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Development of A Test Method and Specifications for the Evaluation of the Fatigue Life of Luminaires

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16. ABSTRACT

Recent fatigue failures of luminaire slipfitter connectors which secure luminaire heads to luminaire arms have resulted from excessive traffic-induced vibrations of bridge-mounted lighting standards. This research study was undertaken to (1) determine fatigue lives of slipfitter connectors for commonly used luminaires, and (2) develop a test method and specifications for evaluating such luminaires. Three luminaires of each three major manufactures, American Electric, General Electric, and Hubbell Lighting were tested under cyclic loading at various "g" levels to failure or 2 million cycles. Clamping brackets of each manufacturer were also tested to determine the amount of permanent set which would result from a typical installation.

It is recommended that where bridge-mounted luminaires are experiencing a fatigue problem, their internal ballast should be removed and a remote ballast installed, and a specification be adopted which requires:

(1) Luminaires to be fatigue tested under cyclic loading. They must satisfy the following, without failure of mounting bolts, brackets, or luminaire housing:

a) a minimum acceleration level of 3.0 g's peak-to-peak (or 1.5 g's peak) in the vertical direction for 2 million cycles with their internal ballast removed, and

b) a minimum acceleration level of 1.0 g's peak-to-peak (or 0.75 g's peak) in the horizontal direction (parallel to traffic flow) for 2 million cycles with their internal ballast installed.

(2) Slipfitter mounting bracket of luminaires not to develop a permanent set in excess of 0.020 inch when mounting cap screws are tightened to a torque of 10 foot-pounds.

17. KEYWORDS
Fatigue life of luminaires, slipfitter connectors, bridge-mounted luminaires, vibration testing, fatigue tests, traffic-induced vibrations, clamping brackets, cyclic loading luminaires

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STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF FACILITIES CONSTRUCTION
OFFICE OF TRANSPORTATION LABORATORY

DEVELOPMENT OF A TEST METHOD AND SPECIFICATION FOR THE EVALUATION OF THE FATIGUE LIFE OF LUMINAIRES

Study Made by . . . . . .Structural Materials Branch

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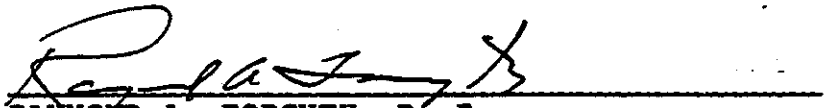
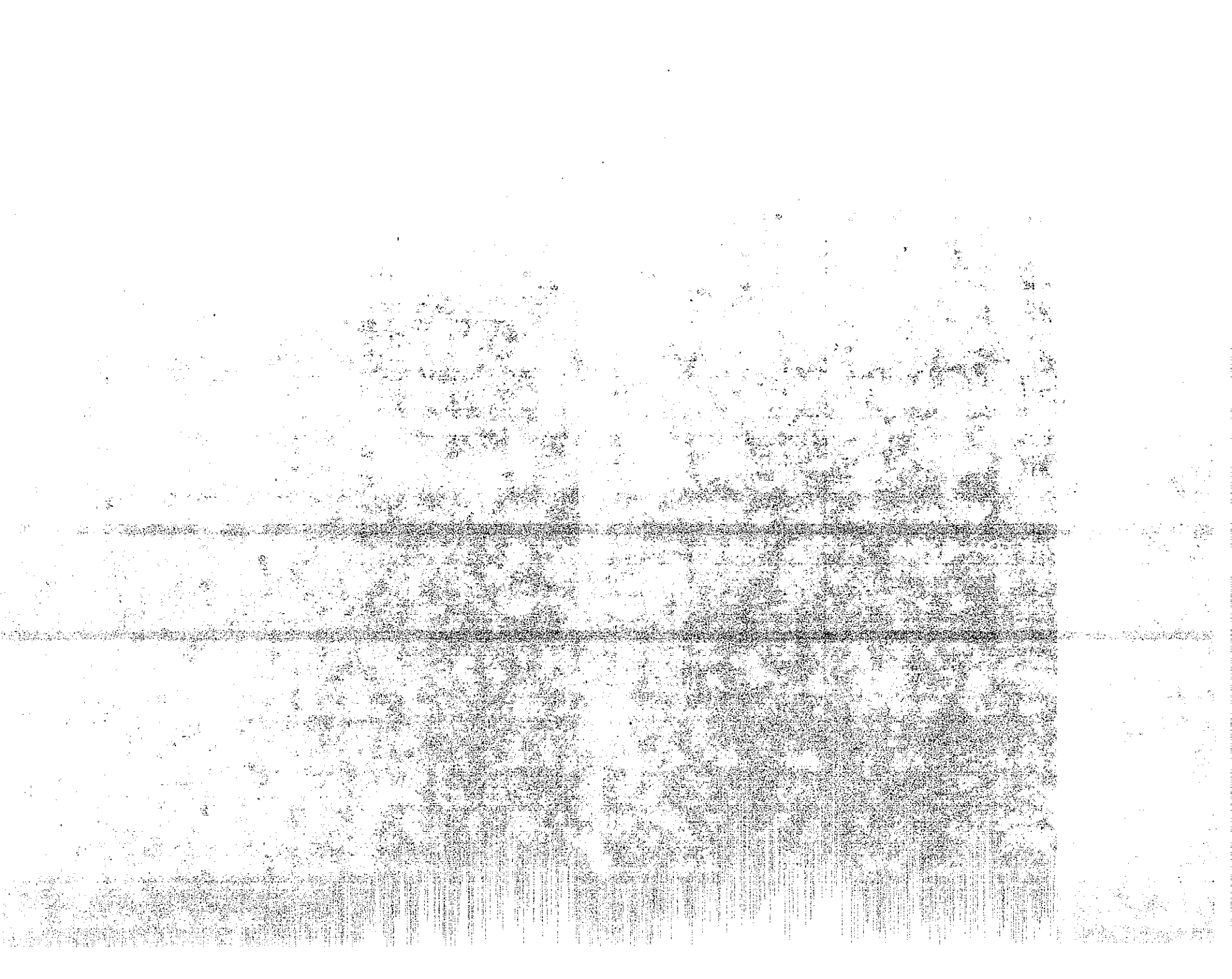
Report Prepared by. . . . . Aspet Ordoubigian, P.E.

APPROVED:



RAYMOND A. FORSYTH, P. E.
Chief, Office of Transportation Laboratory



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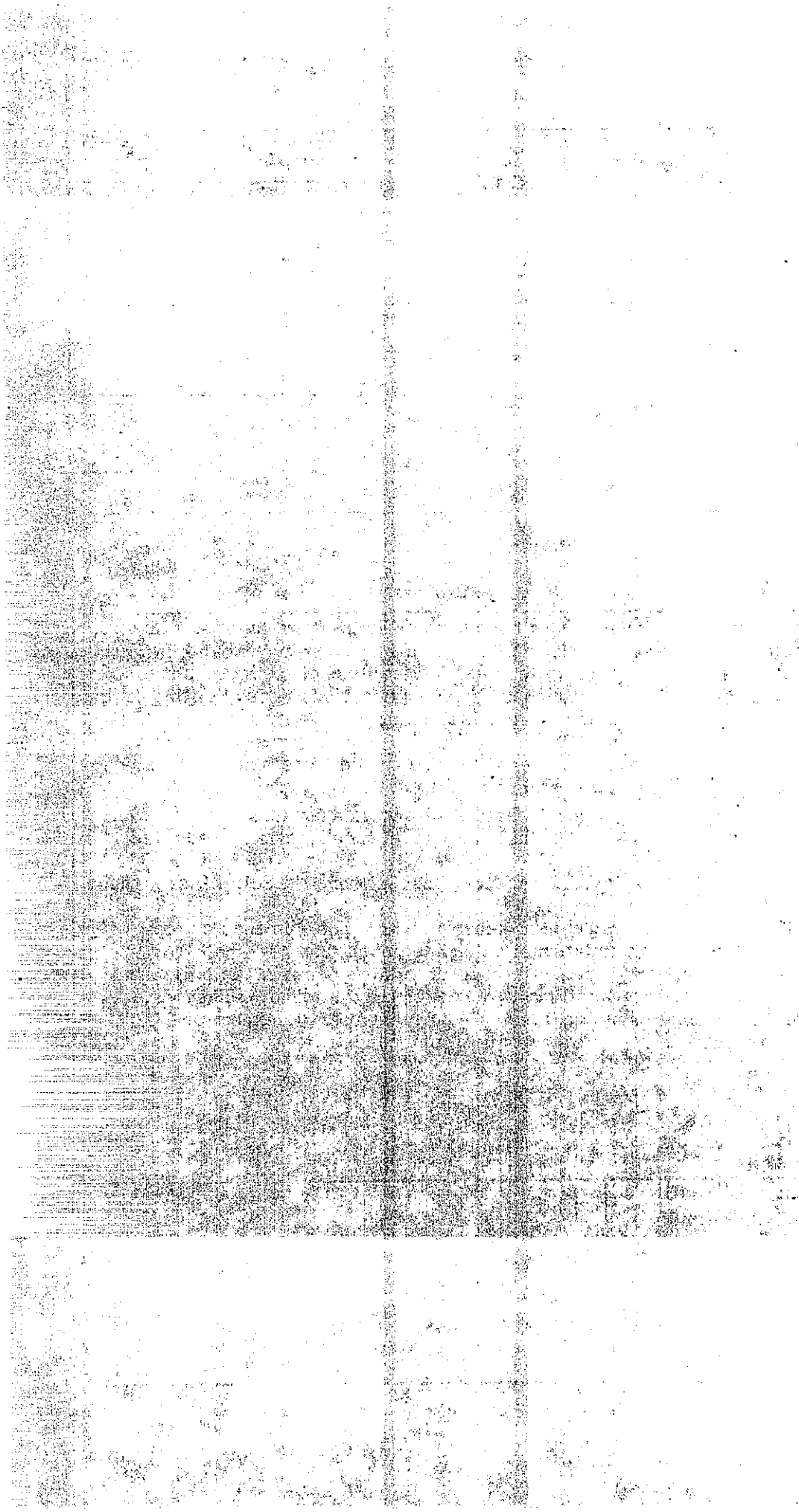

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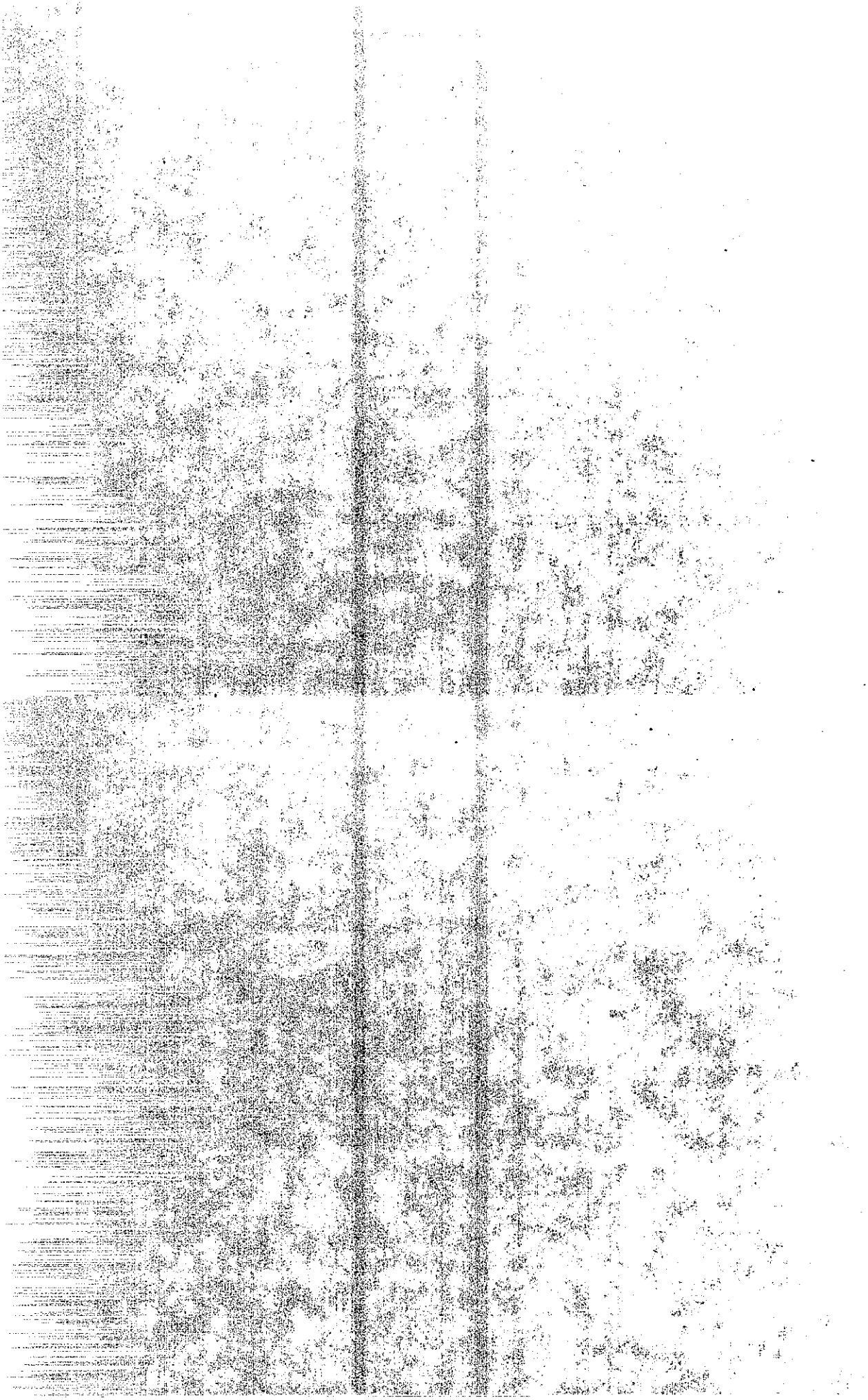
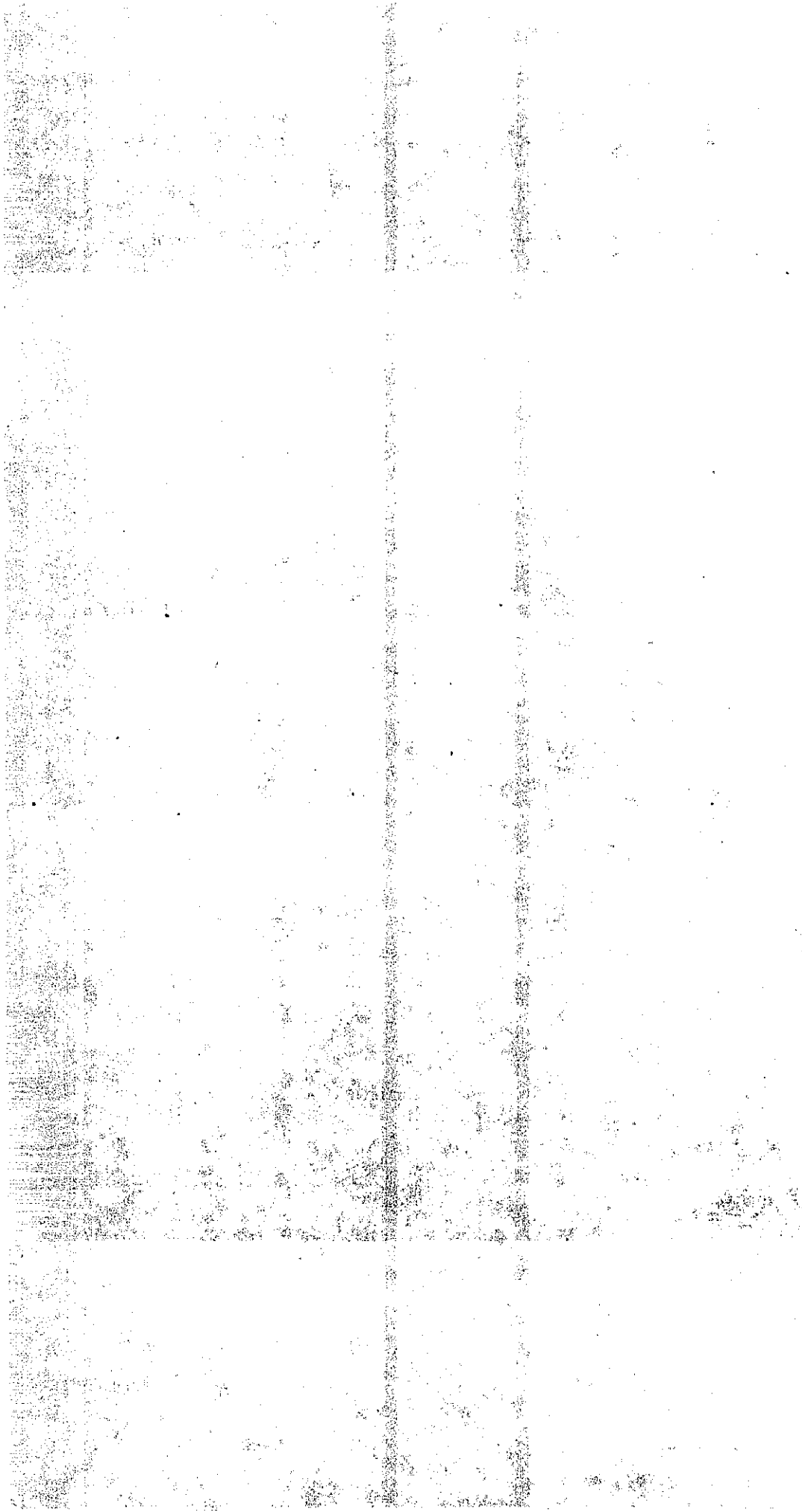


CONVERSION FACTORS

English to Metric System (SI) of Measurement

Quality	English unit	Multiply by	To get metric equivalent
Length	inches (in)or(")	25.40	millimetres (mm)
		.02540	metres (m)
	feet (ft)or(')	.3048	metres (m)
	miles (mi)	1.609	kilometres (km)
Area	square inches (in^2)	6.432×10^{-4}	square metres (m^2)
	square feet (ft^2)	.09290	square metres (m^2)
	acres	.4047	hectares (ha)
Volume	gallons (gal)	3.785	litre (l)
	cubic feet (ft^3)	.02832	cubic metres (m^3)
	cubic years (yd^3)	.7646	cubic metres (m^3)
Volume/Time (Flow)	cubic feet per second (ft^3/s	28.317	litres per second l/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
Mass	pounds (lb)	.4536	kilograms (kg)
Velocity	miles per hour (mph)	.4470	metres per second (m/s)
	feet per second (fps)	.3048	metres per second (m/s)
Acceleration	feet per second squared (ft/s^2)	.3048	metres per second squared (m/s^2)
	acceleration due to force of gravity (G) (ft/s^2)	9.807	metres per second squared (m/s^2)
Density	(lb/ft^3)	16.02	kilograms per cubic metre (kg/m^3)
Force	pounds (lbs)	4.448	newtons (N)
	(1000 lbs) kips	4448	newtons (N)
Thermal Energy	British termal unit (BTU)	1055	joules (J)
Mechanical Energy	foot-pounds (ft-lb)	1.356	joules (J)
	foot-kips (ft-k)	1356	joules (J)
Bending Moment or Torque	inch-pounds (in-lbs)	.1130	newton-metres (Nm)
	foot-pounds (ft-lbs)	1.356	newton-metres (Nm)
Pressure	pounds per square inch (psi)	6895	pascals (Pa)
	pounds per square foot (psf)	47.88	pascals (Pa)
Stress Intensity	kips per square inch square root inch ($ksi\sqrt{in}$)	1.0988	mega pascals$\sqrt{metre}$ ($MPa\sqrt{m}$)
	pounds per square inch square root inch ($psi\sqrt{in}$)	1.0988	kilo pascals$\sqrt{metre}$ ($KPa\sqrt{m}$)
Plane Angle	degrees (°)	0.0175	radians (rad)
Temperature	degrees fahrenheit (F)	$\frac{+F - 32}{1.8} = +C$	degrees celsius (°C)



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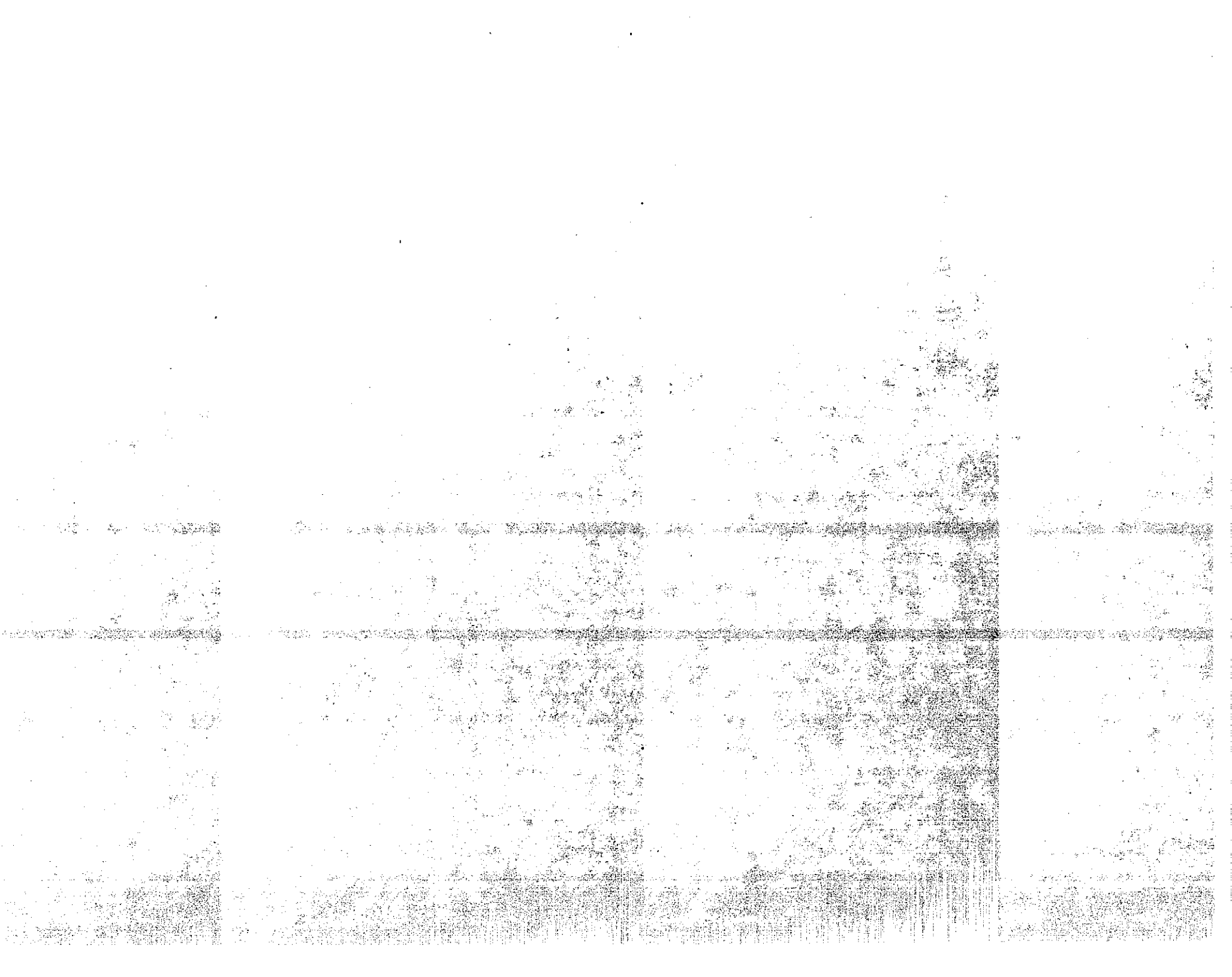

