000 skids.

3. Water Pump
Foreign matter in the water has scored the water pump and the rubber impeller has been replaced in the District.

4. Electrical
There has been no Recorder or LVDT problems. The operator found a "short" in the manual control toggle switch which ws puzzling until remedied.
There has been problems in testing or even roading in the rain. The operator is forced to dry the plugs receptacles (between the track and trailer) prior to continued operation.

5. Mixcellaneous
The operator reports that a counter has been installed which indicates the number of times the brake has been actuated. He also indicates that the water valves has been greased using Outboard Motor Grease. He has had more down time due to truck maintenance and repair than with trailer problems.

The following comments were offered by the operator of Unit 42 (Mr. Bill Teel):

1. Brake System
There has been problems with the brake shoe arresting post (or pin) which is attached to the backing plate. (This pin takes the full force during the braking action.) The pin has broken two times-once accompained by the disintegration of the brake drum. However, the beefed up backing plate has performed satisfactorilly. Two brake drums have been destroyed (the drum split or cracked at the outer circumference and in line with the axle). To cure the problem with the drum the District has fabricated a ring which was heated and swaged around the circumference of the drum. This has not been on very long but this should beef up the brake drum.

The Tyler unit now uses a 6 volt magnet rather than the original 12 volt system. The operator reports this gives an added magnetic force which can be varied using the reostat originally provided.

The operator also reports more braking problems in hot weather as compared to cold weather operations.

2. Drag Link
This unit has had one broken Drag Link.

3. Water Valve
There has been no problem with the water valves since the initiation of greasing the valves. However, one water valve has been reworked in the District and brushes have been installed in the motor of the valve.

4. Miscellaneous
The operator reports trouble testing in a rain. Water apparently penetrates into the junction box (located on the trailer) and shorts out the wiring.

The following comments were offered by the operator or Unit 43 (Mr. Billy Braddock):

1. Brake System
There has been no brake problems since the installation of the beefed up backing plate in the fall of 1969. (Some 3000 skid miles have been obtained since the installation.)

2. Electrical System
The unit has blown several 1 amp fuses located in the side box of the truck.

It is believed that the fuse is in the primary input to the inverter. No remedial action was taken.

Discussion

Attached for reference are the combined correlation plots of the three friction force correlations that has been obtained since May, 1968 (See Figures 4, 5 & 6). The equations, coefficient of Correlations - R, and the Standard Error of Estimate - SE are given for the three correlation tests. The coefficient of Correlation might be termed a statistical measure of the "goodness of fit" of data points around a line or curve of best fit. A value of 90 or above is considered excellent. The Standard Error of Estimate is a statistical measure of the scatter of data about the line (the larger the number the worst the correlation).