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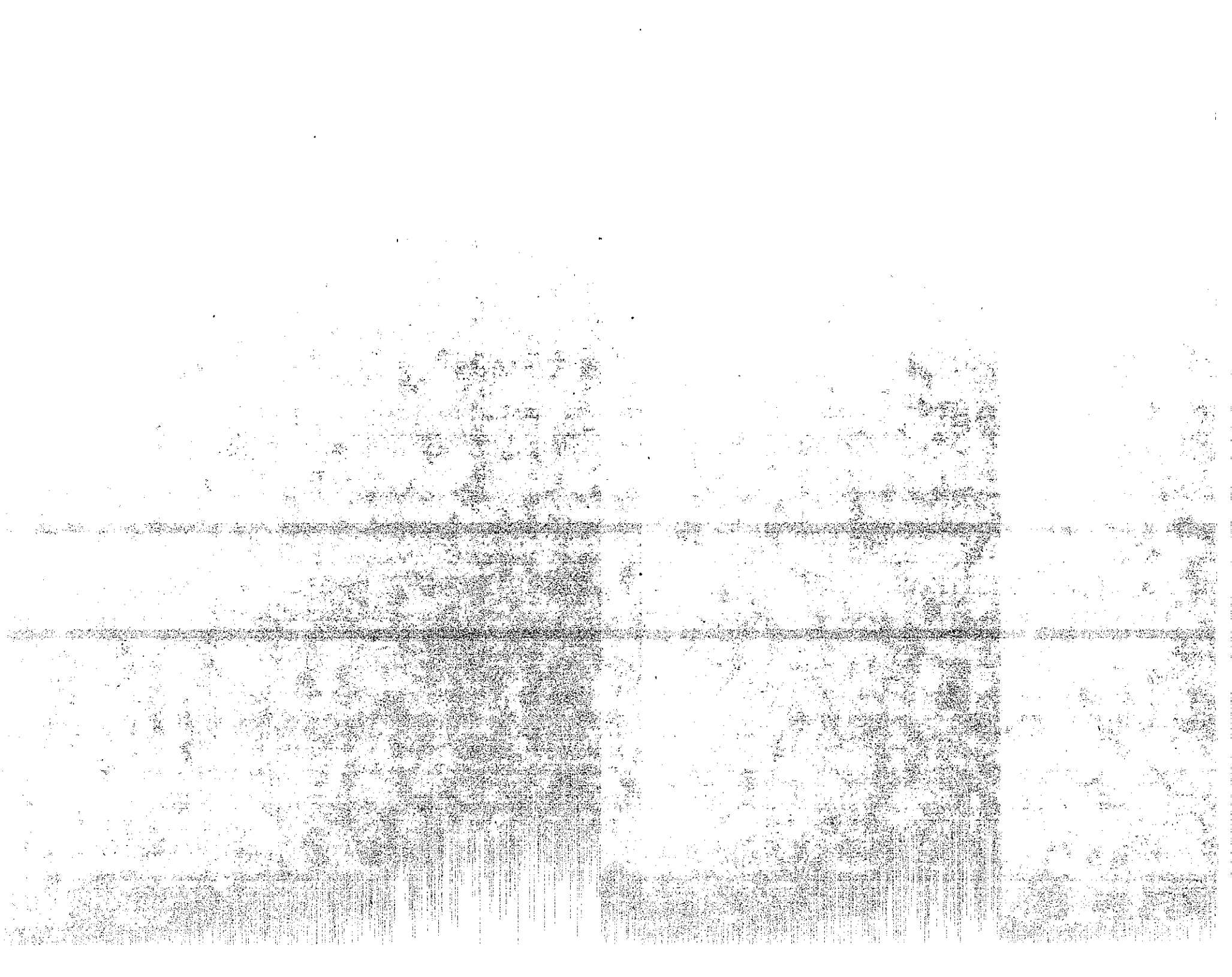


I. INTRODUCTION

Recently in California, slipfitter mounting hardware on some bridge-mounted luminaires has failed. This hardware attaches luminaire heads to the ends of mast arms on lighting standards. The cause of these failures appears to be excessive traffic-induced vertical vibrations originating in flexible bridge decks which are transmitted into lighting standards that are mounted on a bridge barrier near the center of a span. The vibration in the bridge deck excites the base of the lighting standard structure in the vertical direction, and causes a vertical whipping action to be transferred into the mast arm and luminaire. As no failures of luminaires installed on ground-mounted lighting standards have been reported, it is supposed that the horizontal wind loading to which luminaires on ground-mounted lighting standards are subjected, is much less damaging and not critical.

During the 1983-84 winter, District 3 Maintenance reported seven ITT (now "American Electric") luminaire failures in the elevated sections of I-5 between Richards Blvd. and Business 80 interchange in Sacramento. Occasionally catastrophic fatigue failure resulted when the slipfitter bolts fractured. Fatigue of the bolts was caused primarily by repeated stress from traffic-induced vibrations that occurred over a 6 to 12 month period. Wind-induced vibration has not caused luminaire failures when lighting standards have been ground-mounted, and wind loads probably have a minimal effect on bridge-mounted luminaires. Maintenance crews reported that when they replaced ITT luminaires with new G.E. luminaires (which have a stiffer clamping bracket), no further failure to date have occurred at these severe vibration locations. Some of these G.E. luminaires have been in place for over a year.

A similar problem with traffic-induced vibrations in bridge decks occurred in November 1983, on the Commodore Schuyler F. Heim Bridge in the city of Long Beach. The bridge-mounted lighting standards used there are Caltrans type 15 poles fabricated by Pacific Union Metal Company and are fitted with 6-foot mast arms and G.E. 200 watt luminaires. Fatigue failures there, however, occurred in the mast arm base welds, but resulted from a similar traffic-induced vertical vibration of the bridge deck. Even though having been severely vibrated, the G.E. luminaires apparently have stronger mounting hardware and have not yet failed.

As a result of these failures, engineers from the Electrical Unit of the Translab feel that some of the slipfitters may not be adequately designed. At their request, the Structural Materials Research Unit investigated the movement of one Caltrans Type 15 steel lighting standard with a 6-foot-long mast arm and a 38-pound, 200 watt luminaire, on the southbound "J" street offramp on I-5 in Sacramento, California. Findings are reported in a recent research report (1) in which the effectiveness of stockbridge-type dampers in reducing high

acceleration at the luminaire head was evaluated. Peak vertical accelerations of 4.0 g's (peak-to-peak) at the 38-pound luminaire head which contained an internal ballast, were recorded. The flexible bridge deck on which the lighting standard was mounted, was comprised of reinforced concrete supported by steel "I" girders and had a natural frequency of approximately 5 hertz. It was determined that removing the 17.5 pound internal ballast from the luminaire head was an effective means of reducing the luminaire acceleration to an acceptable level of 2.6 g's (peak-to-peak).

This research study was initiated at the request of the Electrical Unit of the Translab with the following objectives:

1. To determine the fatigue life of the slipfitter connectors for various brands of luminaires presently being used by Caltrans, and

2. To develop a test method and specification for evaluating durability of slipfitters (luminaire clamps) used to attach highway luminaires to the mast arms of lighting standards.

II. CONCLUSIONS

A. During fatigue testing in the vertical direction, General Electric and American Electric (formerly ITT) luminaires performed satisfactorily by exceeding 2 million cycles at an acceleration level of 3 g's peak-to-peak or 1.5 g's peak. The slipfitter clamping bolts on Hubbell lighting luminaires failed under these conditions. Table 1 below summarizes the test results.

Table 1. Summary of fatigue tests conducted in the vertical direction.

Manufacturer	No. of cycles passed @ 4.0 g's peak-to-peak	No. of cycles passed @ 3.0 g's peak-to-peak	
		Test No. 1	Test No. 2
American Electric	>2,000,000	>2,000,000	>2,000,000
General Electric	1,542,000	>2,000,000	>2,000,000
Hubbell Lighting	483,000	1,347,000	1,410,000

B. Although American Electric luminaires passed the fatigue test, their slipfitter mounting brackets were very flexible and could not be tightened to their recommended torque level of 10 foot-pounds without developing a substantial permanent set. Although Hubbell Lighting brackets appeared to have developed an acceptable permanent set with 10 foot-pounds of torque applied, it was observed that one bracket bottomed out against the top of the mounting boss. This was deemed

unacceptable as the clamping force could be limited. The permanent set of the newest General Electric slipfitter bracket was found to be acceptable.

III. RECOMMENDATIONS

A. We recommend that where bridge-mounted luminaires are experiencing a fatigue problem, their internal ballast should be removed and a remote ballast installed. These luminaires with their internal ballast removed, should withstand a minimum acceleration level of 3.0 g's peak-to-peak (same as 1.5 g's peak) when vibrated vertically for a minimum of 2 million cycles, without failure of the mounting bolts, brackets, or luminaire housing.

B. Further, luminaires should be fatigue tested in the horizontal direction (parallel to traffic flow) with an internal ballast installed, and should withstand a 1.5-g peak-to-peak (0.75 g peak) sinusoidal loading for a minimum of 2 million cycles without failure of the mounting bolts, brackets, or luminaire housing.

C. In addition, the slipfitter mounting bracket of luminaires shall not develop a permanent set in excess of 0.020 inch when 3/8-inch-diameter cap screws are tightened to a torque of 10 foot-pounds.

D. Section 86-6.01 "Lighting" of the existing Standard Specifications should be modified to insure that luminaires purchased by Caltrans will satisfy the requirements specified in A, B, and C above (Section 86-6.01 of Standard Specifications is included in Appendix C).

E. A statewide survey should be conducted to determine whether any fatigue failure of luminaire slipfitter connectors or mast arm base welds have occurred in other locations.

F. Additional field research should be conducted on various bridge-mounted and ground-mounted luminaires to verify the very limited data collected previously and to evaluate the "g" forces caused by gusty wind loading on ground-mounted luminaires.

IV. IMPLEMENTATION

Caltrans Division of Traffic Engineering will be responsible for modifying the existing specifications and insuring compliance with the new requirements. Manufacturers of highway luminaires shall perform their own testing to demonstrate that their products comply with the new specifications and shall certify their test results. Mr. Merle Wilson of the Electrical Instrumentation Testing and Research Unit of Translab may periodically test the luminaires and mounting hardware to verify the data supplied by the manufacturers.

V. TECHNICAL DISCUSSION

A. Test Program

Three luminaires of each manufacturer were tested for fatigue failure. Clamping brackets of each manufacturer were also tested to determine the amount of permanent set.

To insure an acceptable fatigue life, a luminaire head will have to withstand a minimum acceleration for a given number of cycles, without failure of the mounting bracket or luminaire housing. With this in mind, two luminaires of each manufacturer were tested as follows, with the internal ballast removed.

1. Cycle vertically at 4.0 g's peak-to-peak (see Figure 1) for 2 million cycles. If one fails, then go to step 2.

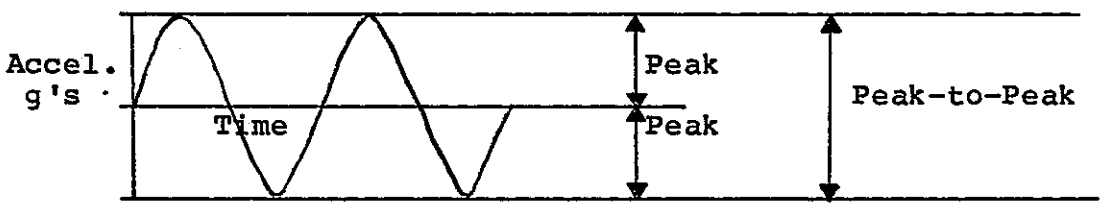


Figure 1. Sinusodial acceleration; peak and peak-to-peak.

2. Cycle at 3.0 g's peak-to-peak for 2 million cycles vertically.

3. Prepare report.

The vibration test frequency was kept below natural (resonant) frequency of the luminaire and test fixture to insure stable vibrations. For a flow chart of the test program outlined above, see Appendix A.

B. Test Conditions

1. Test Specimens:

Originally, luminaires manufactured by American Electric (formerly ITT), and General Electric were selected for testing since they are currently being used by Caltrans. Later, a third manufacturer, Hubbell Lighting, requested that we include their luminaires in our testing program. Their request was approved and included in the test program.

American Electric luminaires catalog No. S-250685, General Electric luminaires catalog No. C268N594, and Hubbell Lighting luminaires catalog No. RLCD40S31032035 were tested in this research.

2. Test Facility and Equipment:

An All American vibration fatigue testing machine available at the Translab was used to cycle General Electric, American Electric, and Hubbell Lighting luminaires at various acceleration levels. To be able to attach the luminaires to the machine, a test fixture was designed, built, and installed on the vibrating table (see Figure 2).

3. Test Procedure:

The following steps were followed to prepare the luminaires for testing, attach them to the testing machine, and conduct the tests.

a. Remove the internal ballast from the luminaire housing.

b. Install an approved lamp currently used by Caltrans in the luminaire.

c. Weigh the luminaire head (in pounds); call this "W".

d. Balance the luminaire head to determine its center of gravity. Mark this point on the head.

e. Insert the luminaire into the test fixture's 2-inch-diameter mast arm, position the luminaire lens facing the floor, then tighten the slipfitter bolts according to manufacturer's recommended procedure (the manufacturers' instructions can be found in Appendix B). In most cases, the test fixture will have to be tilted up for one to mount the lower housing or to tighten the slipfitter bolts. In such instances, the disassembled test fixture can be reassembled to the vibrating table by torquing the eight 3/8-inch-diameter bolts to a 20 ft-lb torque level.

f. Measure the distance between the luminaire center of gravity and the center of the test fixture (in inches); call this "L".

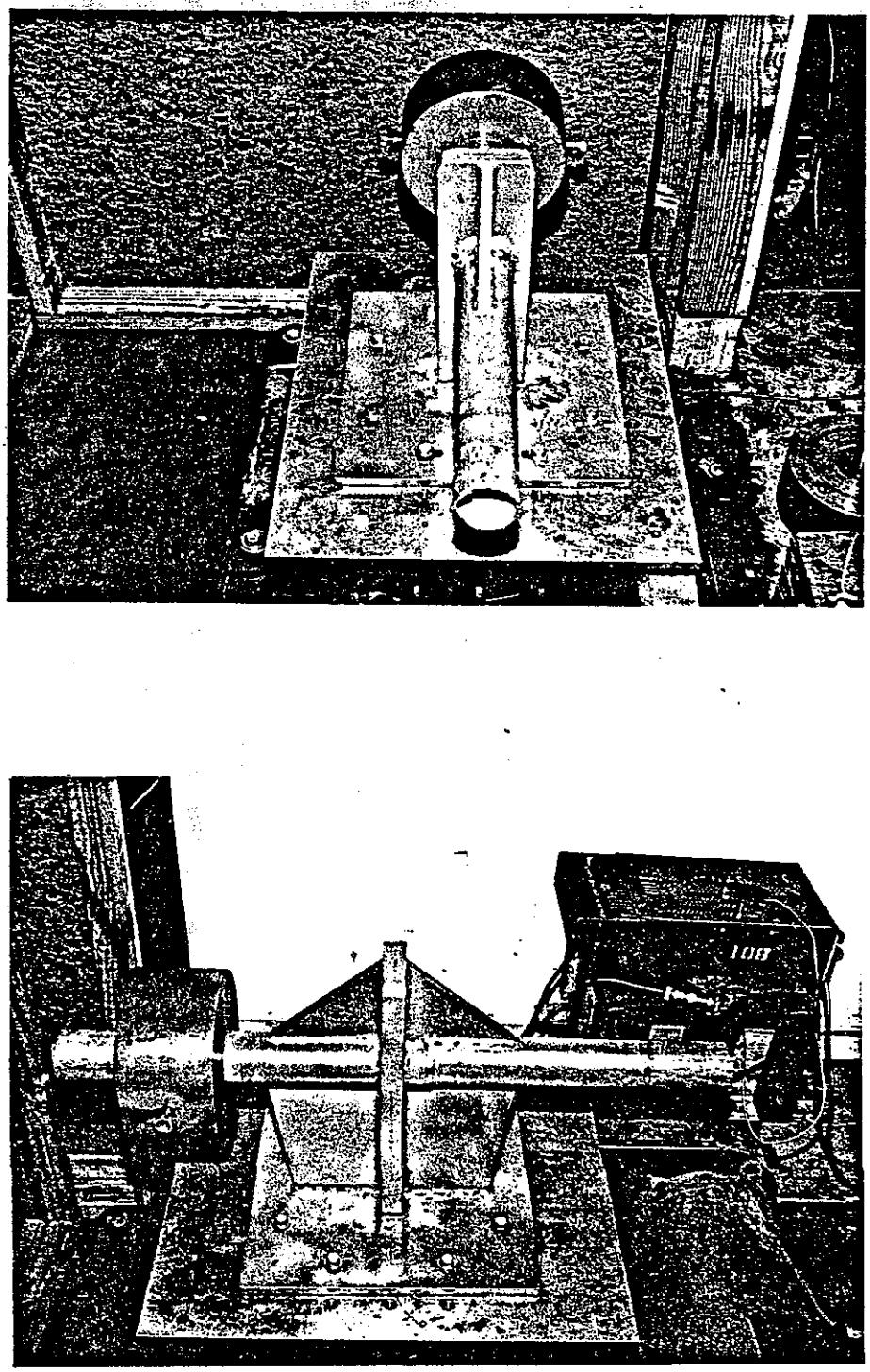


Figure 2. Test fixture for evaluating fatigue life of luminaires.

g. Determine the distance from the center of the test fixture to the center of the counterweight using the following equation:

$$d = \frac{W * L}{51} \qquad \text{(shown in Figure 3)}$$

where d = distance between the center of the test fixture and the center of the counterweight (inches).

W = the weight of the luminaire head (pounds).

L = distance between the luminaire center of gravity and the center of the test fixture (inches),

and 51 = the weight of the counterweight (pounds).

h. Adjust the counterweight position, then tighten the two 1/2-inch-diameter locking set screws located on the two sides of the weight to 20 foot-pounds torque.

i. Tape the calibrated accelerometer to the luminaire center of gravity.

j. Adjust the automatic shutoff switch so in the case of a failure, the machine will shut itself off.

k. Take pictures of the test setup.

l. Turn the testing machine on, adjust the vibrating frequency and displacement until the desired acceleration is obtained (caution: the machine has to be oiled daily).

m. Cycle the luminaire until 2 million cycles is reached or failure occurs, whichever comes first.

n. Record the number of cycles at which failure occurred, observe and note the type of failure and take pictures.

For slipfitter connectors, the following steps were taken to determine the amount of permanent set:

1. Measure the initial shape of unused bracket.

2. Assemble and torque the slipfitter connector (clamping bracket) to desired torque level (shown in Figure 4).

3. Remove the bracket assembly and measure the final shape of bracket.

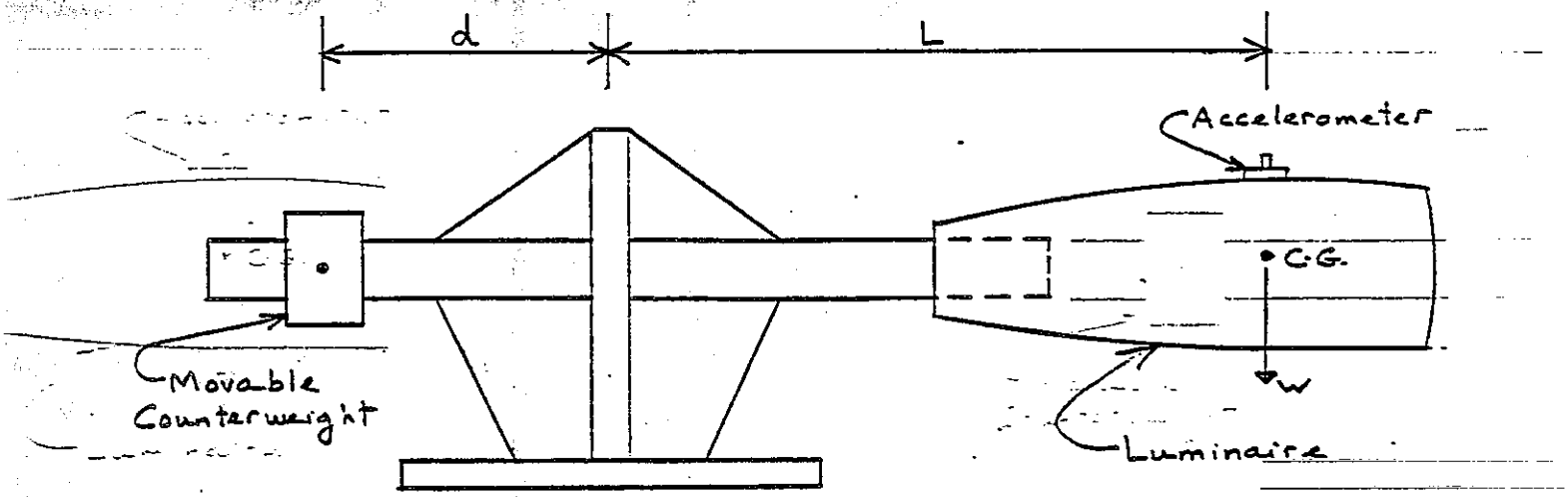


Figure 3. Positioning of counterweight on luminaire fatigue test fixture.

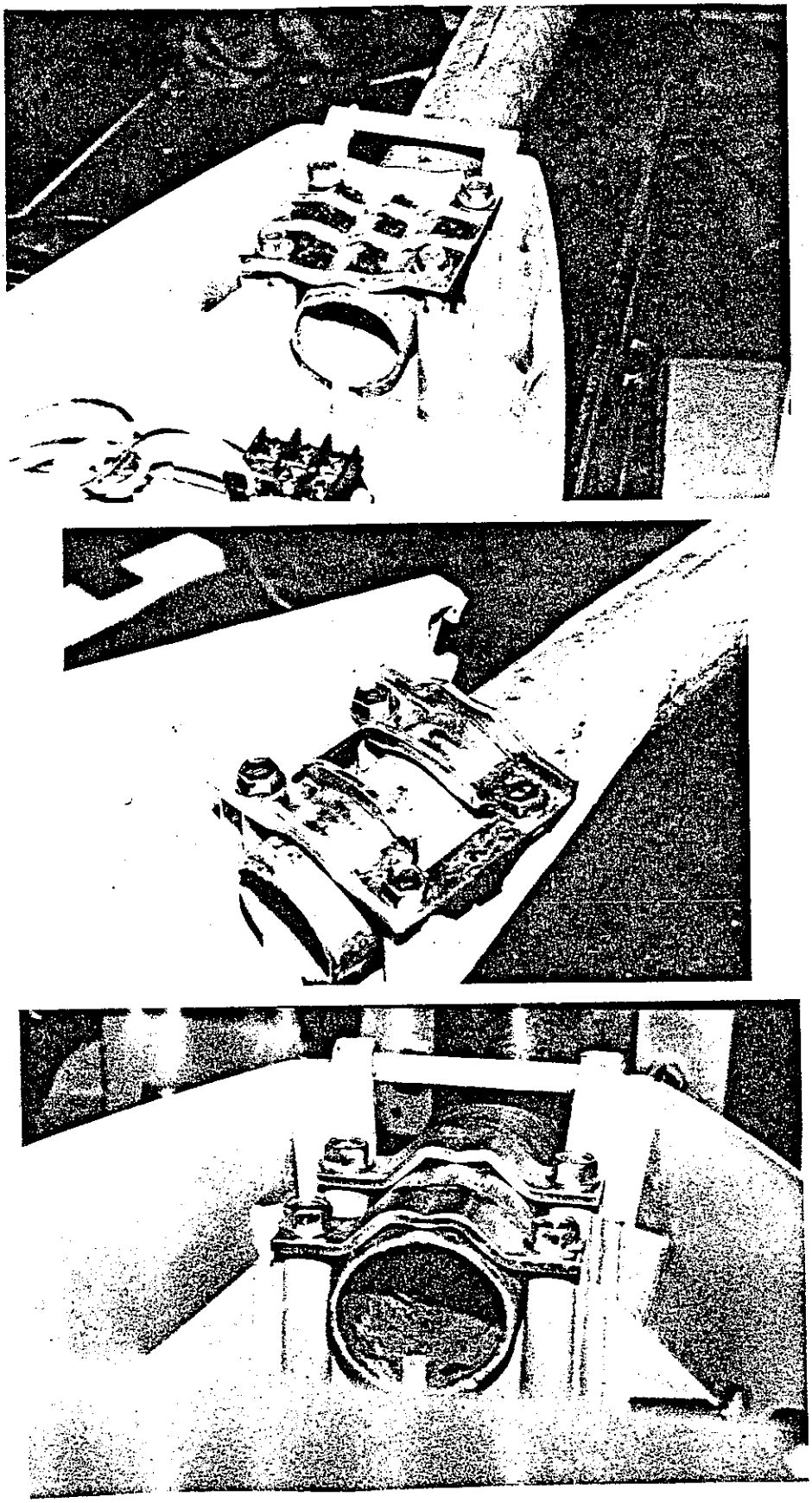


Figure 4. Assembled American Electric, General Electric, and Hubbell Lighting slipfitter connectors.

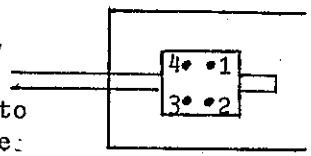
C. Test Results

Results of the vibration fatigue tests are presented in Table 2 for the American Electric luminaires, Table 3 for the General Electric luminaires, and Table 4 for the Hubbell Lighting luminaires. In Figures 5 through 14, the various luminaires and slipfitters are depicted.

A series of tests were also conducted on slipfitter connectors (clamping brackets) of all three manufacturers to determine the amount of permanent set which occurred in the brackets when the bolts were tightened. Tables 5, 6, and 7 summarize the results.

Table 2. American Electric luminaires fatigue test results.

AMERICAN ELECTRIC

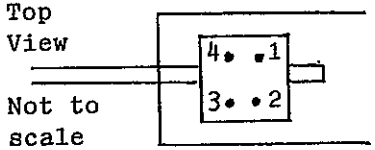
TEST DATE	TORQUE ON BOLTS	TEST ACCELER. g's (Pk-to-Pk)	TEST FREQUENCY (HZ)	NO. OF CYCLES PASSED	MACHINE* DISPLACE-MENT (IN.)	REMARKS
From 5/27/86 to 5/30/86	6.25** (75 in-lbs)	3.0	12.9	2,374,804	0.125	No apparent failure. Testing was stopped since no. of cycles passed exceeded 2 million.
From 6/16/86 to 6/19/86	6.25**	4.0	14.4	2,415,114	0.125	Top View  Not to scale. Bolt No. 2 was found broken. See Figures 5 & 6.
From 6/20/86 to 6/23/86	6.25**	3.0	12.9	3,029,744	0.125	No apparent failure. Testing was stopped since number of cycles passed exceeded 2 million.

*Machine displacement is different and less than luminaire C.G. displacement.

**The manufacturer recommends a torque of 10 foot-pounds or a bracket deflection of 1/16 inch; however, 1/16 inch deflection occurred at 6.25 foot-pounds where at 10 foot-pounds the deflection was measured to be 2.5/16 inch. Mr. J.D. McIngvale, Jr., the Manager of Product Engineering of American Electric suggested to go with 6.25 foot-pounds.

Table 3. General Electric luminaires fatigue test results.

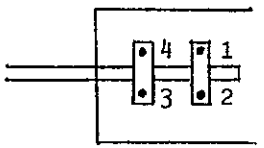
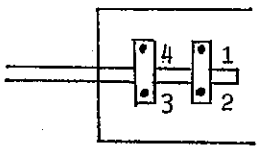
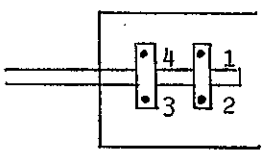
G E N E R A L E L E C T R I C

TEST DATE	TORQUE ON BOLTS	TEST ACCELLER. g's(Pk-to-Pk	TEST FREQUENCY (HZ)	NO. OF CYCLES PASSED	MACHINE * DISPLACE-MENT (IN.)	R E M A R K S
From 4/25/86 to 4/28/86	12 ft-lbs	3.0	12.1	2,768,082	0.125	No apparent failure. Testing was stopped since number of cycles passed exceeded 2 million.
From 6/10/86 to 6/11/86	12 ft-lbs	4.0	14.2	1,541,737	0.125	Top View  Not to scale Bolt No. 3 was found broken. The lamp was also broken. See Figures 7 & 8.
From 6/13/86 to 6/16/86	12 ft-lbs	3.0	12.9	3,050,350	0.125	No apparent failure. Testing was stopped since number of cycles passed exceeded 2 million.

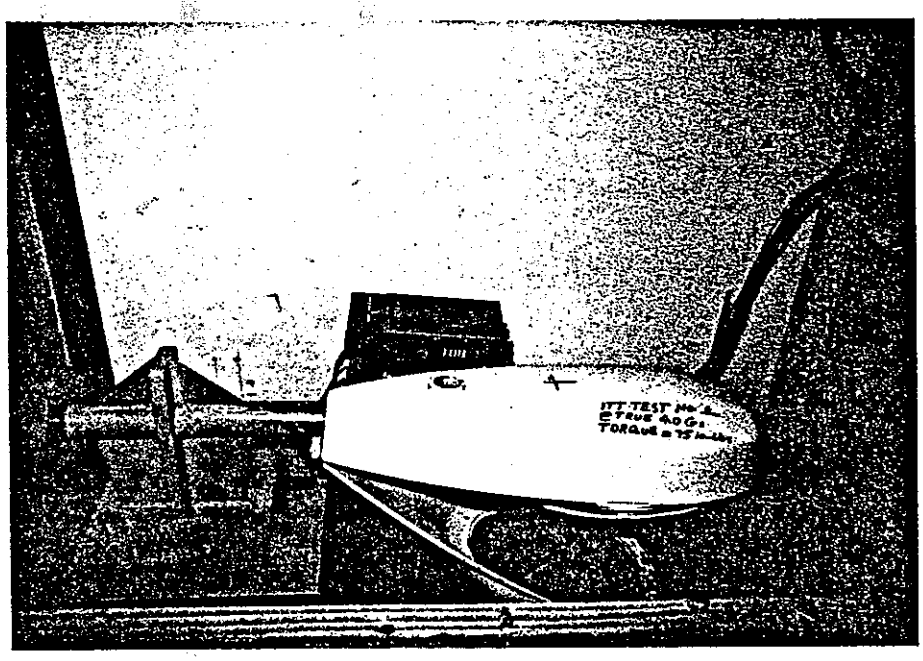
*Machine displacement is different and less than luminaire C.G. displacement

Table 4. Hubbell Lighting luminaires fatigue test results.

H U B B E L L L I G H T I N G

TEST DATE	TORQUE ON BOLTS	TEST ACCELER. g's(Pk-to-Pk	TEST FREQUENCY (HZ)	NO. OF CYCLES PASSED	MACHINE* DISPLACE-MENT (IN.)	R E M A R K S
From 5/20/86 to 5/22/86	20 ft-lbs	3.0	12.3	1,346,948	0.125	Top View Not to scale  Bolt No. 3 was found broken. See Figures 9 & 10.
From 6/6/86 to 6/9/86	20 ft-lbs	3.0	12.7	1,410,196	0.125	Top View Not to scale  Bolt No. 1 was found broken. See Figures 11 & 12.
From 6/9/86 to 6/10/86	20 ft-lbs	4.0	13.6	482,715	0.125	Top View Not to scale  Bolt No. 4 was found broken. See Figures 13 & 14.

*Machine displacement is different and less than luminaire C.G. displacement.



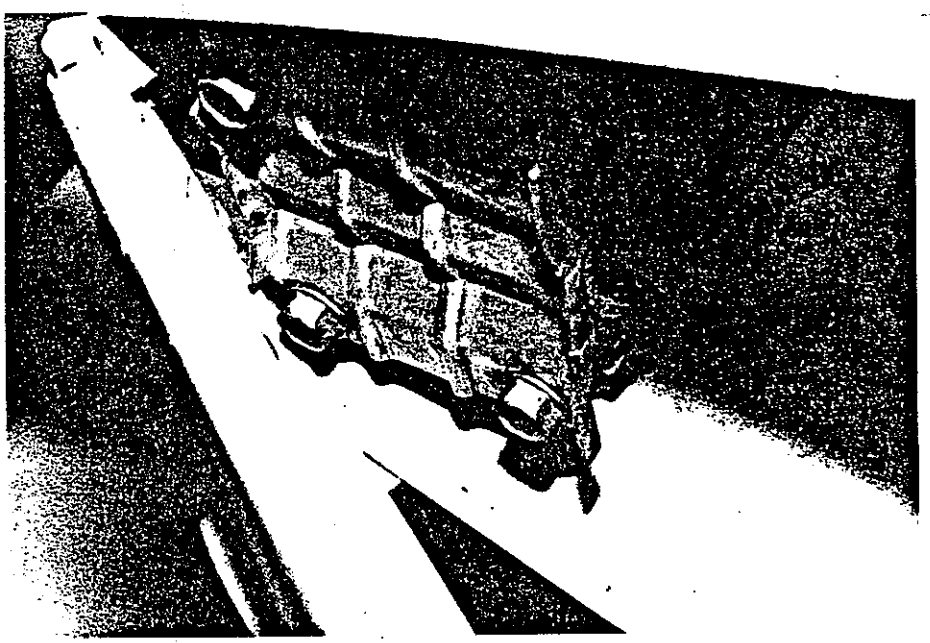


Figure 5. American Electric luminaire vibrated vertically at 4.0 g's peak-to-peak for 2,415,114 cycles. (Note rear cap screw broken off.)

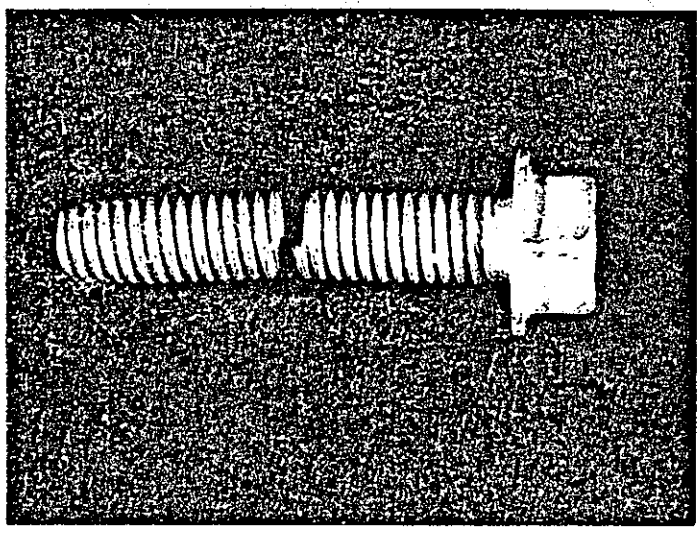


Figure 6. Fractured American Electric cap screw.

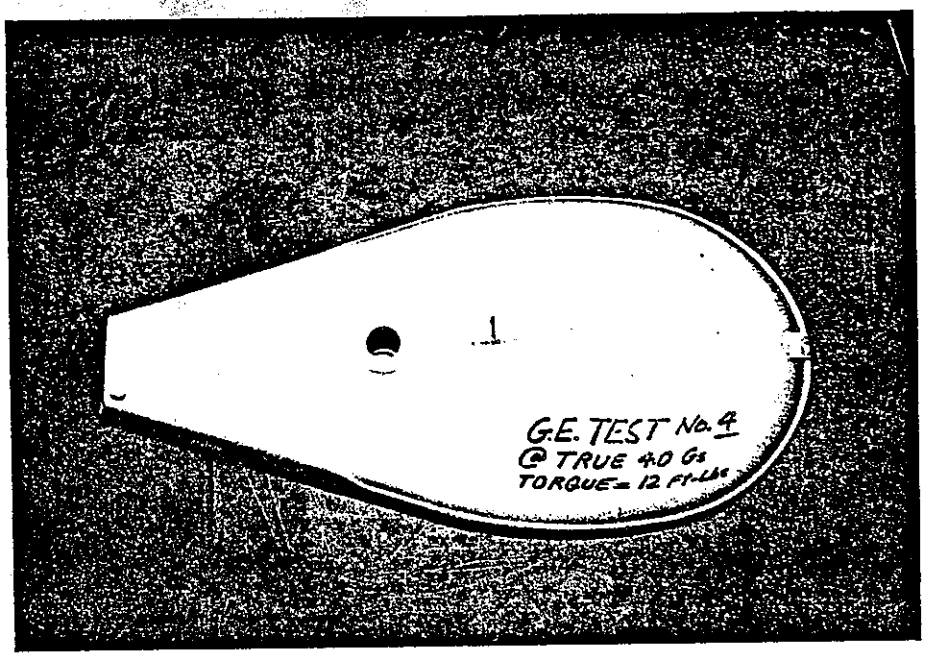


Figure 7. General Electric luminaire vibrated vertically at 4.0 g's peak-to-peak for 1,541,737 cycles. (Note rear cap screw broken off.)

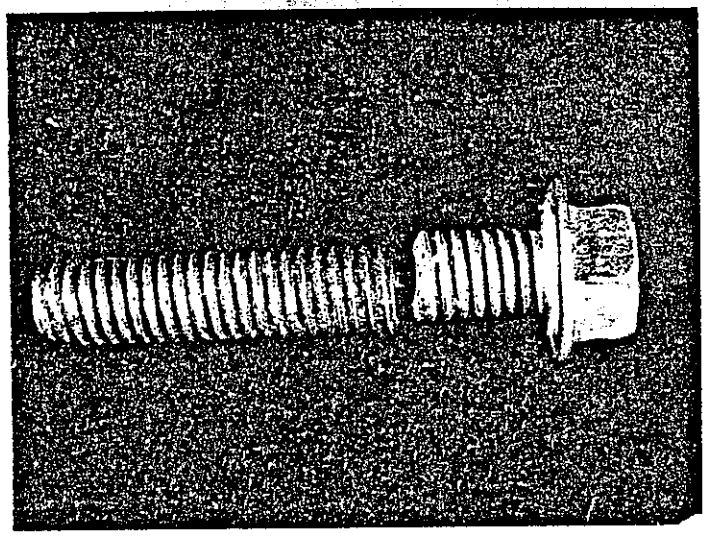


Figure 8. Fractured General Electric cap screw.

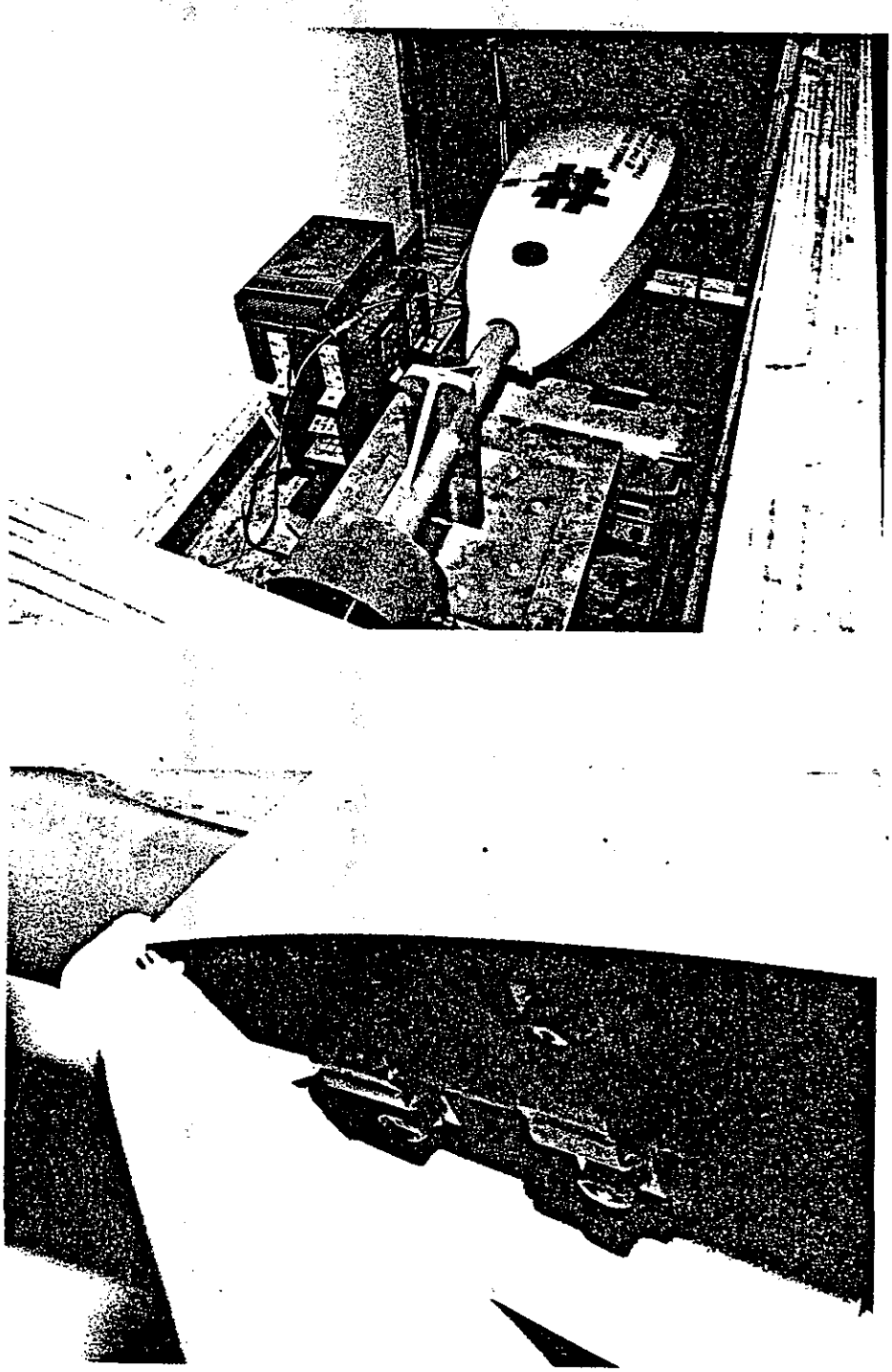


Figure 9. Hubbell Lighting luminaire vibrated vertically at 3.0 g's peak-to-peak for 1,346,948 cycles. (Note rear cap screw broken off.)

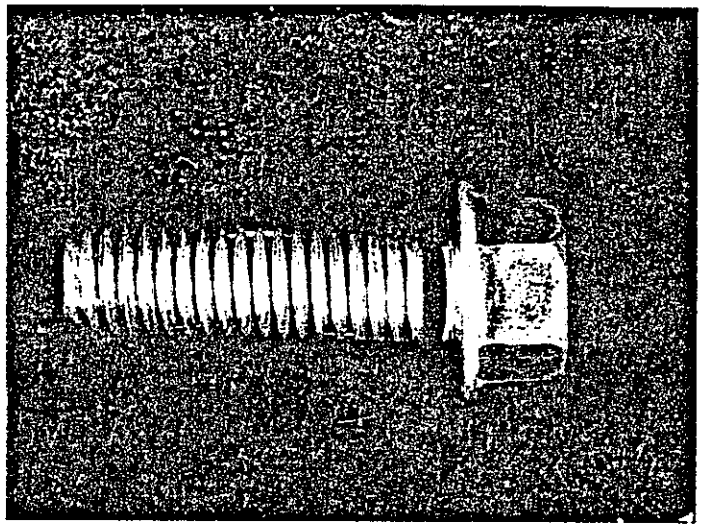


Figure 10. Fractured Hubbell Lighting cap screw.