Trailer 41

May 1968; $Force_{RT} = 113.4 + 0.806 \times Force_{41}$

R = 97.3
Se = 25.2

Dec. 1968; $Force_{RT} = 75.5 + 0.826 \times Force_{41}$

R = 96.2
SE = 29.4

(A) Nov. 1969; $Force_{RT} = 18.8 + 0.967 \times Force_{41}$

R = 97.0
SE = 34.5

Trailer 42

May 1968; $Force_{RT} = 68.8 + 0.828 \times Force_{42}$

R = 98.2
SE = 20.3

Dec. 1968; $Force_{RT} = 119.0 + 0.728 \times Force_{42}$

R = 96.0
SE = 30.1

(A) Nov. 1969; $Force_{RT} = 61.0 + 0.813 \times Force_{42}$

R = 97.8
SE = 29.7

Trailer 43

May 1968; $Force_{RT} = 60.1 + 0.729 \times Force_{43}$

R = 97.7
SE = 22.8

Dec. 1968; $Force_{RT} = 90.2 + 0.816 \times Force_{43}$

R = 94.9
SE = 33.8

(A) Nov. 1969; $Force_{RT} = 39.1 + 0.937 \times Force_{43}$

R = 96.5
SE = 37.1

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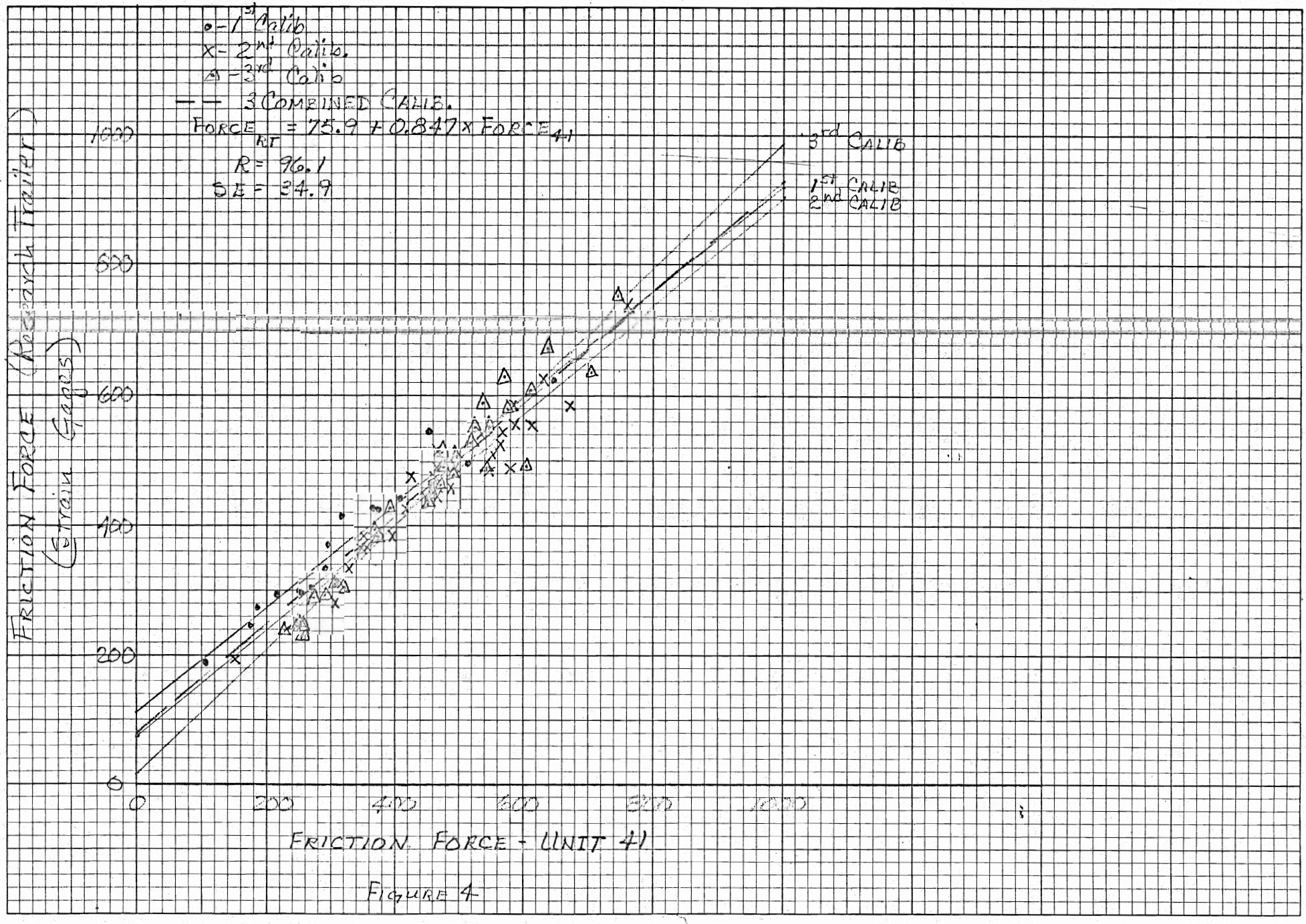

FIGURE 4

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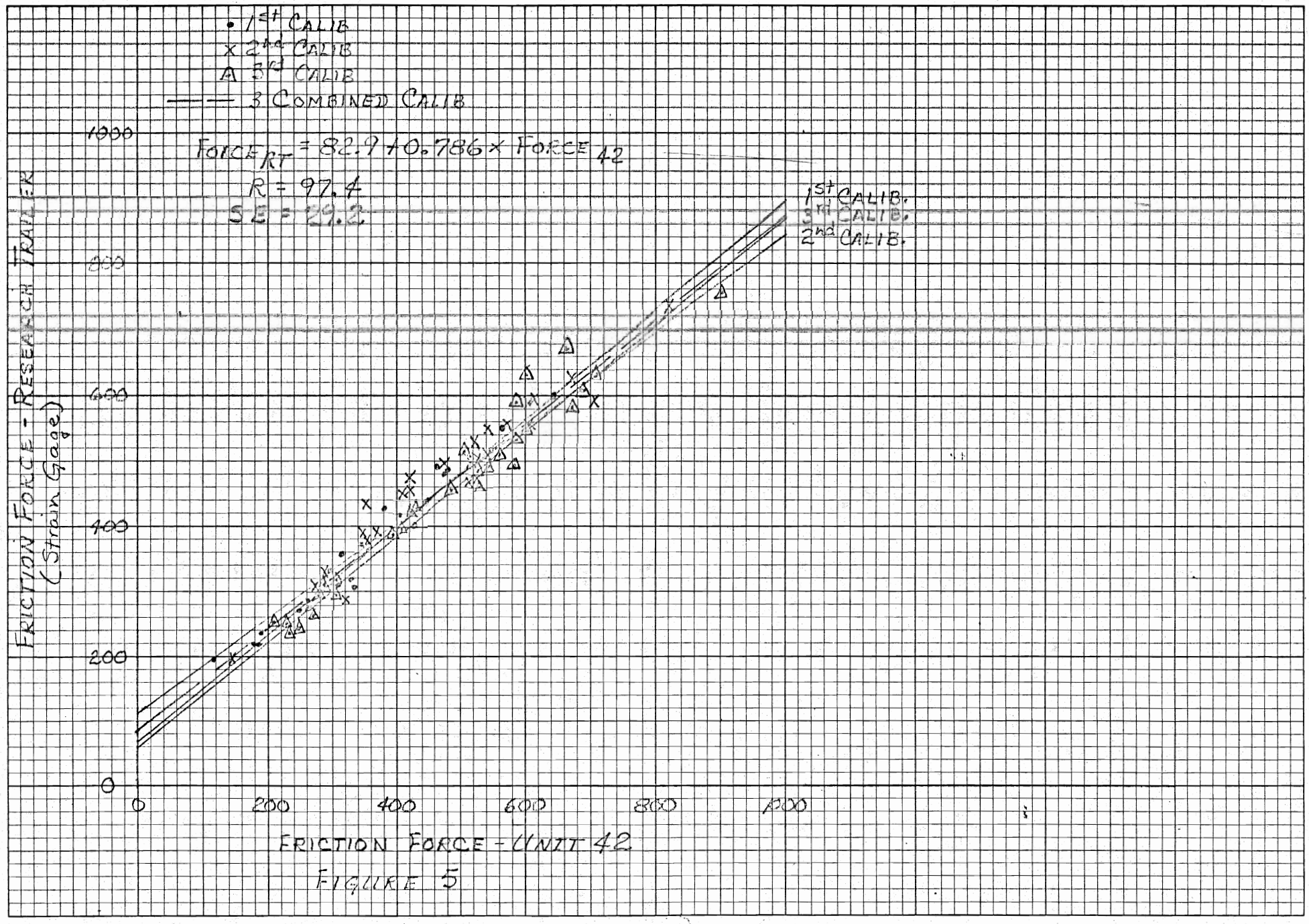

FIGURE 5

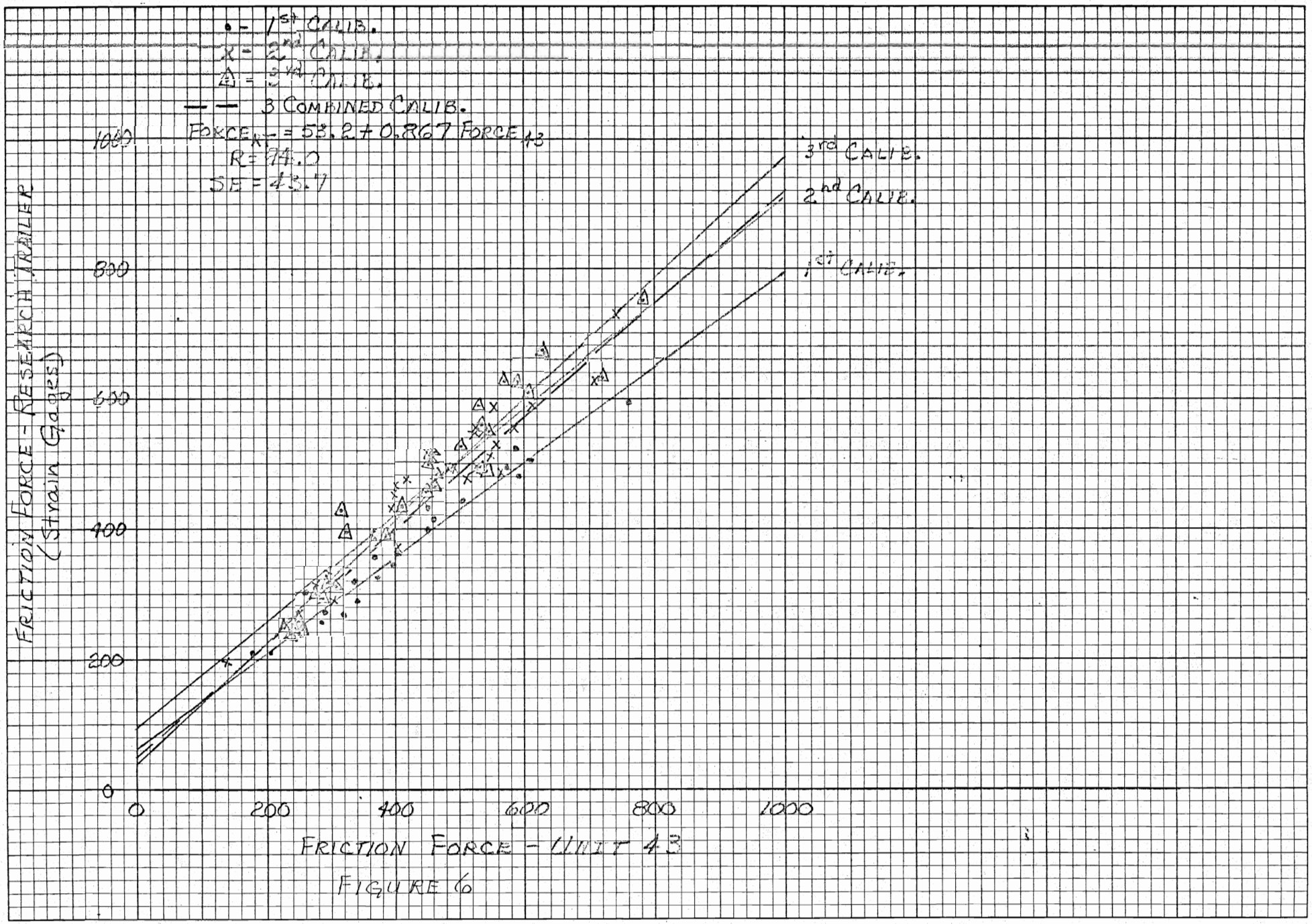

FIGURE 6

We note that two of the three trailers have slopes of the correlation line which are increasing with each calibration (that is: $0.806 < 0.826 < 0.967$ for trailer 41). Also in two of the three trailers the scatter about the line is continuing to increase (that is: SE = 25.2 < SE = 29.4 < SE = 34.5). We have not been concerned about the slopes of the correlation line because we believed they should be around 0.8 with the Maintenance trailers reading higher than the Research Trailer. The reasoning here is because of the difference in force measuring instrumentation. After the third calibration test we find that two trailers have rather large slopes (0.967 and 0.937). This fact is beginning to be disturbing.