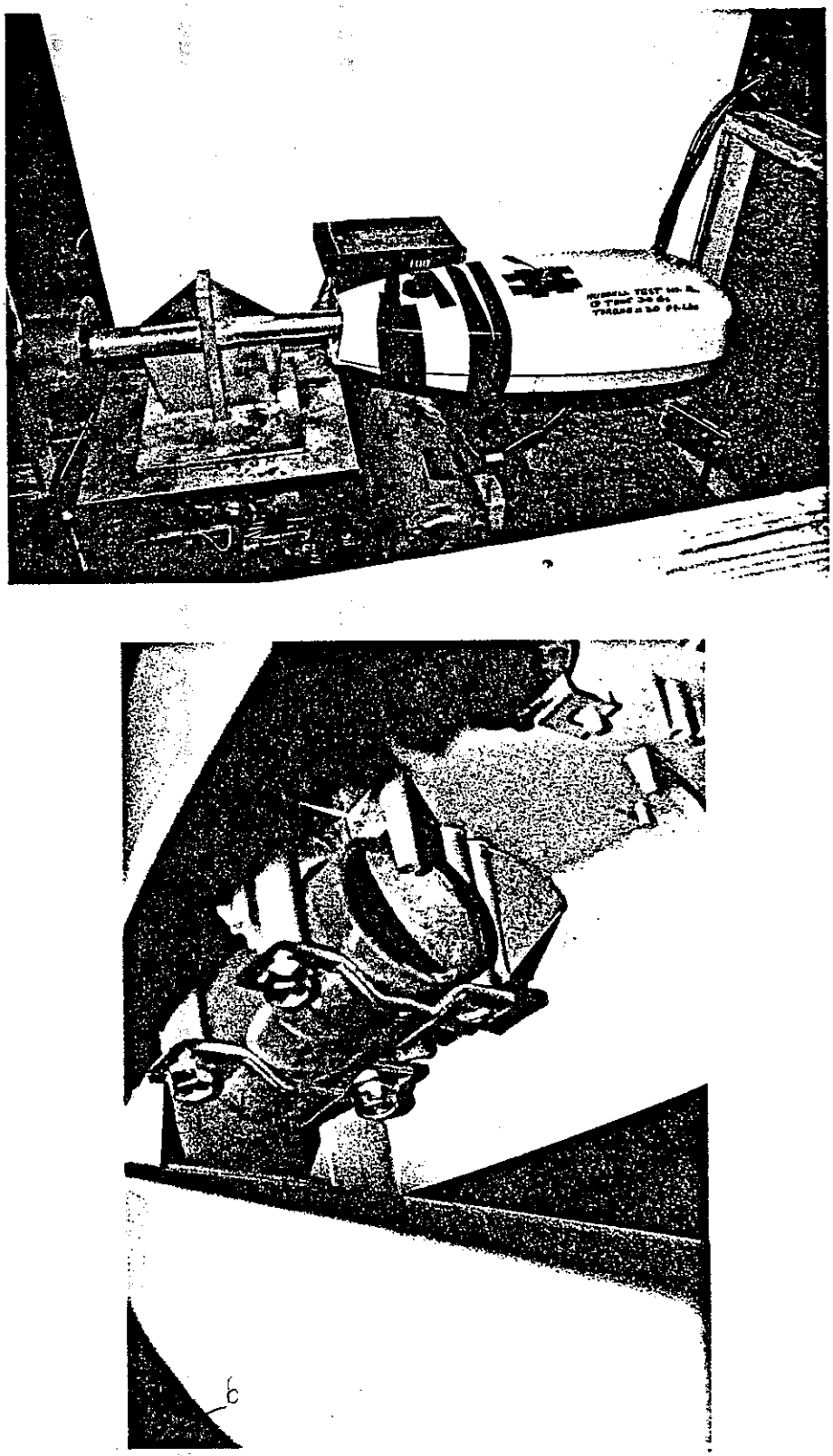


Figure 11. Hubbell Lighting luminaire vibrated vertically at 3.0 g's peak-to-peak for 1,410,196 cycles. (Note front cap screw broken off.)

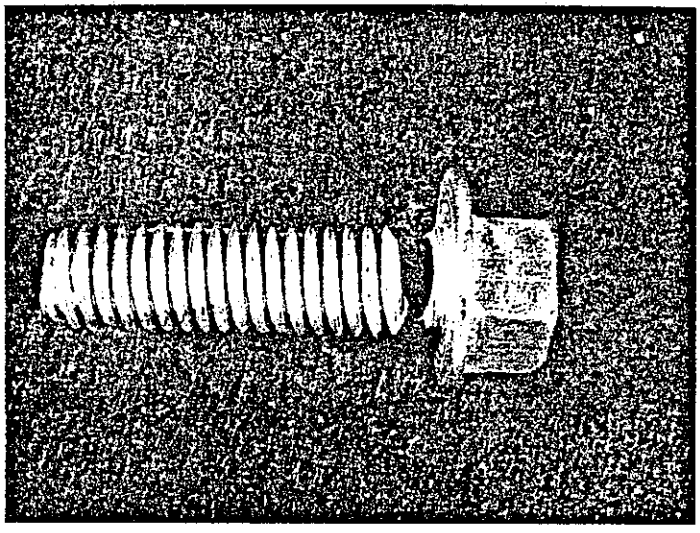
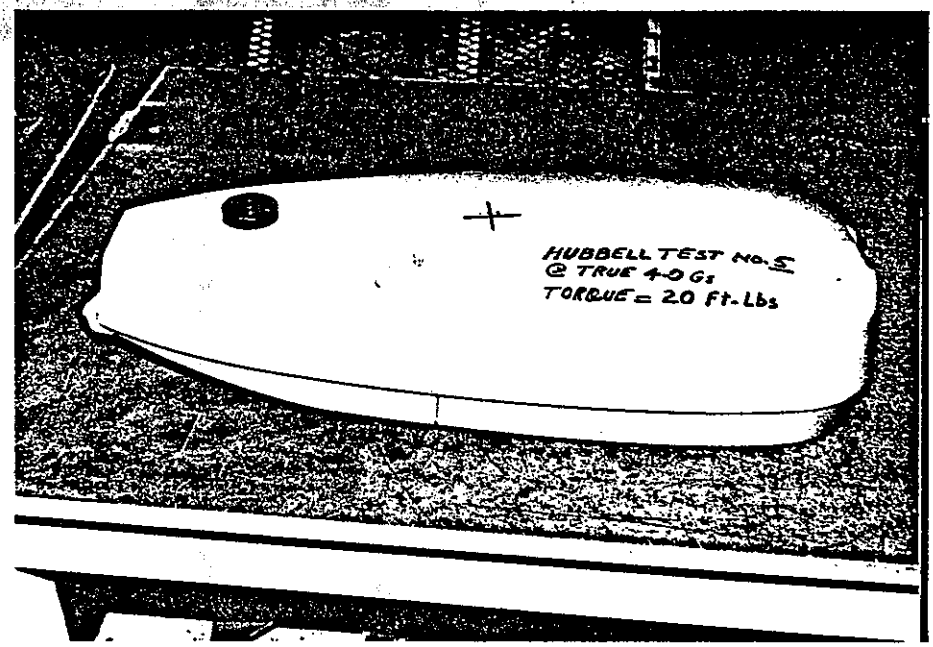


Figure 12. Fractured Hubbell Lighting cap screw.



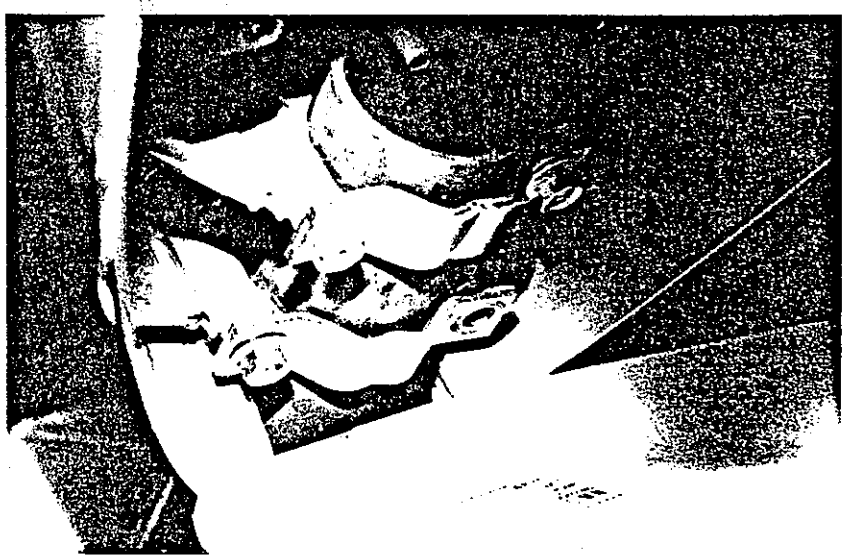


Figure 13. Hubbell Lighting luminaire vibrated vertically at 4.0 g's peak-to-peak for 482,715 cycles. (Note front cap screw broken off.)

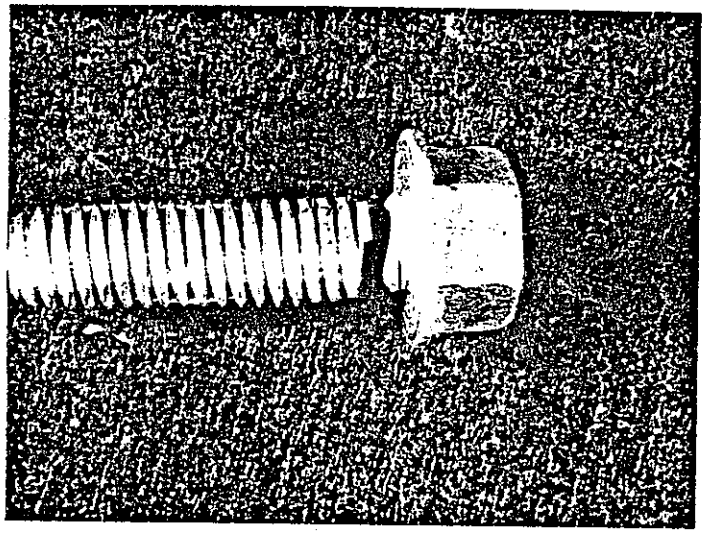


Figure 14. Fractured Hubbell Lighting cap screw.

Table 5. Permanent set of slipfitter mounting brackets on American Electric luminaires which occurred at various bolt installation torques.

Torque foot-pounds	Permanent Set inches	
10	5/32 = 0.156	
8.33 (100 in-lbs)	1/8 = 0.125	
6.25 (75 in-lbs)	1/16 = 0.063	----- Manufacturer's recommended deflection
4.17 (50 in-lbs)	1/32 =0.036	

Notes:

It can be seen from Table 5 that the manufacturer's recommended torque of 10 foot-pounds causes a deflection far greater than 1/16 inch.

Figure 15 shows the location where measurements to determine permanent set were taken.

American Electric recommends a torque of 10 foot-pounds for 2-inch-diameter mast arms, or a 1/16-inch deflection.

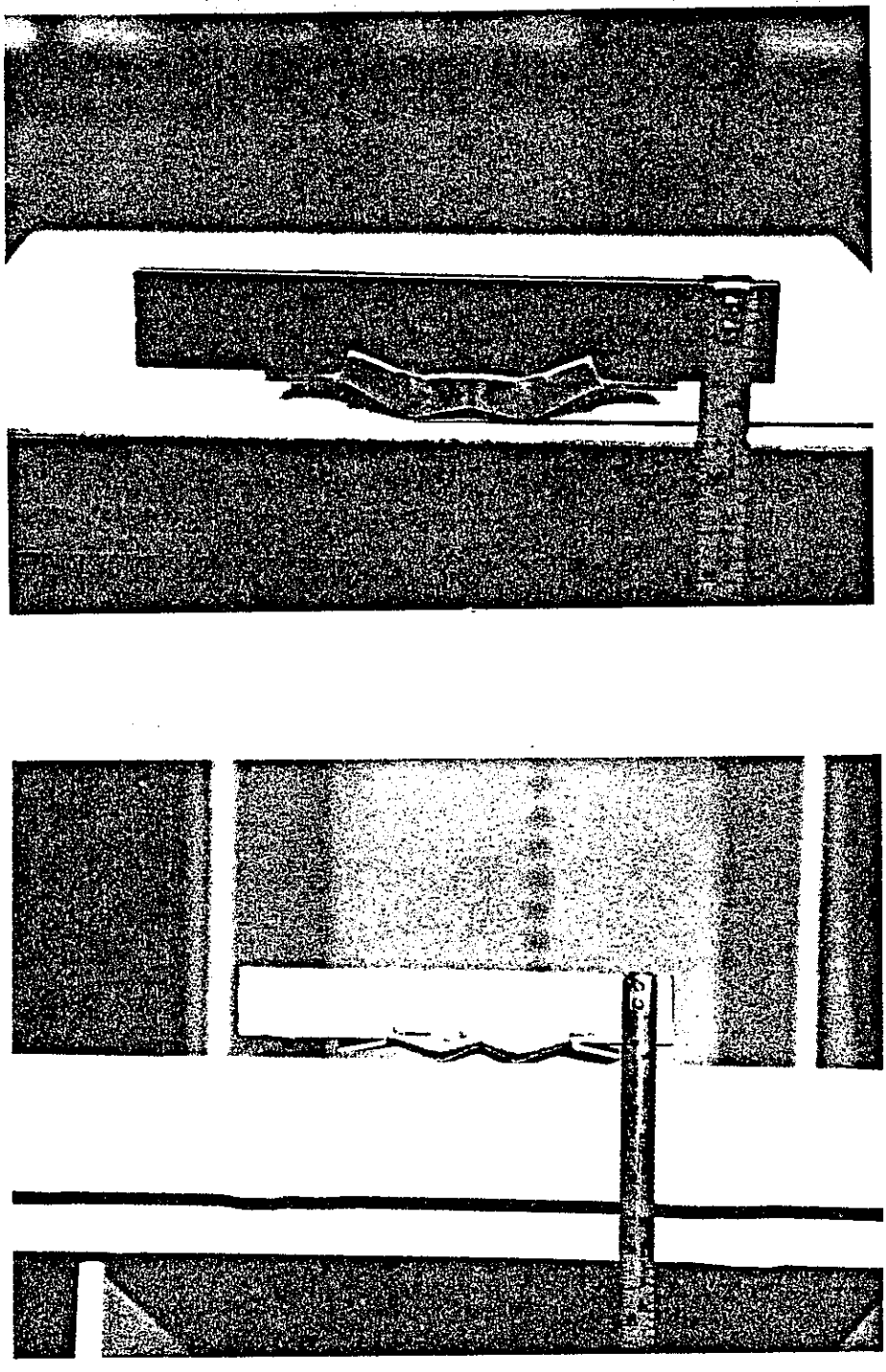


Figure 15. American Electric slipfitter clamping bracket tested for permanent set.

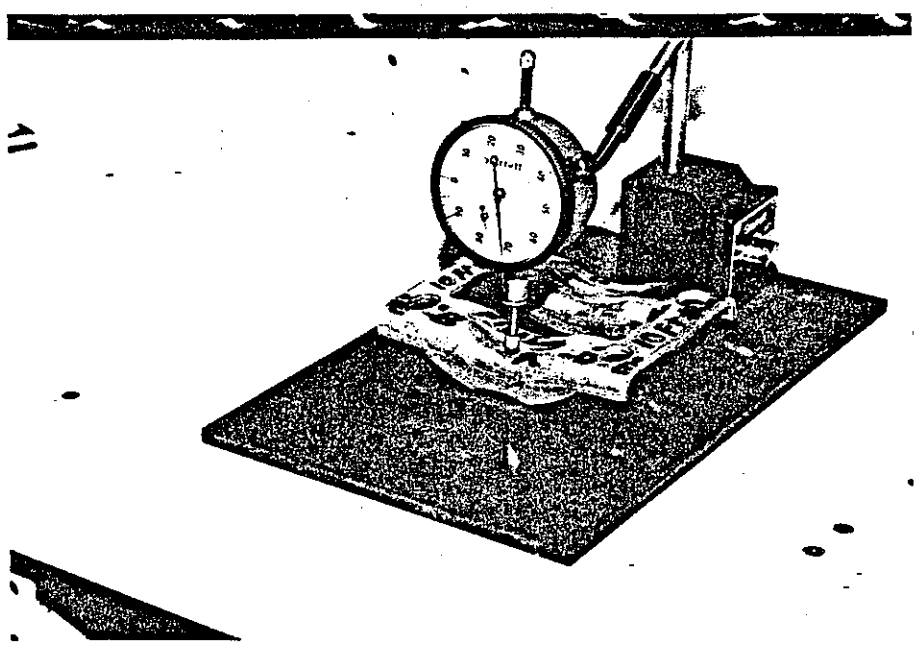
Table 6. Permanent set of slipfitter mounting brackets on General Electric luminaires which occurred at various bolt installation torques.

Location on Bracket	Permanent Set (inches) at torques of:		
	10 ft-lbs	15 ft-lbs (specimen No. 4)	20 ft-lbs (specimen No. 2)
1	0	0	0
2	.006	.011	.032
3	.010	.027	.048
4	.010	.015	.011
5	.014	.017	.027
A	0	0	0
B	.002	.014	.014
C	.006	.028	.021
D	.005	.018	.026
E	.005	.033	.040

Notes:

See Figures 16, 17, and 18 for the location where measurements to determine the permanent set were taken (locations 1,2,3,4,5, A,B,C,D, and E).

General Electric recommends a torque of from 10 to 12 foot-pounds.



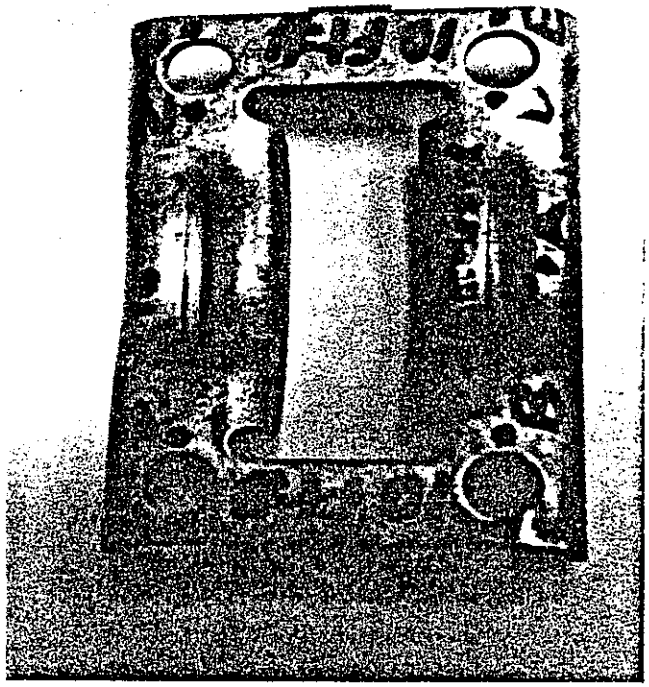


Figure 16. General Electric slipfitter bracket tested for permanent set at 10 foot-pounds.

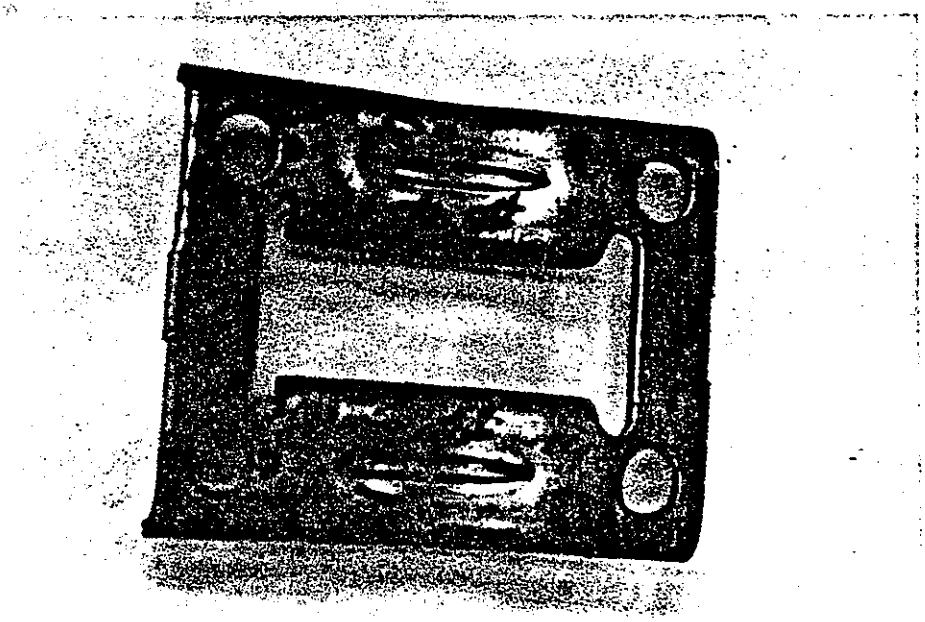


Figure 17. General Electric slipfitter bracket tested for permanent set at 15 foot-pounds.

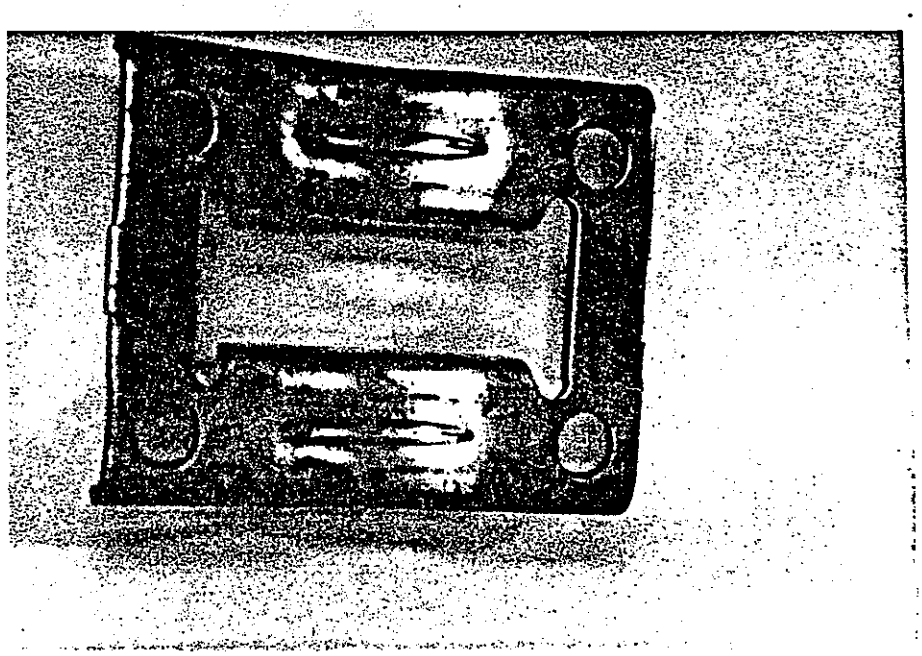


Figure 18. General Electric slipfitter clamping bracket tested for permanent set at 20 foot-pounds.