The increase in scatter about the line is also disturbing. We would have thought that the scatter would be mainly due to the fact that the trailers cannot skid in the same spot (That is, one or the other would be positioned slightly transverse longitudinally along the road from the others at the time of skid and there are large differences in friction within 2 to 3 feet of a given area.) It would seem that the scatter would become slightly better chronologically because the operators would be more familiar with the equipment and could better skid on a given spot on the pavement. Instead, the scatter has worsened indicating that it may be associated with equipment wear. However we still feel that much of the scatter must be due to the trailer positioning in attempting to skid on the same spot.

The relationship of all three calibrations lumped together for each trailer is as follows: (see Figures 4, 5 & 6)

Trailer 41:

(B) $\text{Force}_{RT} = 75.9 + 0.847 \times \text{Force}_{41}$

$R = 96.1$

$SE = 34.9$

Trailer 42:

(B) $\text{Force}_{RT}\ 82.9 + 0.786 \times \text{Force}_{42}$

$R = 97.4$

$SE = 29.2$

Trailer 43:

(B) $\text{Force}_{RT} = 53.2 + 0.867 \times \text{Force}_{43}$

$R = 94.0$

$SE = 43.7$

Figure 7 is the information of all calibrations performed on all trailers lumped into one plot. It was originally believed that the relationship in this plot would become the general equation for use (see equation C below), changing only when a trailer (when correlated in the future) indicated a marked or significant difference. Presently, either the set of equations marked A, B or C as follows could be used in the computer program.

(C) All Trailers

$\text{Force}_{RT} = 74.1 + 0.826$ Force (any Maintenance Trailer)

$R = 95.3$

$SE = 38.9$

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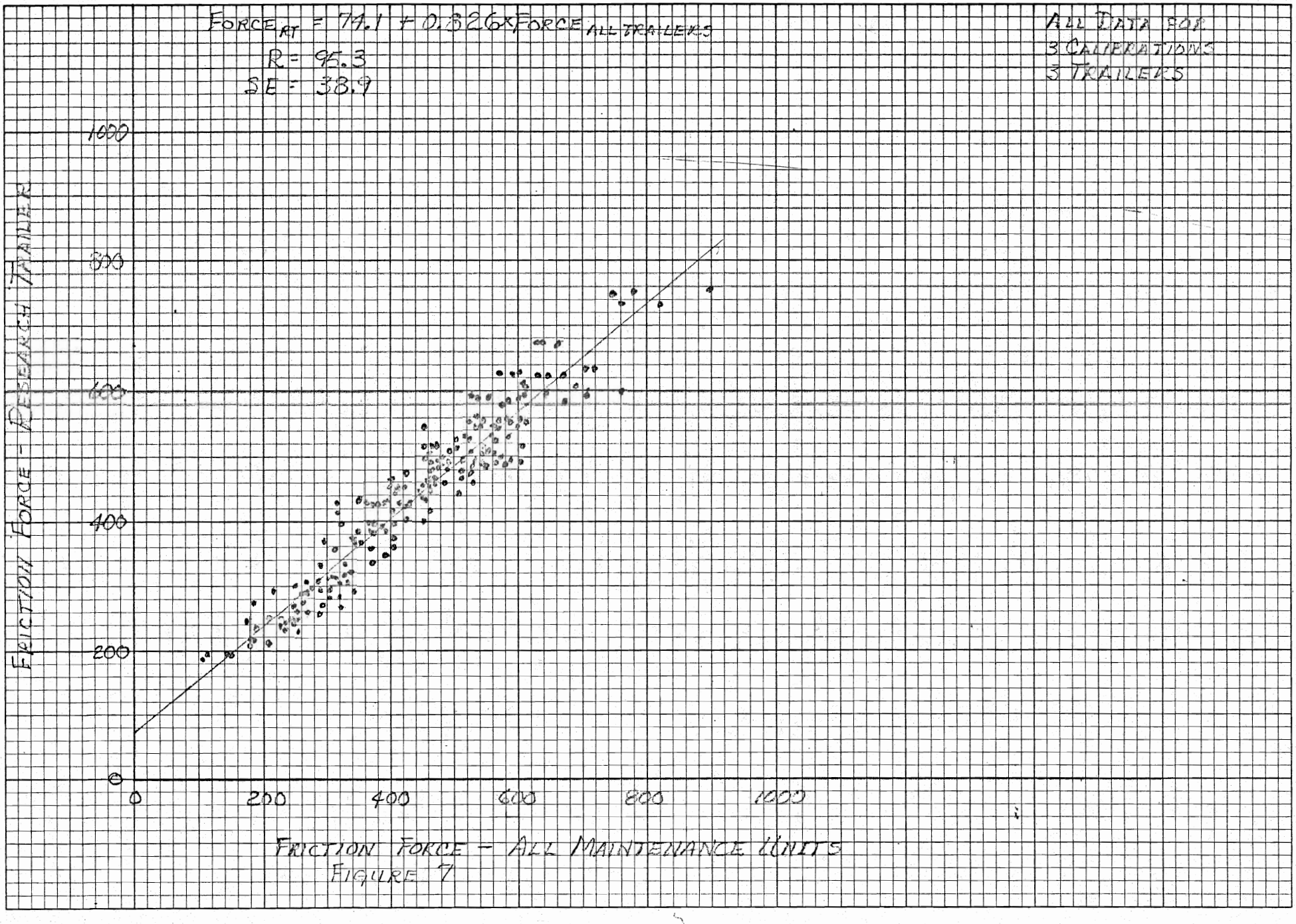

FRICTION FORCE - ALL MAINTENANCE UNITS
FIGURE 7

Presently, the decision was made to use the equations marked B.

The primary problems in maintaining the trailer still seem to be the brakes and especially the brake shoes. Attempts will be made to secure the aluminum brake shoes for the trailers. These seem to work well on the Research Tow Truck, having prevented the problem of brake fade on the truck. We would recommend that Unit 41 try the bonded as well as riveted brake shoe. Efforts will also be made to study the disk brake to determine if this type of brake could be adapted to the trailer.

There has been excessive trouble with the Drag Link during the past year. When a Drag Link is changed there is the possibility that the calibration between trailers will change. That is, one Drag Link could be milled to a slightly thinner or thicker section than another Drag Link or the characteristics of the metal may be different. We would grant that the calibration with the proving ring (generally performed at half day intervals) should allow the operator to reset the recorder to read correctly. But, generally the recorder is set to read a 500 pound force correctly with little emphasis given to the values in the higher or lower ranges. With the recorders being used, there would be no way to correct the higher or lower variation. This type of correction in made in the acutal force calibration equation.

There has been a suggestion from File D-18 to study the replacement of the present drag links with a more flexible drag link. This will be attempted. Also, attempts will be made to study the use of a LVDT with a smaller stroke. Both items will provide more elctric power to the recorder (for a given friction force) as compared to the present system. By these changes we would hope to provide a more accurate reading and therefore reduce the apparently increasing scatter.

Tables II and III reveal a comparison of the second and third calibrations and the differences found. Note that several of the sections have apparently increased in friction values. Since in several cases all four trailers indicate an increase on sections other than the resurfaced this proves the fact that pavements can increase in friction. However, we note this occurs mainly on the TTI sections which receive little or no traffic. This increase would therefore appear to be due to weathering coupled with small traffic volumes, but there could be other reasons.

Figure 8 is a plot of the two force measuring systems on the same (Research) trailer. One of the systems is a LVDT similar to the instrumentation installed on the Maintenance Trailers. The scatter in this plot is very small. In general, there is no point that exceeds 20 pounds and this is as accurately as the friction force can be read from the recorder strip chart. This gives added emphasis to the above statement that most of the scatter between trailers in Figures 1, 2 and 3 must be due to the inability to skid exactly on the same spot.

Figures 9 and 10 are plots indicating the relationship of the Maintenance Trailers.

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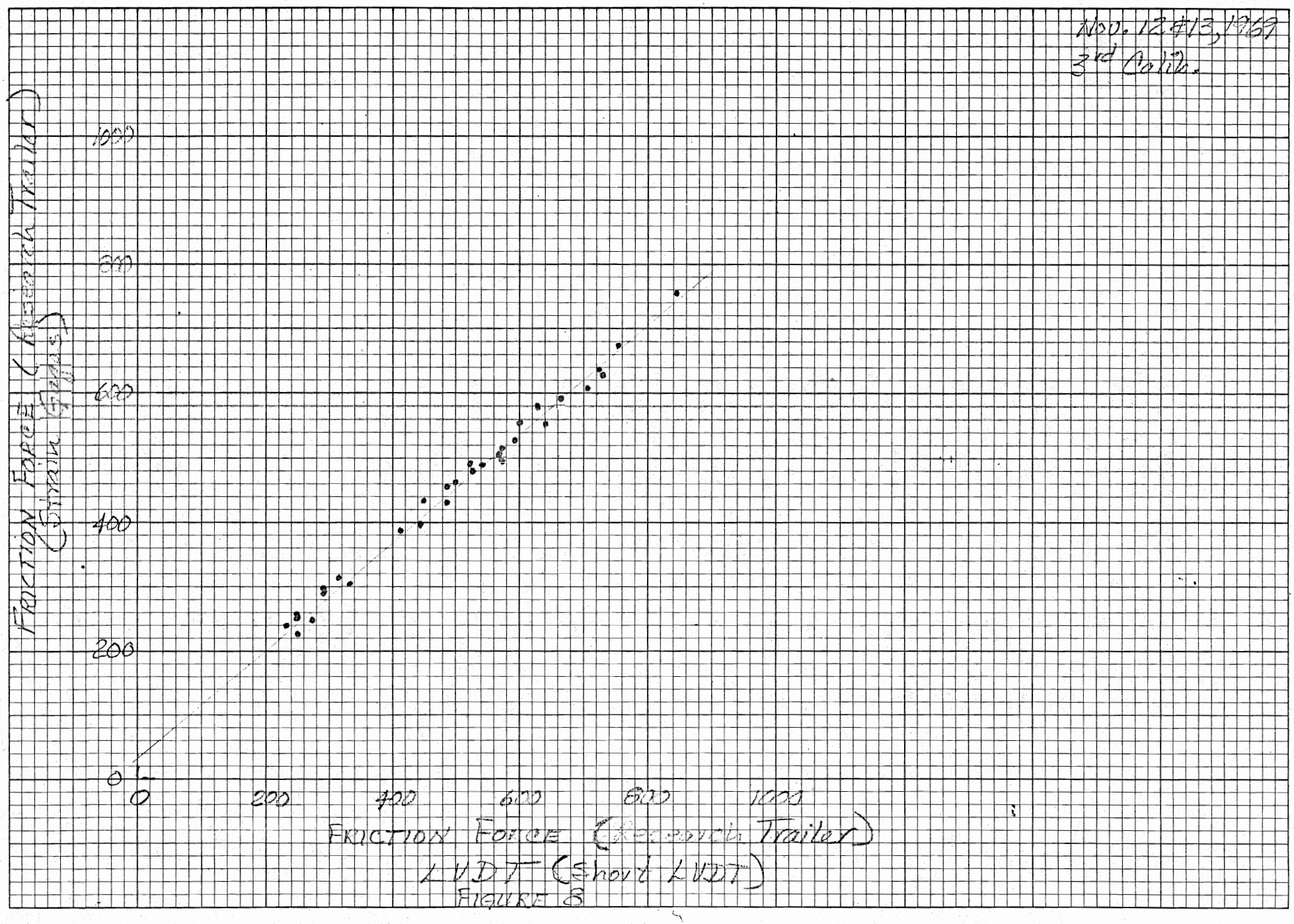