Table 7. Permanent set of slipfitter mounting brackets on Hubbell Lighting luminaires which were measured for various bolt installation torques.

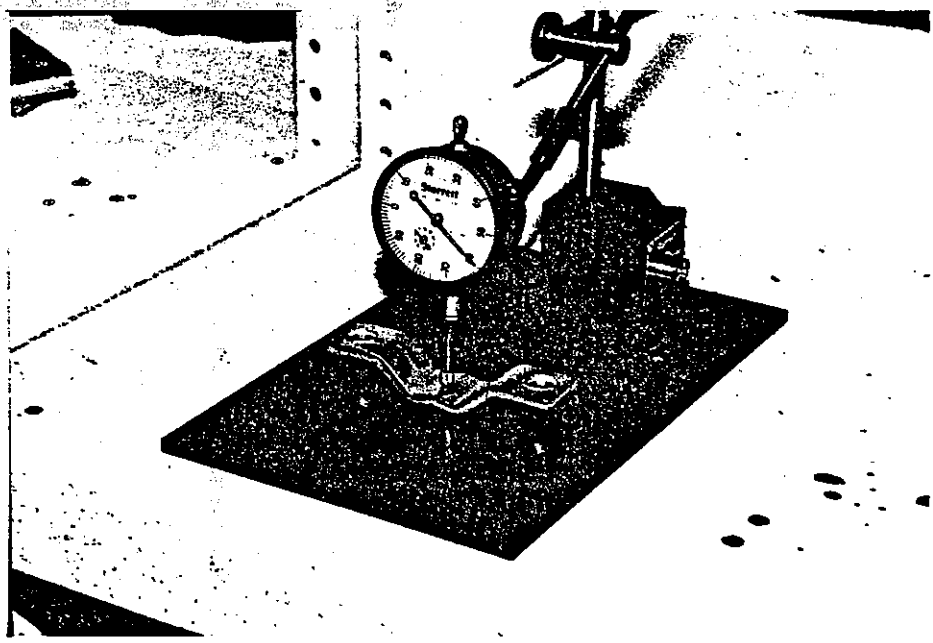
Location on Bracket	Permanent Set (inches) at torque of: 10 ft-lbs	15 ft-lbs	20 ft-lbs
	Bracket K	Bracket C	Bracket A
1	0	0	0
2	.002	.005	.007
3	.004	.011	.012
4	0	.003	.005
5	.005	.008	.008
	Bracket L	Bracket D	Bracket B
1	.002	0	0
2	.002	.001	.004
3	.004	.003	.005
4	.001	.002	.007
5	.002	.007	.009

Notes:

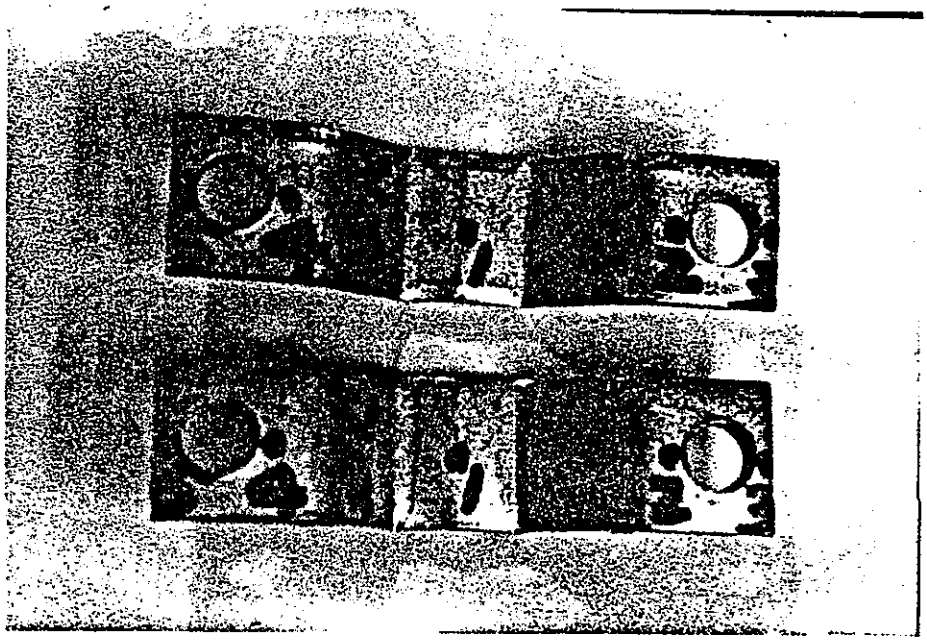
See Figures 19, 20, and 21 for the locations where measurements to determine the permanent set were taken (points 1,2,3,4,5, and brackets A,B,C,D,K, and L).

Important Note: All brackets exept bracket K bottomed out against the top of the mounting boss after being torqued to 10, 15, and 20 foot-pounds. Brackets K, C, and A are outer, and brackets L, D, and B, are inner brackets.

Hubbell Lighting recommends a torque of from 18 to 20 foot-pounds.



a. Dial indicator setup for measuring relative set of clamping brackets.



b. Plan view of a set of Hubbell clamping brackets.

Figure 19. Hubbell Lighting slipfitter clamping brackets tested for permanent set at 10 foot-pounds.

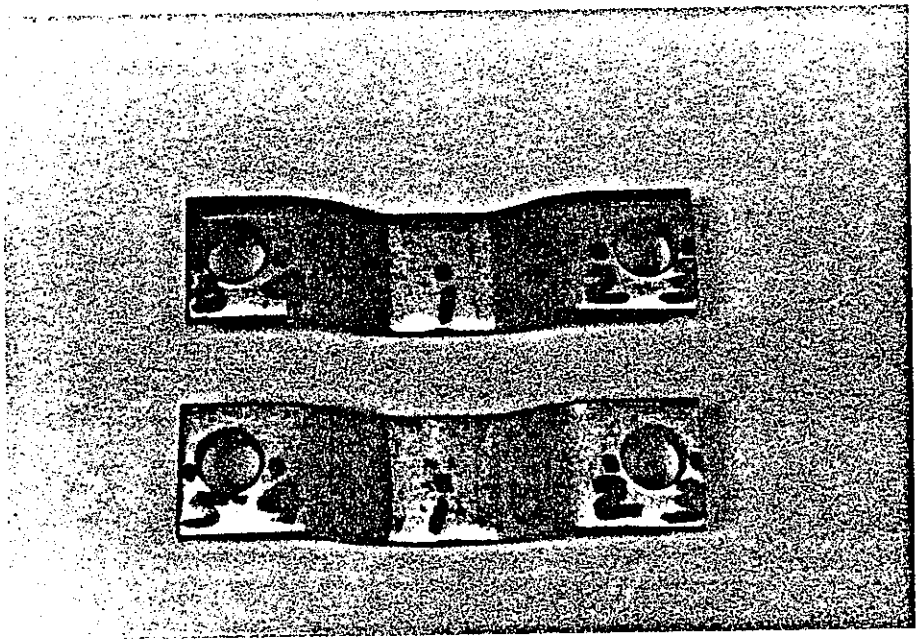


Figure 20. Hubbell Lighting slipfitter clamping brackets tested for permanent set at 15 foot-pounds.

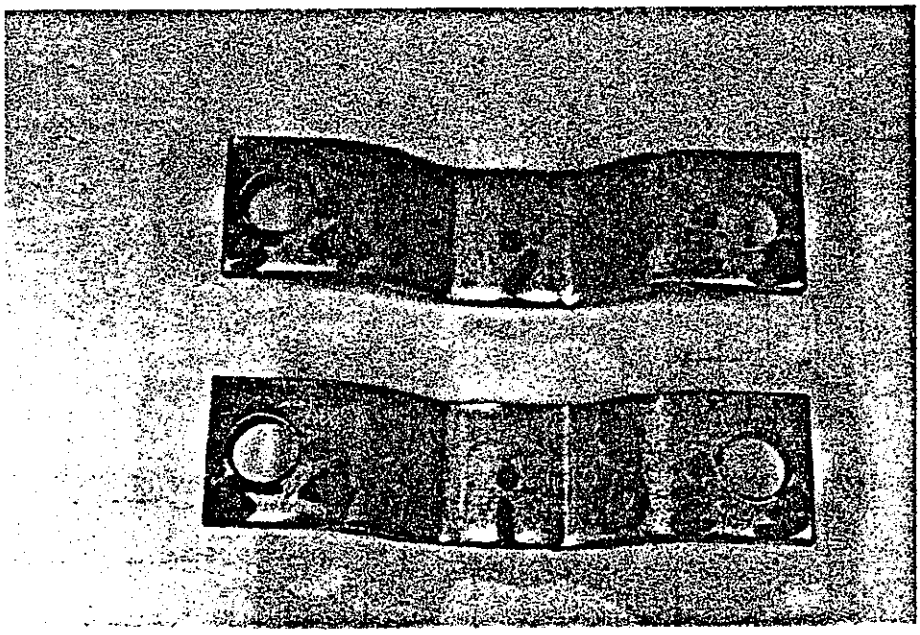


Figure 21. Hubbell Lighting slipfitter clamping brackets tested for permanent set at 20 foot-pounds.

Hardness tests were also performed on brackets of each manufacturer. Rockwell hardnesses of the slipfitter clamping brackets were determined using the Rockwell B scale. Results are shown in Table 8.

Table 8. Rockwell Hardnesses of various slipfitter clamping brackets.

Trial No.	American Electric	General Electric	Hubbell Lighting
1	52 HRB	78 HRB	58 HRB
2	55	76	58
3	54	75	57
4	49	76	--
5	51	77	--
Mean Hardness	52 HRB	76 HRB	58 HRB

From these hardness results, the materials from which the brackets are made appear to be mild galvanized steel.

D. Discussion of Test Results

Test results reveal that slipfitter connectors on both American Electric and General Electric luminaires do not exhibit failure when vibrated vertically at 3.0 g's peak-to-peak for 2 million cycles, with the internal ballast removed. However slipfitter connectors on Hubbell Lighting luminaires failed under these conditions. Even though the 3/8-inch-diameter mounting bolts break first and seem to cause the failures, the slipfitter clamping brackets seem to be the source of the failures and the weak part of the luminaire mounting assembly. They are thin and yield easily when the mounting cap screws are torqued at a relatively low level.

This flexing and permanent yielding of the brackets prevent the high-strength cap screws from carrying a high preload and being used effectively under severe fatigue conditions that are experienced on flexible bridge decks. This high preload is necessary to minimize the internal stress range the brackets experience during severe vertical exitation from bridge traffic, and the resulting prying action. Current cap screw specifications provided by American Electric and General Electric are included in appendix E.

The slipfitter clamping brackets of American Electric luminaires deflected 2.5 times greater than what the manufacturer recommends. For a 2-inch mast arm, American Electric recommends a torque of 10 foot-pounds on 3/8-inch-diameter cap screws or 1/16 inch deflection of the bracket, whichever occurs first. According to our test results, 1/16-inch-deflection occurred at a torque of 6.25 foot-pounds (75 inch-pounds). At a torque of 10 foot-pounds, the deflection was measured to be 5/32 inch. Due to experiencing substantial permanent yielding before reaching 10 foot-pounds and the fact that American Electric luminaires have failed previously on bridges due to vertical excitations, we developed a specification to set the maximum allowable permanent set (yielding) of the slipfitter connectors to be 0.020 inch at an installation torque of 10 foot-pounds (see Appendix F for proposed specifications and test methods).

General Electric luminaires met both fatigue and bracket specifications where American Electric passed the fatigue, but failed the bracket specifications.

Hubbell Lighting failed the fatigue test and could not be evaluated for permanent set of the bracket as it bottomed out against the top of the boss. A possible cause for the fatigue failure of Hubbell Lighting luminaires might be the higher weight of Hubbell Lighting luminaires (from 19.95 to 20.56 pounds) compared to General Electric (from 16.44 to 16.80 pounds) and American Electric (from 16.87 to 17.43 pounds). These weights include that of the lamp, but exclude the internal ballast.

The acceleration level of 3.0 g's peak-to-peak established as the limit for vertical acceleration testing was adopted from the field test conducted by Translab electronics crew (1.)*. This critical load condition appears to occur when luminaires are attached to the ends of mast arms on lighting standards mounted on flexible bridge decks. Actual acceleration measurements on luminaires and bridge decks were taken during a period of approximately 30 minutes, and the vibrations were generated by 72 random passing trucks driving on the bridge structures. Weights of trucks were unknown and their lane locations on the bridge deck were not monitored. Also the location and number of other trucks driving on the bridge were not recorded. The maximum acceleration level recorded was 2.6 g's peak-to-peak; therefore the level 3.0 g's was chosen so as to be slightly conservative. However, due to uncertainties mentioned above, the occurrence of higher acceleration levels is indeed possible. Therefore further field research should be conducted to insure that this acceleration level is indeed representative of the worst conditions.

Prior to this research being conducted, a literature search was performed. Limited literature and background information

was available on the subject of vertical vibration of luminaires on bridge decks.

Mr. Harold A. Van Dusen, Jr. has prepared reports which have been published in "Illuminating Engineering" Journals (2.,3.,) dealing with vibration testing of luminaires. These reports seem to be written about wind-induced horizontal vibrations. His suggested luminaire vibration test criteria are:

1. Vibration fatigue test to simulate an infinite number of cycles (endurance limit number) at a force of 1 g peak (or 2 g's peak-to-peak). This is called the simulated 1 g endurance test.

2. A short-term high intensity test consisting of 1000 cycles at 4 g peak (or 8 g's peak-to-peak).

The manufacturers' testing criteria are listed in Appendix D.

When discussing g levels, one must distinguish between peak g forces and peak-to-peak g forces. The manufacturers and Mr. Van Dusen express g levels as peak values whereas in this report and in the field test data collected by the Translab crew, g levels are expressed as peak-to-peak values. A 1 g peak acceleration is equal to 2 g's peak-to-peak.

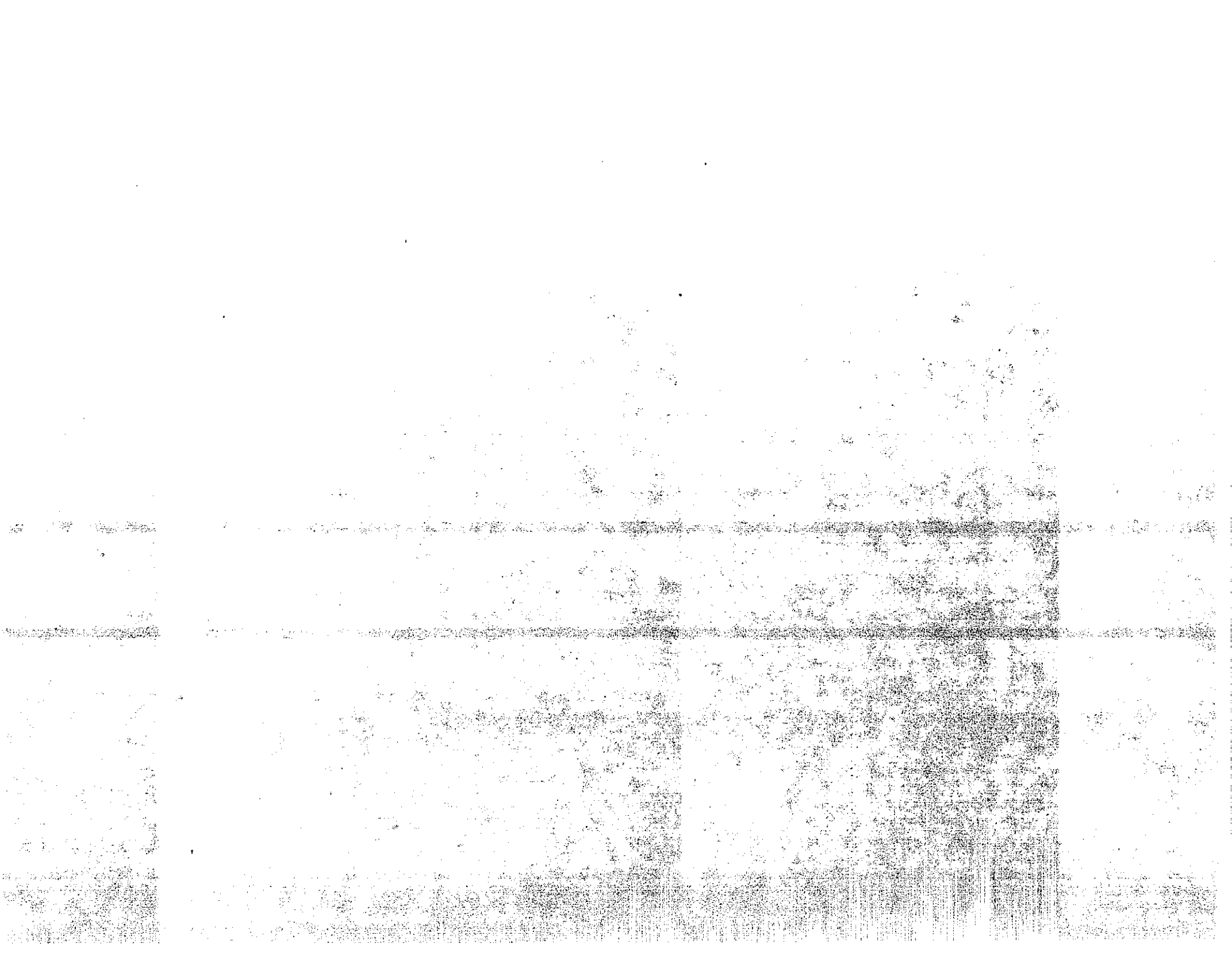
* Numbers in parentheses refer to a reference list at the end of this report.

VI. REFERENCES

1. Dusel J. P. et al, "Effectiveness of Stockbridge-Type Vibration Dampers on Reducing Fatigue Failures of Luminaires and Mast Arms on Lighting Standards Installed on Bridges", California Department of Transportation, Translab research report No. 641139, June 1986.

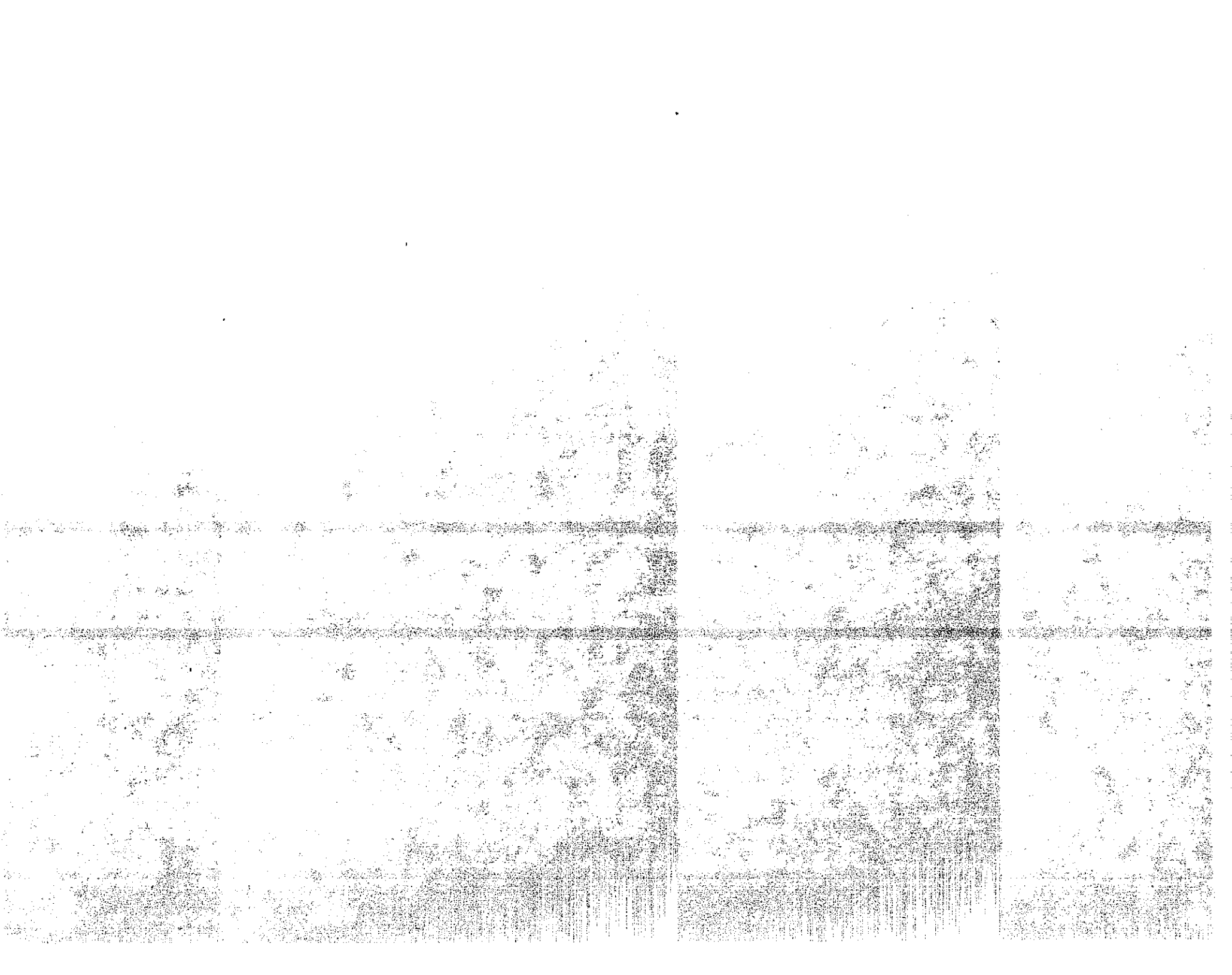
2. Van Dusen, H.A. Jr., "Vibration Testing of Luminaires", Illuminating Engineering, January 1980, p. 115.

3. Van Dusen, H.A. Jr., "Street Lighting Luminaire Vibration", Illuminating Engineering, Vol. 63, No.. 2, February 1968, p. 67.