FIGURE 8

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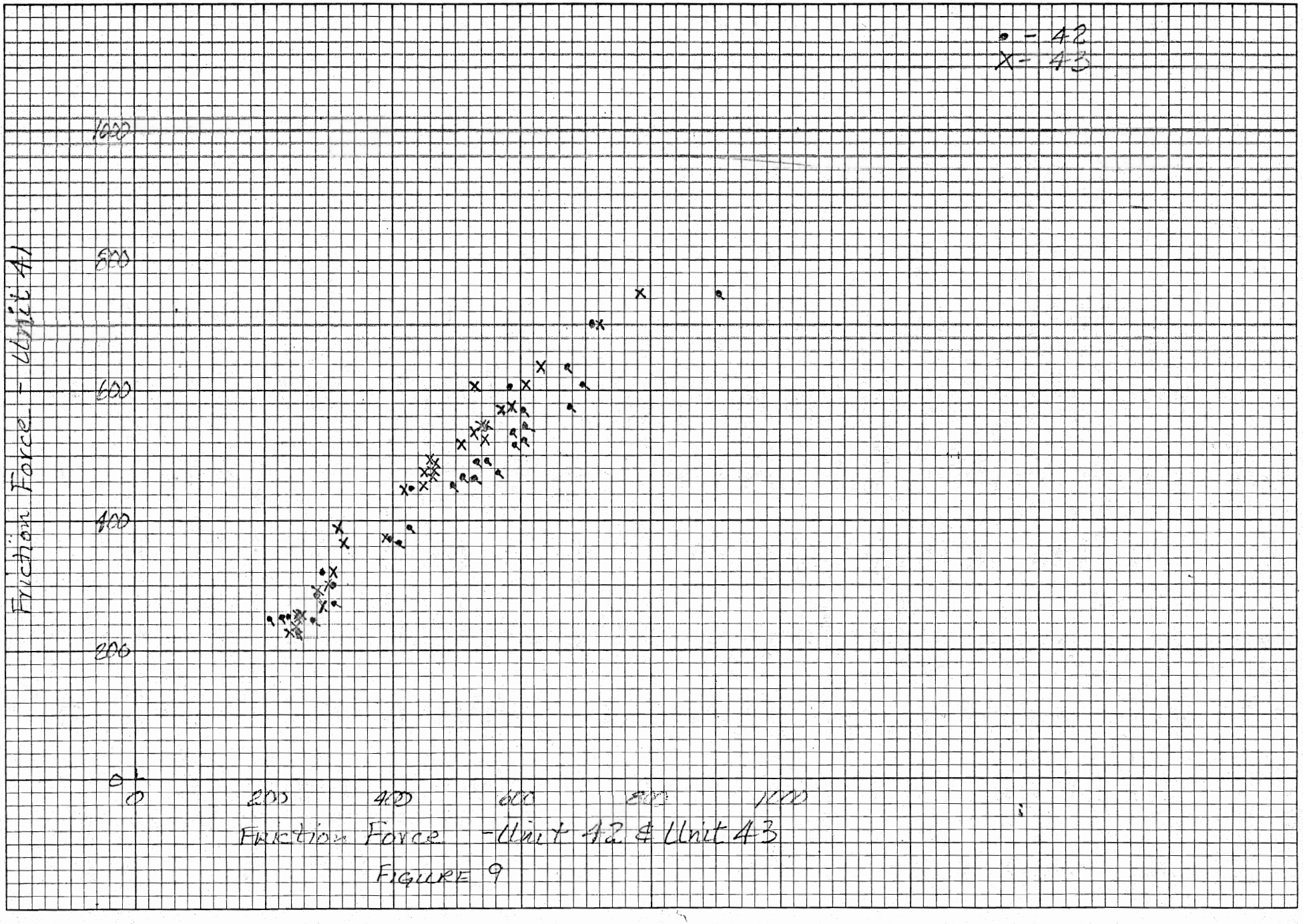
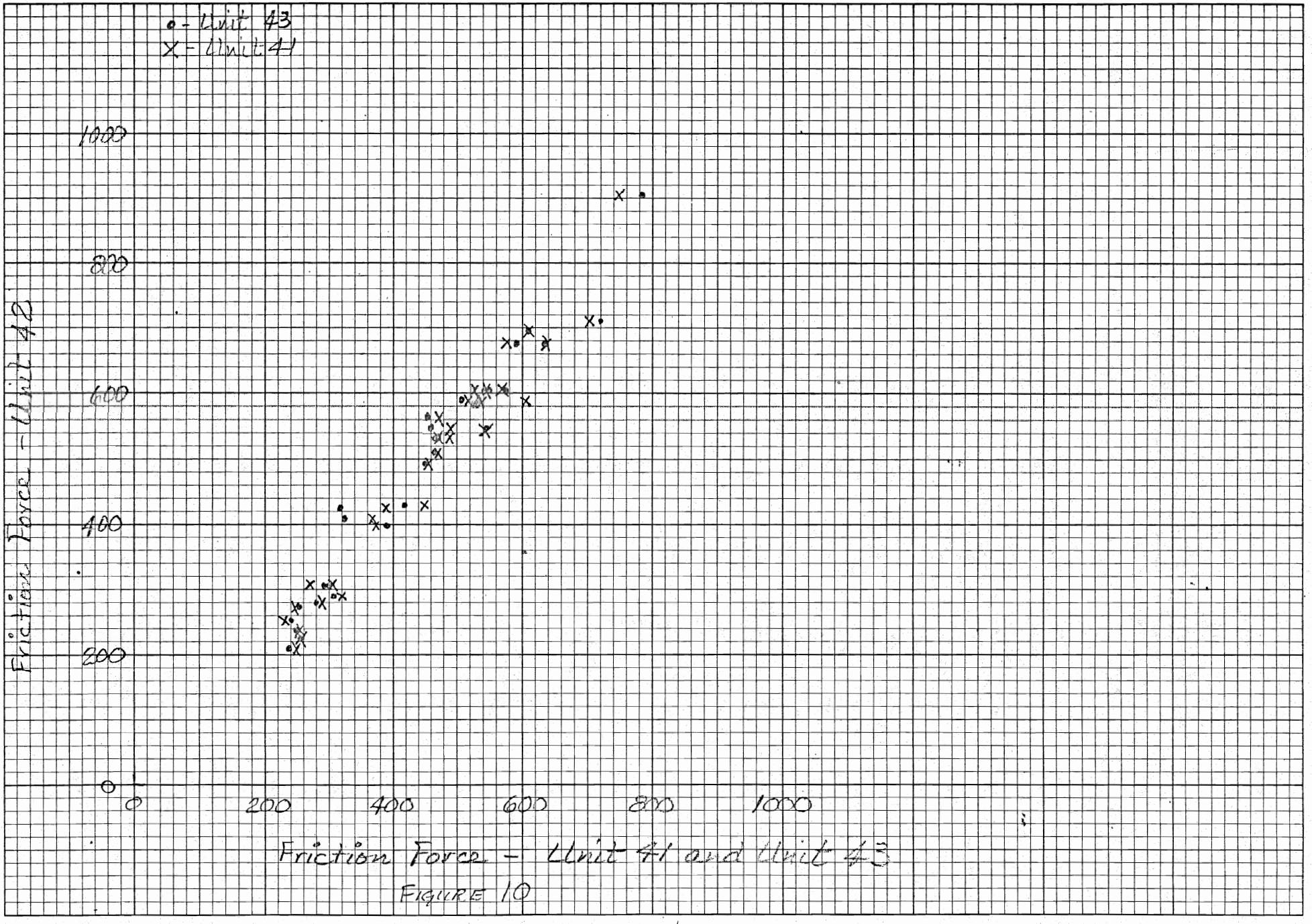


Friction Force - Unit 42 & Unit 43

FIGURE 9



Friction Force - Unit 41 and Unit 43

FIGURE 10

TABLE II

SKID TEST TRAILER
CALIBRATION TESTS
COMPARISON BETWEEN 2nd AND 3rd CALIBRATIONS

Section No.		Unit 4162 - Research				Unit 41 - District 5		
3rd Run	2nd Run	2nd Calib.	3rd Calib.	Diff.		2nd Calib.	3rd Calib.	Diff.
1	1	445	308	-137		444	320	-124
2	2	497	638	+141	Resurfaced	494	701	+207
3	3	428	492	+ 64	Resurfaced	416	607	+191
4	4	558	436	-122		612	450	-162
5	5	335	315	- 20		328	301	- 27
6	6	526	490	- 36		566	542	- 24
7	7	588	556	- 32		588	543	- 45
9	8	388	292	- 96		394	272	-122
10	9	370	298	- 72		356	289	- 67
11	10	544	462	- 82		532	468	- 64
12	11	368	240	-128		344	229	-115
13	12	478	386	- 92		422	373	- 49
14	13	624	608	- 16		632	610	- 22
	14	314				316		
15	15	282	226	- 56		304	255	- 49
16	16	384	246	-138		350	250	-100
17	17	496	456	- 40		462	455	- 7
18	18	468	753	+286	Resurfaced	466	749	+283
19	19	513	480	- 33		464	490	+ 26
20	20	450	398	- 52		462	366	- 96
21	21	738	430	-308		760	390	-370
22	22	556	528	- 28		588	518	- 70
23	23	460	590	+130		485	538	+ 53
24	24	585	676	+ 91		675	638	- 37
25	25	475	628	+153		460	570	+110
26	26	195	244	+ 49		154	254	+100
27	27	545	554	+ 9		570	522	- 48
28	28	510	516	+ 6		555	468	- 87
29	29	485	496	+ 11		550	474	- 76
30	30	490	506	+ 16		580	494	- 86
8			258				248	
13A			580				578	

TABLE II - CONT.