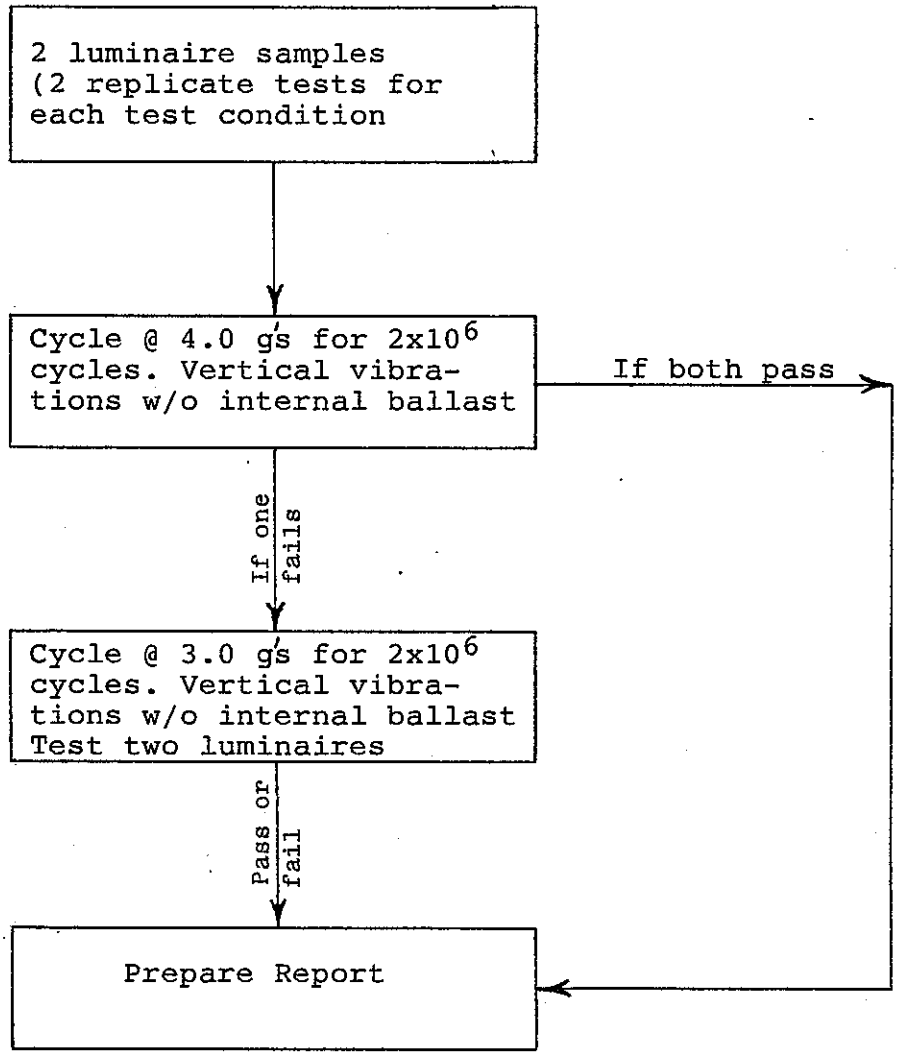


APPENDIX A

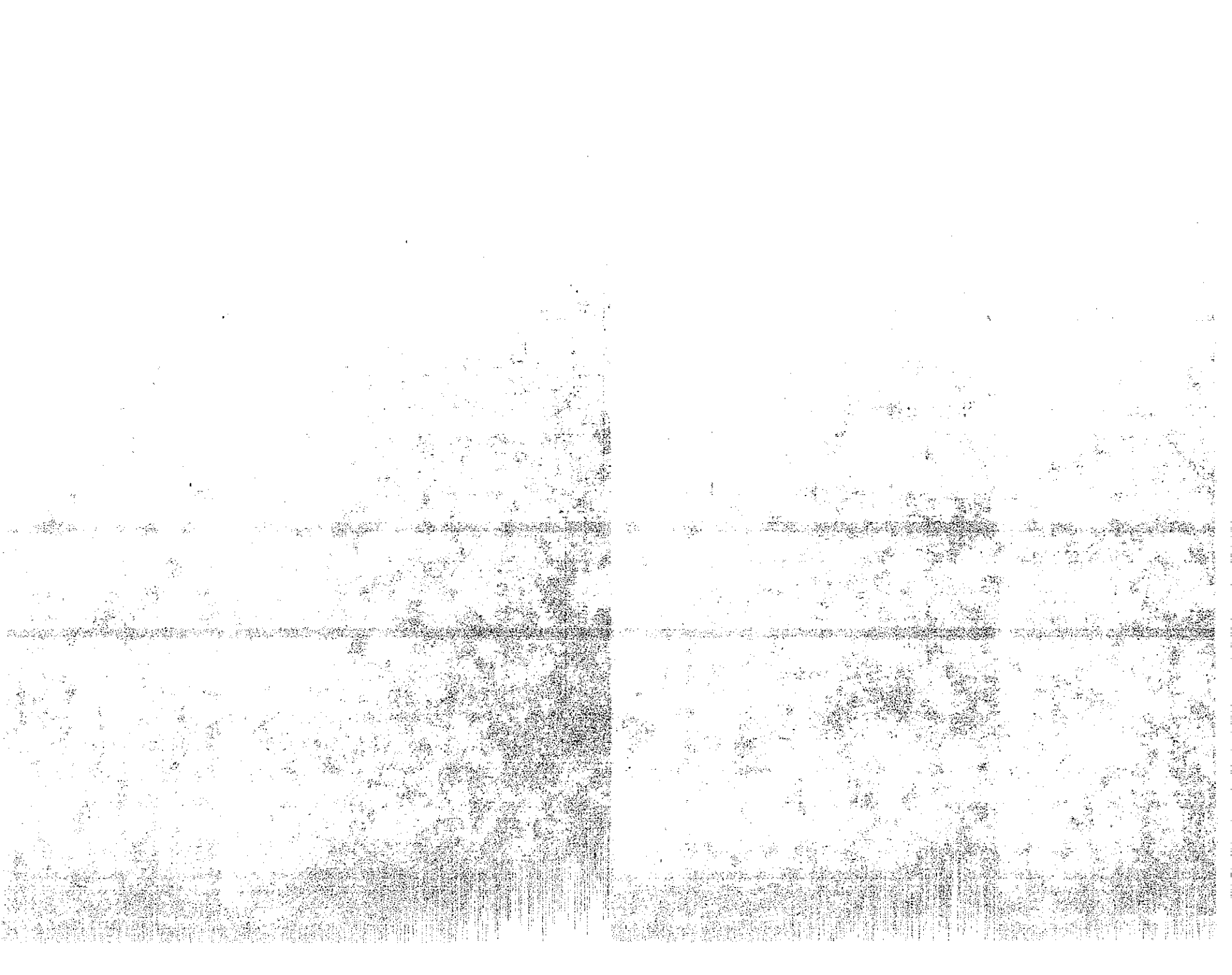
FLOW CHART OF THE TESTING PROGRAM



FLOW CHART OF THE TESTING PROGRAM



Note:
1. All g values shown above are peak-to-peak.
2. The vibration frequency should be kept under natural (resonant) frequency to insure stable vibrations.



APPENDIX B

MANUFACTURERS' INSTALLATION INSTRUCTIONS

25-000 & 26-000 LUMINAIRE INSTALLATION INSTRUCTIONS

I. **REMOVE LOWER HOUSING**

1. Open lower housing by pulling forward on front latch.
2. Pull down on wire latch located on inside rear surface of lower housing.
3. Slide lower housing off hinge bar.

II. **INSTALL**

1. Loosen fitter clamp bolts.
2. Slip on mast arm.
3. For 1½" mast arm, torque bolts to 15 Ft. Lbs. or 1/16" deflection. For 2" mast arm, to 10 Ft. Lbs. or 1/16" deflection.

III. **INPUT VOLTAGE** If the voltage available is different from that shown on the terminal board, consult the wiring diagram for directions. (Multivolt units are normally wired for 120 volts. To change follow instructions inside fixture.)

IV. **LEVELING**

A two-way leveling pad is provided on top of upper housing.

1. Place level on leveling pad.
2. Tighten all four fitter bolts.

FRONT END LOW

3. Loosen two front bolts and tighten two rear bolts.
4. Repeat 3. as necessary until unit is level.

FRONT END HIGH

3. Loosen two rear bolts and tighten two front bolts.
4. Repeat 3. as necessary until unit is level.

V. **INSTALLING LOWER HOUSING (Luminaire on Mast Arm)**

1. Slide lower housing hinge over upper housing hinge bar.
2. Slide hinge spring over hinge bar.
3. Swing the lower housing up to the upper housing and press firmly upward until latch snaps into position.

VI. **TYPE & DISTRIBUTION ADJUSTMENT**

LAMP	TYPE	SOCKET SETTING VERT	HORZ.
Polycarb 400W Mercury/MH	II MSC	2 w/o spacer	A
Polycarb 400W Mercury/MH	III MSC	3 w/o spacer	A
Flat Lens 400W Mercury/MH	II MC	3 w/o spacer	A
Flat Lens 400W Mercury/MH	III MC	3 w/o spacer	A
Flat Lens 250W Mercury/MH	II MC	3 w/spacer	D
Flat Lens 250W Mercury/MH	III MC	3 w/o spacer	C
Drop Lens 250W Mercury/MH	III MC	3 w/spacer	D
Drop Lens 400W Mercury/MH	II MSC	3 w/o spacer	C
Drop Lens 400W Mercury/MH	III MSC	3 w/o spacer	A
Drop Lens 400W Mercury/MH	IV MSC*	3 w/o spacer	A
Drop Lens 50-150W HPS	III MSC	2 w/spacer	B
Drop Lens 50-150W HPS	II MSC	2 w/spacer	D
Flat Glass 50-150 HPS	III MSC	3 w/spacer	A
Drop Lens 200-400W HPS	II MSC	3 w/spacer	D
Drop Lens 200-400W HPS	III MSC	3 w/o spacer	D
Polycarb 200-400W HPS	II MSC	2 w/spacer	A
Polycarb 200-400W HPS	III MS	3 w/o spacer	D
Drop Lens 200-400W HPS	IV MSC	3 w/o spacer	A
Flat Glass 200-400W HPS	II MC	3 w/spacer	C
Flat Glass 200-400W HPS	III MC	3 w/spacer	B

*NOTE: Type IV MV/MH available coated lamp only.

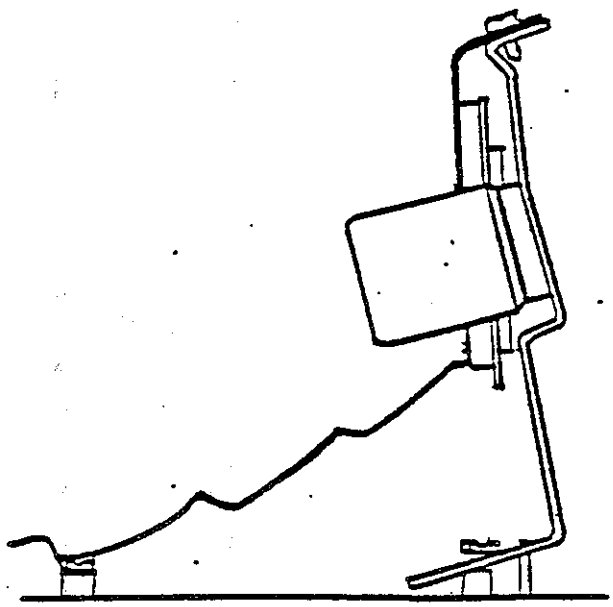
NOTE: IT IS NEVER NECESSARY OR ADVISABLE TO SLAM THE HOUSING CLOSED.

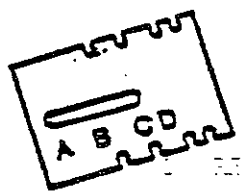
PART NUMBER 0587128370
DWG. NUMBER 63150-
Rev. C

ITT LIGHTING

400 WATT HORIZONTAL SOCKET ADJUSTMENT

SOCKET POSITION IS NORMALLY SET FOR TYPE III MED. SEMI-CUTOFF, UNLESS OTHERWISE SPECIFIED ON ORDER





1. REMOVE LAMP
2. REMOVE SCREW IN CENTER OF REFLECTOR AND SCREW IN REFLECTOR FLANGE.
3. LIFT REFLECTOR AND SLIDE OUT OF UNIT.
4. LOOSEN SCREW IN SOCKET BRACKET, SLIDE BRACKET FORWARD OR BACK TO LINE SCREW UP WITH DESIRED POSITION, A,B,C, OR D. TIGHTEN SCREW.
5. REMOVE SOCKET SCREWS TO MAKE VERTICAL SOCKET CHANGE AS REQUIRED BY CHART ON BACK OF INSTRUCTION SHEET.
6. REPLACE REFLECTOR OVER SOCKET, ALINE HOLE IN REFLECTOR FLANGE WITH BRACKET HOLE, WHICH AGREES WITH THE LETTER USED IN STEP 4. REPLACE SCREW.
7. REPLACE REFLECTOR SCREW AND TIGHTEN. RELAMP.

PART NUMBER 0587125370
DWG. NUMBER

LIGHTING

INSTRUCTIONS

M-400A2 POWR/DOOR LUMINAIRES

READ THOROUGHLY BEFORE INSTALLING

GENERAL

This luminaire is designed for outdoor lighting service, and should not be used in areas of limited ventilation, or in high ambient temperature enclosures. Best results will be obtained if installed and maintained according to the following recommendations.

UNPACKING

This luminaire has been properly packed so that no parts should have been damaged during transit or overlooked in packing. Inspect to confirm.

CAUTION: GLASS REFRACTORS MUST BE PROTECTED FROM SURFACE CHIPS AND SCRATCHES. EVEN MINOR SURFACE DAMAGE WILL REDUCE THE BREAKAGE RESISTANCE TO A FRACTION OF ITS INITIAL STRENGTH.

INSTALLATION

The Powr/Door luminaires have a captive screw required to secure the door to the top housing. In addition, a convenience latch is provided for "TEMPORARILY" holding the door in position while the captive screw is loosened or tightened. To secure the door to the top housing the captive screw **MUST BE TIGHTENED.**

Remove the rear door by loosening the captive screw and unlatching. Rotate door to the vertical position. Now grasp the door securely in both hands and rotate the door backwards until it comes free from the hinges in the top housing. This occurs at approximately 35 degrees from vertical on the pole side of the hinge. In this position the hinge pins will easily slide upward out of their hinges in the top housing.

The pipe clamp accommodates 1¼ inch through 2 inch pipe brackets.

NOTE: The luminaire is shipped with pipe clamp oriented for 2 inch pipe brackets. If 1¼ inch pipe is used, the four bolts must be removed, the pipe clamp turned over, and bolts re-assembled.

If necessary, adjust the 4 pipe clamp bolts such that the opening is slightly larger than the pipe size being used. The birdshield behind the slipfitter clamp comes with an opening for 1¼ inch pipe. If a larger pipe size is used, detach the knockout to provide a larger opening. Insert the pipe carefully through the birdshield and into the back of the luminaire until it hits the stop pin which sticks down from the top of the housing.

The luminaire may be adjusted up or down 5 degrees with respect to the pipe. A circular pad is provided on the top of the top housing for convenient application of a hand level.

To mount, hold the luminaire approximately level and snug up the bolts (4-5 foot-pounds). If more upward tilt of the front of the luminaire is needed, first loosen the front two bolts slightly, lift the luminaire and re-snug the back two. If downward tilt is needed, reverse the procedure by loosening the back two bolts first.

Once the proper level has been achieved, tighten each bolt to 10-12 foot-pounds, alternating front to back along the diagnal of the bracket as shown in Figure 1. If a torque wrench is not available, the correct torque may be achieved by turning the bolts two to three full turns (or until bottoming occurs) past their "snug" position. This should be done one turn at a time alternating in the pattern according to Figure 1 (back page).

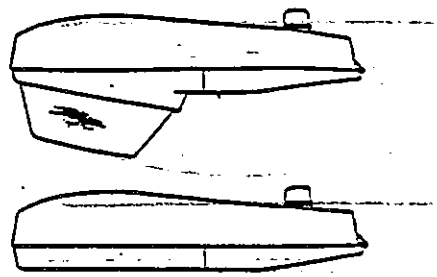
NOTE: Correct tightening of the bolts is important to insure proper function of the mounting system. Under no circumstances should the bolts be torqued to a level less than 10 foot-pounds or greater than 20 foot-pounds.

PHOTOELECTRIC CONTROL

When a photoelectric control is used, the photoelectric receptacle should be oriented so that the word "North" is directed toward the true north direction. This can be easily done by seating a photoelectric control into the receptacle, lifting upward on the photoelectric control (which will lift the photoelectric receptacle also), and rotating them clockwise until the word, "North", is directed toward the true north direction. Then lower the photoelectric control and receptacle to firmly seat them into position. No tools are required to make this orienting adjustment.

Alternately, the photoelectric receptacle can be oriented before the photoelectric control is installed. This is done by lifting up on the rim of the photoelectric receptacle and rotating it until the

INSTALLATION INSTRUCTIONS RL - SERIES



READ THOROUGHLY BEFORE INSTALLING

NOTE:
This luminaire is designed for outdoor lighting applications and should not be used in areas of high ambient temperature enclosures or limited ventilation.

WARNINGS:
Dangerous voltages exist within these units and all precautions usually observed in handling high voltage equipment should be observed when replacing lamps or otherwise servicing luminaires. Disregarding this warning could result in electrical shock and possible injury to the individual installing or servicing this equipment. **Installation and servicing should be done by qualified personnel.**

Read lamp manufacturer warning notice on lamp carton before handling or installing. Do not install a damaged lamp.

Make certain power is off before starting installation or performing any maintenance.

Glass must be protected from surface chips and scratches. Even minor surface damages will reduce the breakage resistance to a fraction of its initial strength.

I. REMOVAL OF POWER/ACCESS DOOR

1. Unit may be supplied with one or both of the power/access door fastening methods listed below:
   a. Self-captivating screw: Loosen screw until threads are fully disengaged.
   b. Spring-loaded latch: Pull latch forward until door swings free.

   Note: Always keep support under power/access door to ensure against damage to fixture or personal injury.
2. For power door removal, lower the door to a vertical position and disengage the polarized disconnect plug connecting the upper housing wiring to the power door wiring center.
3. Rotate power/access door to approximately 45 degrees from vertical to the pole end of fixture. Door will now easily lift from hinge seats.

II. INSERTION OF MAST ARM

1. This luminaire will accommodate mounting on either a 1¼" or 2" mast arm. Mounting is as follows:
   a. 1¼" mast arm: Remove the four 3/8" bolts securing the fitter clamps. Turn fitter clamps over and reinstall four 3/8" bolts. Insert mast arm through birdshield and fitter clamps until arm hits stop on housing.
   b. 2" mast arm: Detach the knockout in the birdshield to provide a larger opening. Insert mast arm through birdshield and fitter clamps until arm hits stop on housing.

III. LEVELING

The luminaire is supplied with four leveling pads on top of the unit for plus or minus 5 degrees horizontal adjustment with respect to the mast arm. Adjustments are made as follows:

1. Hold the luminaire approximately level and tighten the four 3/8" slipfitter bolts.
   a. If more upward tilt is required, loosen the two forward bolts slightly and tighten the two rear bolts.
   b. If more downward tilt is required, loosen the two rear bolts slightly and tighten the two forward bolts.
2. After leveling, tighten all four bolts to 18-20 foot-pounds.

IV. WIRING

Note: Unless otherwise specified, all multi-voltage ballasts are factory wired as follows:

120/240V - Wired for 120 Volt
240/480V - Wired for 480 Volt
Quad Tap - Wired for 277 Volt

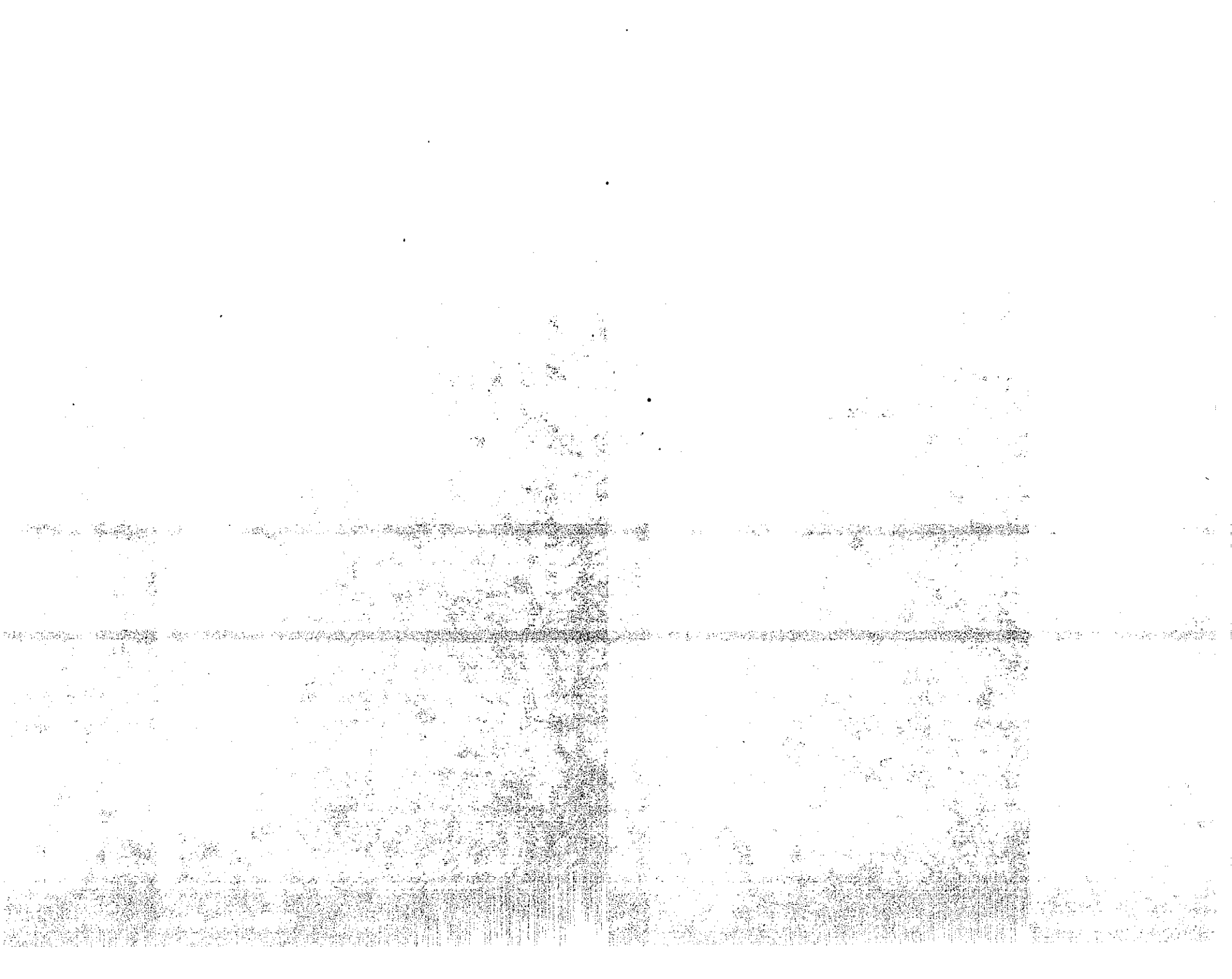
1. Attach service leads to the terminal block as shown on the wiring diagram. Luminaire voltage is shown on the luminaire nameplate. Terminal block will accept service leads ranging in size from AWG No. 14 through No. 8. Service leads should have 75°C minimum insulation.