Section No.		Unit 42 District 10				Unit 43 - District 15		
3rd	2nd	2nd Calib	3rd Calib.	Diff.		2nd Calib	3rd Calib.	Diff.
1	1	418	290	-128		444	308	-136
2	2	478	710	+232	Resurfaced	487	720	+233
3	3	354	584	+230	Resurfaced	394	530	+136
4	4	573	430	-143		588	419	-169
5	5	292	305	+ 13		304	300	- 4
6	6	524	545	+ 21		560	542	- 18
7	7	614	602	- 12		616	540	- 76
9	8	380	308	- 72		396	292	-104
10	9	360	280	- 80		406.	280	-126
11	10	546	534	- 12		522	462	- 60
12	11	350	252	- 98		342	240	-102
13	12	425	398	- 27		420	390	- 30
14	13	674	696	+ 22		712	608	-104
	14	278				280		
15	15	312	238	- 74		308	249	- 59
16	16	350	208	-142		362	238	-124
17	17	518	492	- 26		496	452	- 44
18	18	520	904	+384	Resurfaced	402	784	+382
19	19	525	533	+ 8		456	469	+ 13
20	20	426	410	- 16		400	322	- 78
21	21	826	426	-400		740	316	-424
22	22	606	590	- 16		526	508	- 18
23	23	455	588	+133		403	532	+129
24	24	715	672	- 43		558	632	+ 74
25	25	530	602	+ 72		512	574	+ 62
26	26	144	226	+ 82		140	256	+116
27	27	610	605	- 5		542	543	+ 1
28	28	542	510	- 32		546	465	- 81
29	29	608	562	- 46		564	456	-108
30	30	513	548	+ 35		534	460	- 74
8			274				252	
13A			678				594	

TABLE III
SKID TEST TRAILER CALIBRATION TESTS (11-12 & 12-69)

DIFFERENTIAL (2nd & 3rd)

Section No.	4162-D	Unit #41	Unit#42	Unit #43
1	- 137	- 124	- 128	- 136
2	+ 141	+ 207	+ 232	+ 233
3	+ 64	+ 191	+ 230	+ 136
4	- 122	- 162	- 143	- 169
5	- 20	- 27	+ 13	- 4
6	- 36	- 24	+ 21	- 18
7	- 32	- 45	- 12	- 76
8				
9	- 96	- 122	- 72	- 104
10	- 72	- 67	- 80	- 126
11	- 82	- 64	- 12	- 60
12	- 128	- 115	- 98	- 102
13	- 92	- 49	- 27	- 30
14	- 16	- 22	+ 22	- 104
15	- 56	- 49	- 74	- 59
16	- 138	- 100	- 142	- 124
17	- 40	- 7	- 26	- 44
18	+ 286	+ 283	+ 384	+ 382
19	- 33	+ 26	+ 8	+ 13
20	- 52	- 96	- 16	- 78
21	- 308	-370	- 400	- 424
22	- 28	- 70	- 16	- 18
23	+ 130	+ 53	+ 133	+ 129
24	+ 91	- 37	- 43	+ 74
25	+ 153	+ 110	+ 72	+ 62
26	+ 49	+ 100	+ 82	+ 116
27	+ 9	- 48	- 5	+ 1
28	+ 6	- 87	- 32	- 81
29	+ 11	- 76	- 46	- 108
30	+ 16	- 86	+ 35	- 74

TEST SECTIONS - 11/12/69

1. Balcones Drive (NB) - Approximately 300' No. of Northland Drive
2. US 183 - Shoulder (NB) - 1st. Crossover past Dills Outlet
   *RESURFACED
3. US 183 Travis Co. (NB) - Outside Lane Approximately 0.2 Mi. No. Bell Drive
   *RESURFACED
4. US 183 Williamson Co. (NB) - Outside Lane at Mc Neil Road.
5. FM 1431 (WB) - Just past RR crossing
6. Mc Neil Road (EB) - Approximately 1 Mile E of US 183
7. FM 1325 (NB) - Inside Lane at Howard Lane
8. Howard Lane (WB) - Approximately 0.5 Mi. W. of FM 1325
9. IH 35 (SB) - Outside Lane approximately 1 Mi. South FM 1325 at Downtowner Motor Inn Sign
10. US 81 Business Rt. (SB) - Inside lane approximately 200' So. Braker Lane
11. IH 35 (SB) - Outside lane just So. of St. Johns Overpass
12. US 183 (NB) - Outside lane at W. End Walnut Creek Bridge
13. Cameron Rd. (NB) - Just No. of Rundberg Lane

13A - Cameron Rd. (SB) - Just So. of Infotronics Driveway

14. FM 1100 (NB) - Approximately 0.5 Mi. No. of US 290 at Culvert
15. SH 95 (NB) - Approximately 1.5 M.S. of US 290
16. US 290 (WB) - Approximately 0.6 Mi. E. of Giddings across from Drive in Theatre
17. US 77 (NB) - Approximately 1.4 Mi. So. of Giddings
    Approximately 2.5 Mi. So. of US 290
    Just So. of Co. Rd.
18. US 77 (NB) - Approximately 1.3 Mi. No. of Giddings
    Approximately 2.1 Mi. No. of US 290
    Just No. of end of 4 Lane Section

    *Resurfaced & widened to 4 lane - Just No. of MBC

19. SH 21 (NB) - Approx. 0.3 Mi. No. of Yegua Creek Bridge
20. FM 50 (NWB) - Approximately 1 Mi. SE of SH 21
21. OSR (SB) - Approximately 0.5 Mi. So. of FM 1687
22. FM 1687 (EB) - Approximately 4.0 Mi. E. of OSR
23. TTI - Pad # 1
24. TTI - Pad # 3
25. TTI - Pad # 2
26. TTI - Pad # 4
27. TTI - Bus Pad # 1 (Most Easterly)
28. TTI - Bus Pad # 2
29. TTI - Pad # 5 - Concrete
30. TTI - Concrete Curve