268-0531-9909
REV. A

lighting division
HARVEY HUBBELL INCORPORATED Electric Way, Christiansburg, Virginia 24073 (703) 382-6111

APPENDIX C

SECTION 86-6.01 OF CURRENT (JULY 1984) CALTRANS STANDARD SPECIFICATIONS



and a nickel content of at least 8 percent.

86-6 LIGHTING

86-6.01 High-Intensity-Discharge Luminaires.—High-intensity-discharge luminaires shall be the enclosed type with a horizontal burning lamp. Luminaires shall be either a semi-cutoff type or a cutoff type, and shall be provided with a high-pressure sodium lamp.

Semi-cutoff luminaires shall be provided with a refractor and a glare shield. Each luminaire shall consist of a housing, a reflector, a refractor or a lens, a lamp socket, an integral ballast, a terminal strip and a lamp.

Housings and glare shields shall be fabricated from aluminum. Housings and glare shields that are painted shall withstand a 1,000-hour salt spray test as specified in ASTM Designation: B 117.

All other metal parts of the housing shall be fabricated from metal at least equal in corrosion resistance and finish to the metal in the housing.

Each housing shall be provided with a slipfitter capable of mounting on a 2 inch pipe tenon and of being adjusted ±5 degrees from the axis of the tenon.

The surface of each reflector shall be specular and shall be protected by either an anodized finish or a silicate film. The reflector shall be shaped so that a minimum of light is reflected through the arc tube of the lamp.

Each refractor or lens shall be mounted in a frame that is hinged to the housing and secured with a spring-loaded automatic latch. Each refractor shall be made of glass or polycarbonate plastic. Each lens shall be made of heat and impact resistant glass.

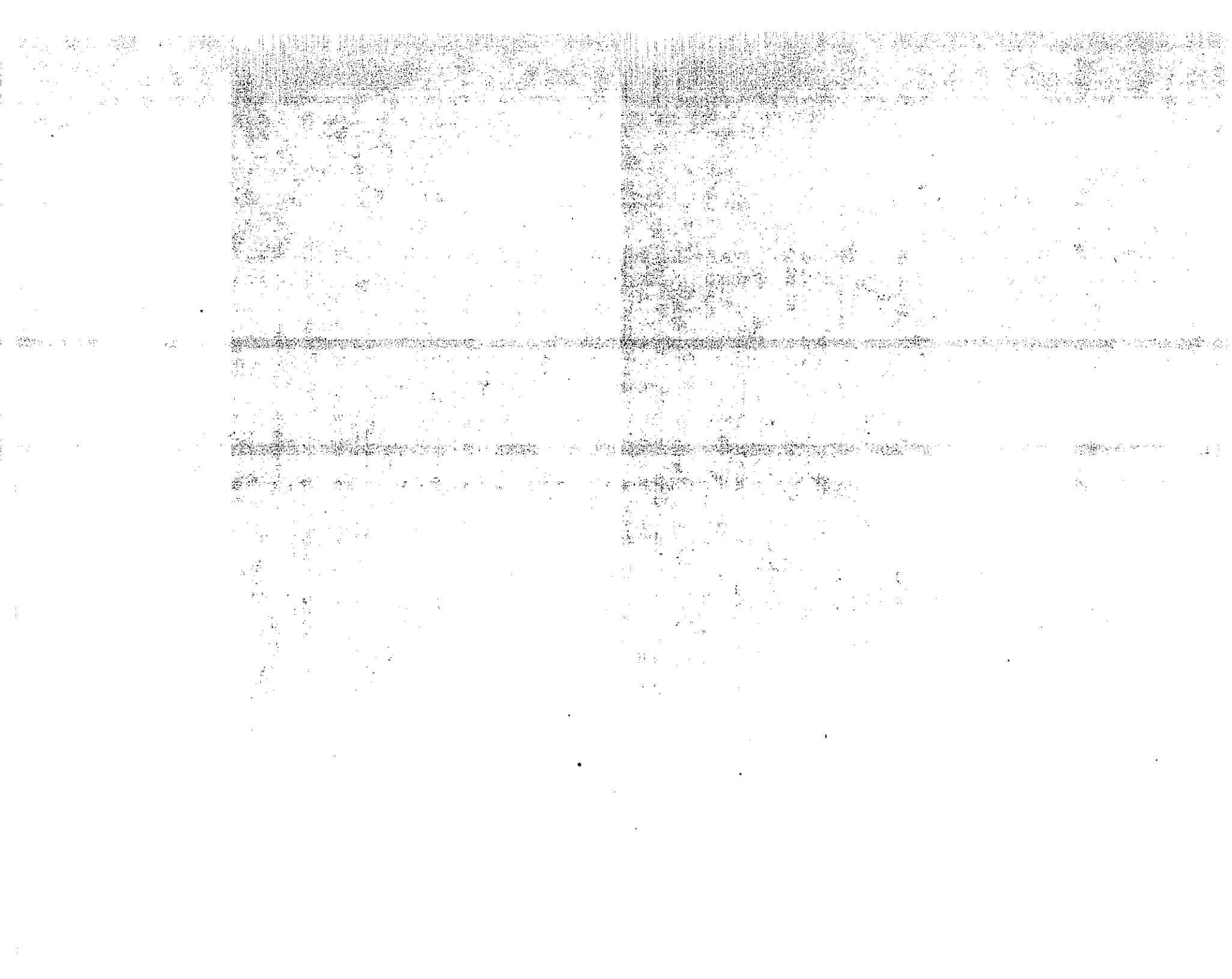
The optical system, consisting of the reflector, refractor or lens, lamp socket and lamp, shall be in a sealed chamber. Sealing shall be provided by a gasket between the reflector and refractor or lens and a gasket between the reflector and lamp socket. The chamber shall have provision for filtered flow of air in and out of the chamber due to lamp heat. Filtering shall be accomplished by either a separate filter or a filtering gasket.

Each lamp socket shall be a porcelain enclosed mogul-multiple type. The shell shall contain integral lamp grips to assure electrical contact under conditions of normal vibration. The socket shall be mounted in the luminaire in a manner to permit pre-setting a variety of specified light distribution patterns. The socket shall be rated for 1,000 watts and shall withstand a 5-kilovolt rms high potential test.

Field wires connected to the luminaire shall terminate on a barrier type terminal block secured to the housing. The terminal screws shall be captive and equipped with wire grips for conductors up to No. 6. Each terminal position shall be clearly identified.

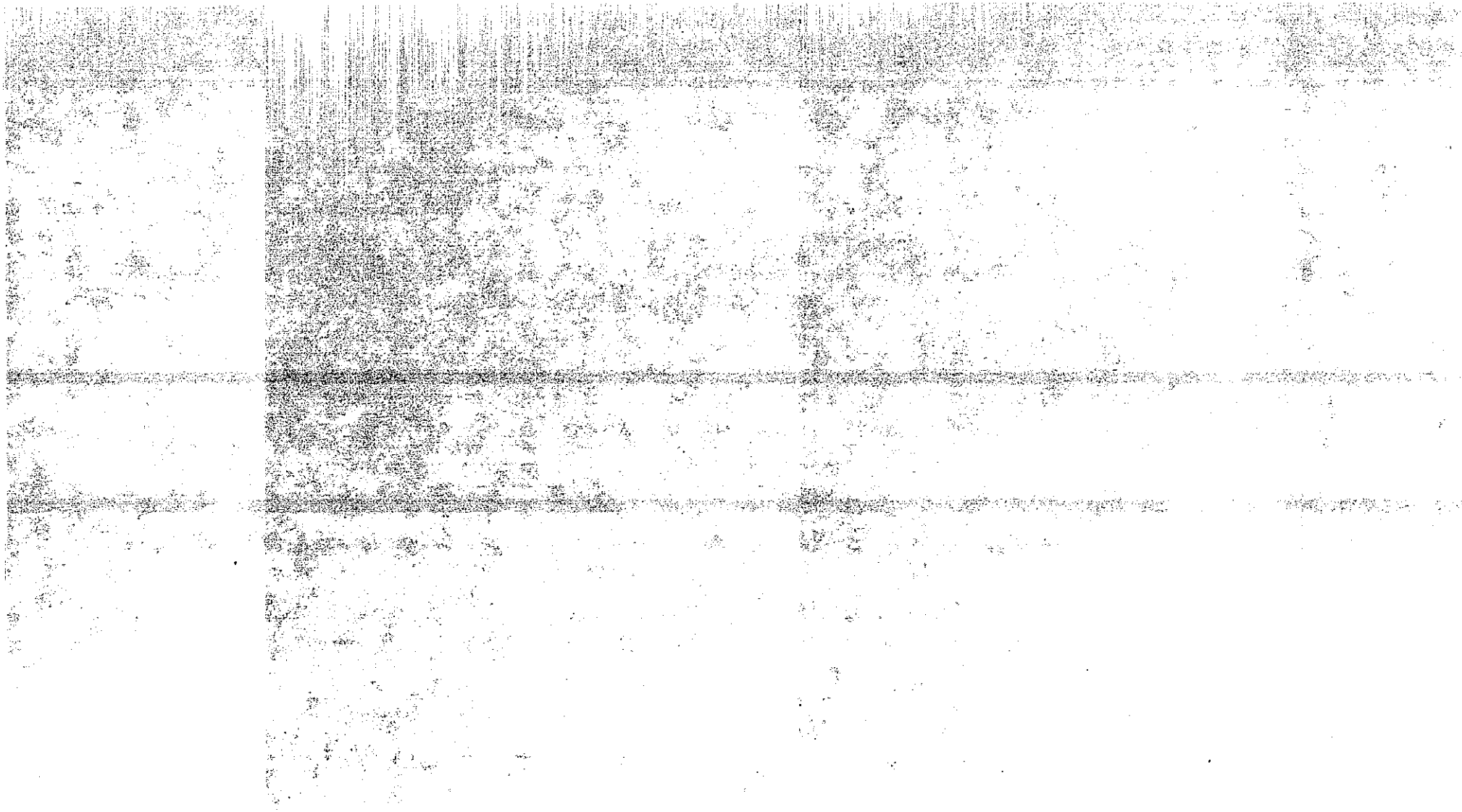
The minimum light distribution for each luminaire shall be as shown on the isofootcandle diagrams on the plans.

The maximum brightness of each semi-cutoff and cutoff luminaire, with the lamp indicated, shall be as follows:



APPENDIX D

MANUFACTURER'S VIBRATION TESTING CRITERIA



FL AMERICAN ELECTRIC

FL INDUSTRIES, INC.
AMERICAN ELECTRIC DIVISION
P.O. Box 100
Southaven, MS 38671
601-342-1545
Telex: 53952

January 21, 1986

Dr. Aspet Ordoubigian
Trans Lab Structural Materials
Research Branch
5900 Folsom Blvd.
Sacramento, CA 95819

Subject: American Electric Vibration Testing

Dear Aspet:

As we discussed, American Electric (formerly ITT Outdoor Lighting) uses vibration test equipment (reference attached Facilities Brochure and equipment literature) as part of its mechanical qualification of fixture designs. A luminaire is installed to a rigid member attached to the vibration table and a "frequency scan" is done to determine the luminaire's resonant frequency. At that resonant frequency, the luminaire is vibrated for 100,000 cycles at 1.5 g's force in both the horizontal and vertical planes.

In regard to Trans Lab investigation of the ramifications of using pole base mounted ballasts instead of integral ballasts, we suggest the following:

1. High pressure sodium lamps require a high voltage pulse to start. Special ballasts that operate at higher stress levels are needed to generate these pulses in pole base applications. (Suggest you contact Dave Sampson, Connecticut DOT for additional input.)

2. Removing the weight (ballast) from the luminaire will tend to "undampen" the unit subjecting the lamp itself to higher mechanical stress.

Aspet, if we can provide additional information, please let us know.

Very truly yours,

AMERICAN ELECTRIC

J. D. McIngvale, Jr., P. E.
Manager of Product Engineering

JDM/ss

cc: Mr. Merle Wilson, Assoc. EE, Trans Lab
Mr. Dal Black, Black & Egbert Assoc. #2098
Mr. Jay Brown
Mr. Bill Bacon
Mr. Larry Lydick

SUBJECT	TAB	
VIBRATION TESTING INSTRUCTIONS	Std. Test Method	06.326

STANDARDS

GENERAL

Dynamic stresses imposed on luminaires in service result from four principal causes:

1. Wind induced vibration of lighting structures such as luminaire and pole assemblies and floodlights on towers or poles.

2. Traffic induced movement transferred to the luminaire from a bridge or overpass, being generated by the passage of vehicles. A similar type of loading is experienced by floodlights and industrial type fixtures mounted in areas adjacent to heavy rotating equipment, gantry cranes, punch presses, etc.

3. Wind loading, particularly high velocity wind creating a dynamic pressure on the projected area of the luminaire.

4. Handling, shipping and accidental impact loading on the luminaire.

METHODS

Vibration testing provides a means of laboratory simulation for these conditions but several modes of testing are required to cover the variety of conditions.

A. Sustained Vibration Endurance Tests:

This provides a measure of fatigue evaluation for wind induced and traffic induced types of vibration. Recommend 2g acceleration intensity measured at the luminaire center of gravity for 100,000 cycles at each of the three major axes (two horizontal and one vertical). Frequency and amplitude adjusted for the required 2g acceleration such that the frequency is not the fundamental resonant frequenty of the luminaire.

$$Ag = 2 = 0.0511\ f^2\ D$$

Where: Ag = Acceleration, g units
f = frequency, Hz
D = displacement, total excursion, inches

by G F Johnston

7-1

SUBJECT	TAB	NO.
VIBRATION TESTING INSTRUCTIONS	Std. Test Method	06.326.001

B. High Loading Vibration Test:

This provides a measure of high velocity wind loading and low impact loading evaluation.

Recommend 4g acceleration intensity measured at the luminaire center of gravity for 5000 cycles at each of two major horizontal axes. The frequency and amplitude adjusted for the 4g acceleration such that the frequency is not the fundamental resonant frequency.

Additional References:

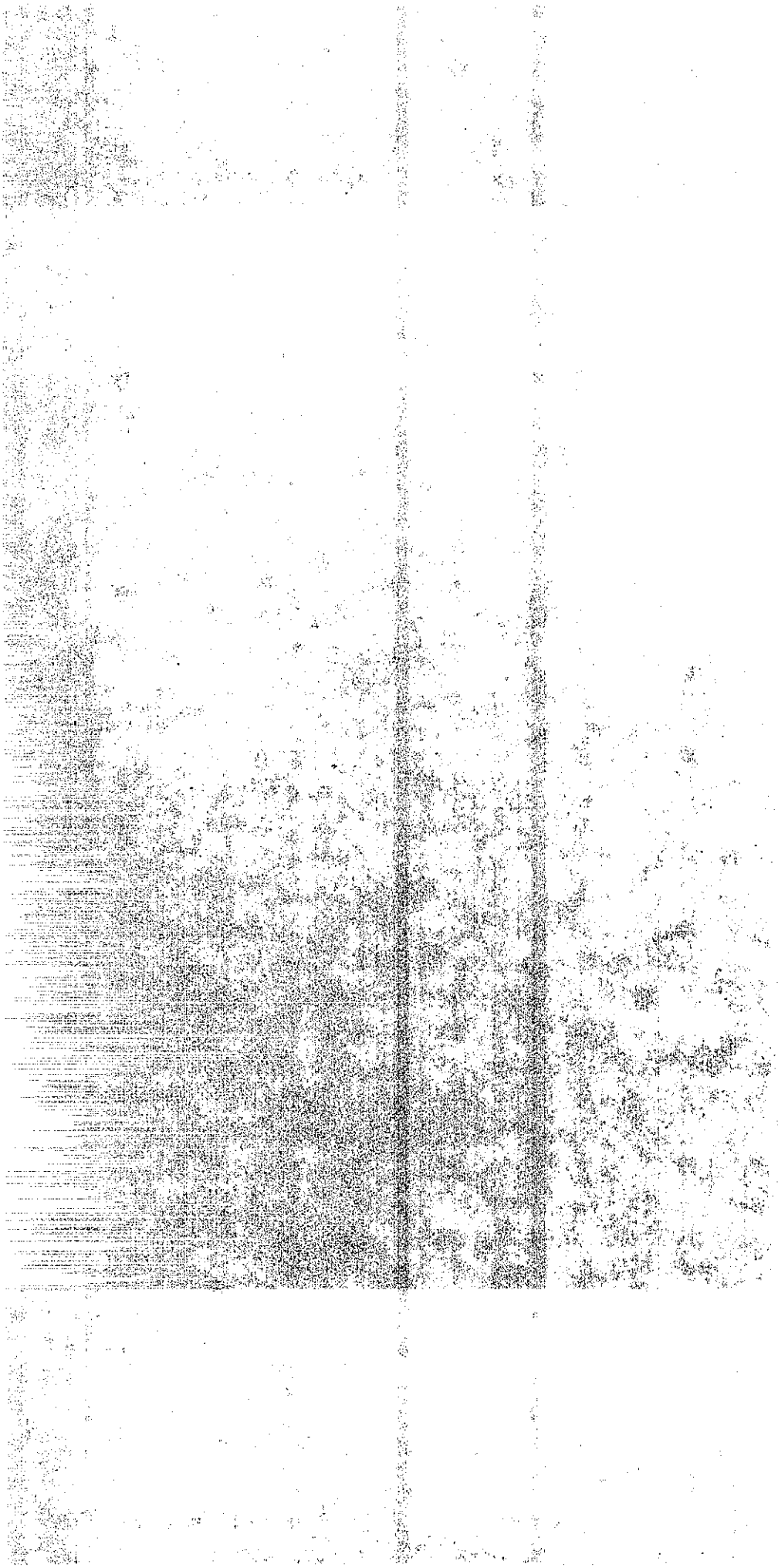
1. "Street Lighting Luminaire Vibration" Van Dusen, Illuminating Engineering, Feb. 1968.
2. "Vibration of Street Lighting Poles and Luminaires" EEI-NEMA Pub. SH67-53, Sept. 1967.

"Hubbell Lighting" has not furnished us with any published vibration testing instructions. However, Steve Holdaway of "Associated Lighting Representatives, Inc." who is representing Hubbell Lighting has given us the following testing procedure which Hubbell Lighting test their luminaires.

Cycle at 1 g (peak) for 100,000 cycles both in horizontal and vertical directions.

APPENDIX E

CURRENT BOLT SPECIFICATIONS PROVIDED BY AMERICAN ELECTRIC AND GENERAL ELECTRIC



AMERICAN ELECTRIC
A DIVISION OF FL INDUSTRIES, INC.

P.O. BOX 100
SOUTHAVEN, MS 38671
TELEPHONE 601-342-1545 • TELEX 53-952

March 3, 1986

Mr. Aspet Ordoubigian
Transportation Laboratory
Structural Materials Branch
5900 Folsom Blvd.
Sacramento, CA 95819

Dear Mr. Ordoubigian:

Subject: Screw 3/8"-16 x 1-3/4" Hex Washer Head
P/N 052-14-24578, Spec 4313

Per your request, enclosed is a copy of Spec 4313 for the above part. Also, coating specs 3634 and 3637 are included.

Sincerely,

David Teague
Production Engineer

DET/gd

cc: Ernie Albonetti

WRITTEN	DATE
JRD	11/30/82
APPR. JRD	DATE 11/30/82

SPECIFICATION SHEET

SPEC. NO. 4313

PART NO. 052-14-24578

DESCRIPTION: SCREW

3/8-16 x 1-3/4" HEX WASHER HEAD, STEEL THREAD ROLLING SCREW.

TYPE TT, SW & SF CONFORMING TO STANDARD IFI 112.

STEEL SHALL BE COLD HEADING QUALITY, KILLED STEEL, CONFORMING TO ANSI 1019-1022.

FINISH PER ITT SPEC 3634 OR 3637. WAX COATING APPLIED BY VENDOR IS MANDATORY.

HEAD DIMENSIONS TO CONFORM TO ANSI B18.6.4.

SCREWS TO BE TREATED FOR HYDROGEN EMBRITTLEMENT AFTER PLATING IF ELECTRO-PLATING PROCESS IS USED OR IF SCREW IS EXPOSED TO ACID.

WHEN SUBJECTED TO THE FOLLOWING TESTS, DURING RECEIVING INSPECTION:

1. TORSIONAL STRENGTH TEST, PER IFI-112-3.5.
2. HARDNESS TEST, ACCORDING TO IFI-112-2.3.1.
3. CHEMICAL ANALYSIS.

BOLTS WILL HAVE TO ADHERE TO THE FOLLOWING RESULTS:

1. MINIMUM TORQUE VALUE 50 FT-LBS.
2. HARDNESS TEST RC 28-38 CORE
   RC 45 MIN. CASE
3. CONFIRM BY ANALYSIS THAT THE STEEL IS ANSI 1019-1022.

DRAWN	DATE
MJW	
APPR.	DATE
EAA	12/8/81

SPECIFICATION SHEET

SPEC. NO. 3634

PART NO. COATING SPEC

DESCRIPTION:

TEB-KOTE FASTENER FINISH
POLYSEAL FASTENER FINISH
DORRLTONE FASTENER FINISH
SERMAGARD FASTENER FINISH

CORROSION RESISTANCE: SHALL WITHSTAND 500 HOURS MINIMUM OF 5% SALT SPRAY TEST TO LATEST REVISION OF ASTM SPEC. #B117-64

COLOR: BLACK PREFERRED, GRAY ACCEPTABLE

COATING: AN AQUEOUS COATING CONTAINING CHROMIUM AND/OR ZINC AND OTHER PROPRIETARY ORGANICS. APPLIED BY SPRAY, FLOW COAT, OR DIP METHOD.
SEAL OR FINISH SHALL NOT UPSET DIMENSIONAL TOLERANCES NOR CAUSE ANY LOSS OF HARDNESS AND/OR TEMPERING.

COATING SHALL NOT CRACK, PEEL NOR FLAKE OFF WHEN FASTENERS ARE DRIVEN INTO STEEL BRACKETS, ALUMINUM CASTING, OR ANY OTHER METAL PARTS.

WRITTEN MJW	DATE 5/17/83
APPR. EAA	DATE 5/17/83

SPECIFICATION SHEET

SPEC. NO. 3637

PART NO. COATING SPEC

DESCRIPTION:

TEB-KOTE FASTENER FINISH
POLYSEAL FASTENER FINISH
DORRLTONE FASTENER FINISH
SERMAGARD FASTENER FINISH

CORROSION RESISTANCE: SHALL WITHSTAND 240 HOURS MINIMUM OF 5% SALT SPRAY TEST TO LATEST REVISION OF ASTM SPEC. #B117-64

COLOR: BLACK PREFERRED, GRAY ACCEPTABLE

COATING: AN AQUEOUS COATING CONTAINING CHROMIUM AND/OR ZINC AND OTHER PROPRIETARY ORGANICS APPLIED BY SPRAY, FLOW COAT, OR DIP METHOD.

SEAL OR FINISH SHALL NOT UPSET DIMENSIONAL TOLERANCES NOR CAUSE ANY LOSS OF HARDNESS AND/OR TEMPERING.

COATING SHALL NOT CRACK, PEEL NOR FLAKE OFF WHEN FASTENERS ARE DRIVEN INTO STEEL BRACKETS, ALUMINUM CASTINGS OR ANY OTHER METAL PARTS.

3-3-86

MR. A. ORDOUBIGIAN:

ENCLOSED YOU WILL FIND A COPY OF OUR SKIFFITTER SCREW DRAWING AND SPECIFICATION, ALONG WITH THE ZINC FINISH SPECIFICATION.

I HAVE ALSO INCLUDED A COPY OF THE IFI (INDUSTRIAL FASTENER INSTITUTE) TABLE GIVING THE MECHANICAL PERFORMANCE REQUIREMENTS FOR ~~THESE~~ SCREWS.

THE TENSILE AND YIELD STRENGTH OF THE CORE OF THESE SCREWS SHOULD BE:

T. S. - 120 - 135,000 psi
Y. S. - 95 - 115,000 psi

LET US KNOW IF WE CAN BE OF FURTHER HELP.

H. T. Gregg

704-693-2144

GENERAL ELECTRIC

993729
CONT ON SHEET 2 SH NO 1

TITLE THREAD FORMING TAPPING SCREW-TYPE C WITH HEX WASHER HEAD

FIRST MADE FOR

REVISIONS

FOR SPECIFICATIONS SEE SHEETS 2 AND 2.1
FOR DIMENSIONS SEE SHEET 3

FINISH: A-NO FINISH
B-F70B4E2 (ZINC ELECTROPLATE W/CHROMATE) COATING
C-F50WA106A (CADMIUM ELECTROPLATE W/CLEAR) CHROMATE COATING & POLYMER COATING)

PT.	SIZE	LENGTH	FINISH	REVISION		
01	3/8-16	2"	B			
02	3/8-16	2"	C			
03	3/8-16	1 5/8	B			
04	3/8-16	1 5/8	C			

PRINTS TO

D. TAYLOR
SW-492-85 7-29-85

APPROVALS

DIV OR DEPT.

LOCATION CONT ON SHEET 2

993729
SH NO 1

GENERAL ELECTRIC

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CONT ON SHEET 2.1 SH NO 2

TITLE

THREAD FORMING TAPPING SCREW - TYPE C
WITH HEX WASHER HEAD

FIRST MADE FOR

REVISIONS

SPECIFICATIONS

Material: Screws shall be made from cold heading quality, fine grain (ASTM 112 No. 6-9), low carbon steel wire conforming to the following chemical composition.

Carbon	.13 - .25%
Manganese	.60 - 1.65%
Phosphorous	.04% max.
Sulphur	.05% max.

Heat Treatment: Screws shall be carburized or carbonitrided and quenched to 90% min. martensitic structure. Tempering shall be at 650°F. min.

Case Depth:

Size	Min.	Max.
4 - 6	.002"	.007"
8 - 12	.004"	.009"
1/4 and larger	.005"	.012"

Hardness: Core R_C 28 - 38
Case R_C 45 min.

Finish: See Sheet 1

Hydrogen Embrittlement: Unlubricated screws shall be threaded into a tapped hole or free running nut having a thickness of at least 1-1/2 times the nominal thread diameter. The head of the screw shall bear on a flat surface or washer perpendicular to the axis of the screw. Spacers may be used providing there is full thread engagement in the threaded hole or nut. Screws shall withstand the following torques for 48 hours without fracture. The original torque shall be reapplied at the end of 48 hours prior to removing the screws from test.

Size	Torque, lb. ft.
1/4 - 20	11
5/16 - 18	23
3/8 - 16	42.5
7/16 - 14	60
1/2 - 13	77.5

PRINTS TO

DRAWN BY D. TAYLOR

APPROVALS

DW OR DEPT.

LOCATION

ISSUED EN-493-85 7-29-85

9 9 3729

CONT ON SHEET 2.1 SH NO 2

CODE IDENT NO

GENERAL ELECTRIC

993729 CONT ON SHEET 3 SH NO. 2.1

REV NO

TITLE THREAD FORMING TAPPING SCREW-TYPE C WITH HEX WASHER HEAD

CONT ON SHEET SH NO.

FIRST MADE FOR

REVISIONS

SPECIFICATIONS

Torsional Strength: Screws shall meet the following minimum torsional strength requirements:

Size	Torque, lb. ft.
1/4 - 20	13
5/16 - 18	27.5
3/8 - 16	50
7/16 - 14	70
1/2 - 13	90

PRINTS TO

MADE BY D. TAYLOR

APPROVALS

DIV OR DEPT.

LOCATION

EN-493-85 7-29-85

993729 CONT ON SHEET 3 SH NO 2.1

CODE IDENT NO

GENERAL ELECTRIC

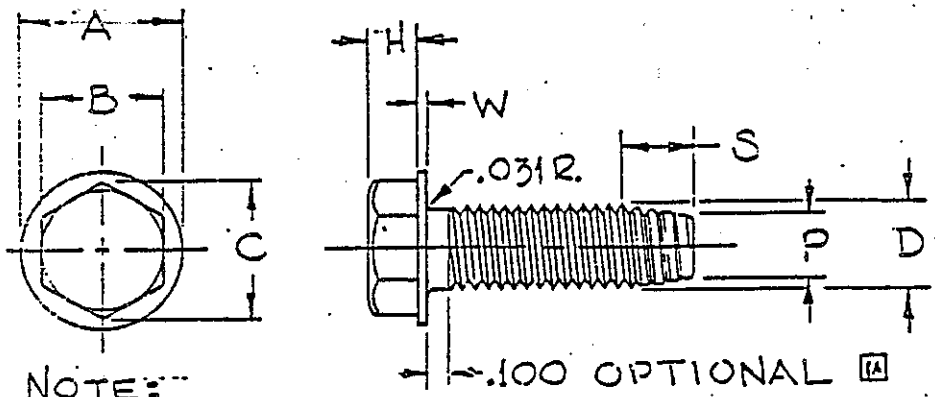
993729
CONT ON SHEET 4 SH NO. 3

TITLE THREAD FORMING TAPPING SCREW-TYPE C
WITH HEX WASHER HEAD

CONT ON SHEET SH NO.

FIRST MADE FOR

REVISIONS



NOTE:
UNLESS OTHERWISE SPECIFIED, SCREW TO BE THREADED ENTIRE LENGTH.

DIM.	SCREW SIZE					
	10-32	1/4-20	5/16-18	3/8-16		
'A'	.414 / .384	.520 / .480	.676 / .624	.780 / .720		
'B'	.312 / .305	.375 / .367	.500 / .489	.562 / .551		
'C'	.340	.409	.545	.614		
'D'	.190 / .183	.250 / .241	.313 / .303	.375 / .355		
'H'	.120 / .105	.190 / .172	.230 / .208	.295 / .270		
'P'	.158 / .148	.200 / .184	.257 / .239	.312 / .293		
'S'	.141 / .109	.225 / .175	.250 / .194	.281 / .219		
'W'	.031 / .015	.050 / .030	.055 / .033	.063 / .037		

1 IEN-97-86 RLT 2-10-86

PRINTS TO

DRAWN BY D. TAYLOR
5-19-85 7-29-85

APPROVALS

DIV OR DEPT.
LOCATION

993729
CONT ON SHEET 4 SH NO 3

CHROMATE TREATED BRIGHT ZINC ELECTROPLATE

SULFURIC ACID

Supersedes F70B4-S6

GE Finish F70B4 identifies bright surface zinc electroplate with a sulfuric acid-sodium dichromate treatment, as follows:

GE designation		Thickness min, inch (b)
Not treated	Treated to minimize danger from hydrogen embrittlement (a)	
F70B4A	F70B4A2	0.0002
F70B4B	F70B4B2	0.0005
F70B4C	"	0.001
F70B4D	F70B4D2	0.00015
F70B4E	F70B4E2	0.0003

(a) Specify for hardened steel parts only.
(b) See table below for maximum limits.

PROPERTIES:

Thickness of electroplate - All material shall have a thickness of electroplate on significant surfaces, as follows: (c)

GE designation	Thickness of electroplate	
	inch	mm*
F70B4A, F70B4A2	0.0002 -0.0004 (c)	0.005-0.010*
F70B4B, F70B4B2	0.0005 -0.00075	0.013-0.019
F70B4C "	0.001 -0.0015	0.025-0.038
F70B4D, F70B4D2	0.00015-0.0003	0.004-0.008
F70B4E, F70B4E2	0.0003 min	0.008 min

(c) Only applies to surfaces that can be touched by a sphere 0.75 inch (19 mm) in diameter. The screw portion of externally threaded products that are mated with nuts or enter internally tapped holes shall have a total thickness of deposit between 0.0002-0.0003 inch (0.005-0.0076 mm).

(NOTE: All other significant surfaces of the fastener and significant surfaces of the thread portion of tapping screws shall have plating thickness as required by the selected grade.)

Salt spray resistance - The chromate film shall withstand the salt spray test for 96 hours. At completion of this test the appearance of white corrosion products, visible to the unaided eye at normal reading distance, at accidental scratches through the chromate film to the zinc plate or at unscratched areas of the chromate film shall be cause for rejection, except white corrosi products at the edges shall not constitute failure. The test specimen shall be aged for 24 hou before subjection to the salt spray. When the plated articles are of such a form as to be not readily adaptable to the salt spray test separate specimens plated concurrently with the articl represented may be used. The tests are to be made at the place of manufacture unless otherwise specified.

Preparation - The material to be plated shall be substantially free from flaws or other defects that will be detrimental to the appearance or the protective value of the coating. It shall be subjected to such cleaning procedures as are necessary to yield deposits with the desired appearance and quality. Oil, grease, etc, shall be removed by suitable cleaners. Scale shall be removed mechanically rather than by pickling from hardened steel parts which are to be plated and treated for removal of hydrogen embrittlement. Such parts shall not be flexed prior to baking.

Plating - The finished plating shall have a uniform appearance, shall be adherent and free from blisters, and substantially free from other defects that may affect the appearance or protective value of the coating.

Embrittlement relief treatment - Where called for by the designation, material shall be given a baking treatment to minimize danger from hydrogen embrittlement. This embrittlement treatment shall be given prior to the chromate treatment and preferably within one hour after plating.

Chromate treatment - Shall be a sulfuric acid-sodium dichromate treatment to retard the formation of white corrosion products and to give the material a golden brown iridescent appearance.

(Continued on page 2)

*These and subsequent equivalent SI metric units and values are provided for information only and are not intended for specification purposes.

GENERAL ELECTRIC
SPECIFICATION

CHROMATE TREATED BRIGHT ZINC ELECTROPLATE: SULFURIC ACID

REFERRE METHODS:
Salt spray test ---------- ASTM B117
Thickness of electroplate ---------- ASTM B487 or B504
Hydrogen embrittlement - Parts treated to minimize danger from hydrogen embrittlement shall be clamped, extended, or otherwise flexed to approximate the stress induced in the intended application and held in such position for 16 hours. After such tests, no parts shall show any signs of failure. Where the application is not obvious, the test shall be by agreement between the manufacturer and purchaser.

CERTIFICATE OF TEST:
When requested, the supplier shall submit promptly to the purchaser at the point of delivery a certificate of test in triplicate showing the results of tests for properties required by this specification. This certificate shall be addressed to the section, unit or person specified on the purchase order, and shall contain the GE designation, the purchase order number, and the quantity shipped so that the certificate may be identified with the shipment.

PACKING AND MARKING:
All material shall be shipped in suitable containers to give adequate protection during transit. All containers shall be legibly marked with the purchase order, supplier's name, and the GE designation of material or part.

MECHANICAL AND PERFORMANCE REQUIREMENTS FOR HIGH PERFORMANCE THREAD ROLLING SCREWS

Nominal Screw Size and Threads Per Inch	Tensile Strength	Torsional Strength		Drive Torque				Clamp Load	Clamp Load Torque				Proof Torque				Hydrogen Embrittlement Torque			
				For ZPC & CP Screws		For ZP Screws			For ZPC & CP Screws		For ZP Screws		For ZPC & CP Screws		For ZP Screws		For CP Screws		For ZP Screws	
	Min lbs	Min in. lb	Min ft lb	Max in. lb	Max ft lb	Max in. lb	Max ft lb	lbs	Max in. lb	Max ft lb	Max. in. lb	Max ft lb	in. lb	ft lb	in. lb	ft lb	in. lb	ft lb	in. lb	ft lb
No. 2 56	500	6	–	4.5	–	6	–	–	–	–	–	–	7	–	8	–	4.5	–	5	–
3 48	660	10	–	7.5	–	9.5	–	–	–	–	–	–	12	–	13.5	–	7.5	–	8.5	–
4 40	810	14	–	9	–	13	–	–	–	–	–	–	17	–	19	–	10.5	–	12	–
5 40	1,100	22	–	12	–	16	–	–	–	–	–	–	25	–	28	–	17	–	19	–
6 32	1,250	24	–	14	–	20	–	460	19	–	25	–	28	–	33	–	18	–	20	–
8 32	1,900	48	–	25	–	32	–	700	37	–	48	–	50	–	57	–	36	–	41	–
10 24	2,350	65	–	35	–	52	–	900	55	–	68	–	68	–	77	–	49	–	55	–
1/4 20	4,300	156	13	90	7.5	120	10	1,600	120	10	144	12	162	13.5	186	15.5	114	9.5	132	11
5/16 18	7,100	330	27.5	180	15	240	20	2,600	252	21	312	26	342	28.5	372	31	252	21	276	23
3/8 16	10,500	600	50	240	20	300	25	4,000	480	40	612	51	636	53	690	57.5	456	38	510	42.5
7/16 14	14,400	840	70	360	30	480	40	5,400	744	62	900	75	888	74	960	80	630	52.5	720	60
1/2 13	19,100	1,080	90	540	45	660	55	7,200	996	83	1,140	95	1,170	97.5	1,260	105	816	68	930	77.5

NOTES: 1. CP — cadmium electroplated
ZP — zinc electroplated
ZPC — zinc phosphate coated

2. All torque values given in the table for drive, clamp load, proof and hydrogen embrittlement, are those to be met when inspecting for acceptability of screws to the requirements of this standard. These values are not valid for use in design or assembly unless all conditions of the application are identical with those specified for the inspection test.

APPENDIX F

PROPOSED SPECIFICATIONS AND TEST METHODS

PROPOSED STANDARD SPECIFICATIONS TO AUGMENT
EXISTING STANDARD SPECIFICATIONS 86-6.01
CONCERNING LUMINAIRES

All luminaires to be mounted on horizontal mast arms shall be capable of withstanding cyclic loading in;

(1) a vertical plane at a minimum peak acceleration level of 3.0 g's peak-to-peak sinusoidal loading (same as 1.5 g's peak) with the internal ballast removed for a minimum of 2 million cycles without failure of any luminaire parts, and

(2) a horizontal plane perpendicular to the direction of the mast arm at a minimum peak acceleration level of 1.5 g's peak-to peak sinusodial loading (same as 0.75 g's peak) with the internal ballast installed for a minimum of 2 million cycles without failure of any luminaire parts.

No part of the slipfitter mounting brackets on the luminaires shall develop a permanent set in excess of 0.020 inches when the four 3/8-inch-diameter cap screws typically used for mounting are tightened to a torque of 10 foot-pounds.

PROPOSED TEST METHOD FOR EVALUATING SLIPFITTER CONNECTOR FATIGUE LIFE AND DURABILITY OF SLIPFITTERS USED TO ATTACH BRIDGE-MOUNTED LUMINAIRES TO THE MAST ARMS OF LIGHTING STANDARDS.

PART I. EVALUATION OF SLIPFITTER CONNECTOR FATIGUE LIFE

A. SCOPE

The procedure to be used for the evaluation of the fatigue life of the slipfitter connector on luminaires mounted on mast arms is described in Part I of this test method.

B. APPARATUS

1. Any vibrating fatigue testing machine capable of cycling luminaires at an acceleration of 3.0 g's peak-to-peak (or 1.5 g's peak), and be able to keep the vibration frequency under resonant frequency of the test fixture and luminaire.

2. A test fixture to be used for attaching luminaires to the vibrating machine (see Figure 1).

3. Accelerometer

4. Oscillograph

5. Counter to count number of cycles.

6. Torque wrench

7. Scale capable of weighing 25 pounds with an accuracy of hundredth of a pound.

C. CALIBRATION OF APPARATUS

To calibrate the accelerometer, following steps should be taken:

1. Place the accelerometer on a flat surface and adjust the signal conditioner to obtain a suitable zero reference point on the oscillograph.

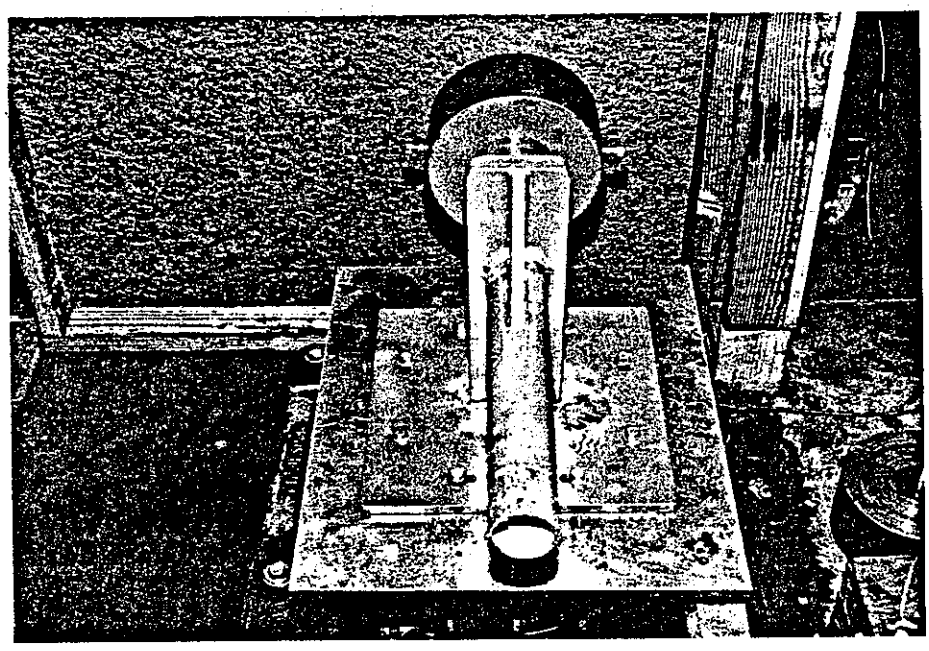
2. Turn the accelerometer over, 180 degrees for 2 g's, and adjust the gain of the signal conditioner so that the oscillograph shows a deflection of 2 inches which equals 1 g per inch.

D. PREPARATION OF TEST SPECIMENS

1. Remove the internal ballast from the luminaire housing.

2. Install an approved lamp currently used by Caltrans in the luminaire.

3. Weigh the luminaire head (in pounds); call this "W".



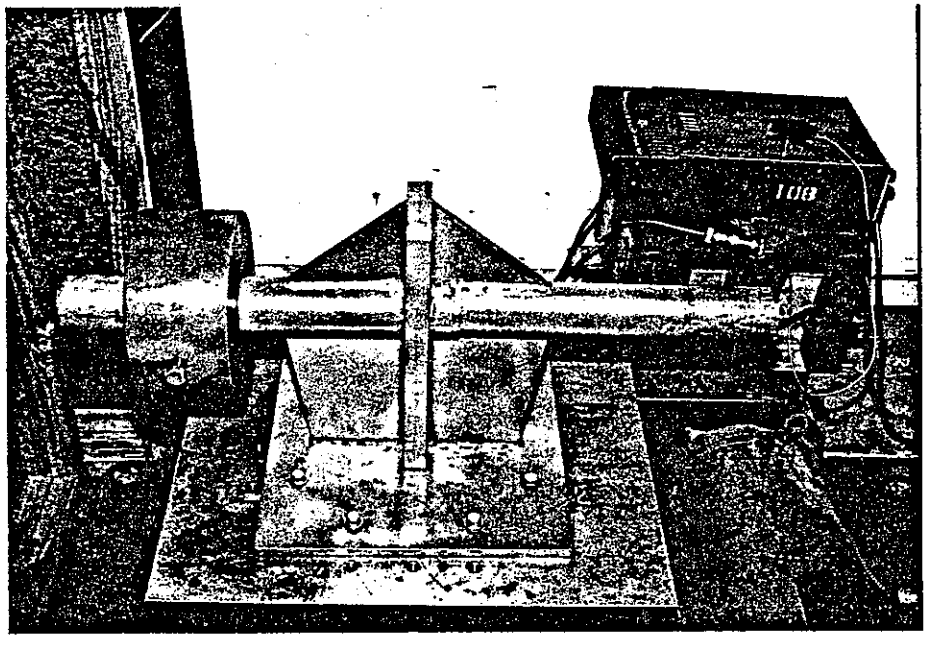


Figure 1. Test fixture.

4. Balance the luminaire head with two hands to determine its center of gravity. Mark this point on the head.

E. TEST PROCEDURES

1. Vertical cyclic loading test (critical for bridge-mounted luminaires)

a. Slide the luminaire onto the test fixture's 2-inch-diameter mast arm stub, and orient the luminaire head so that the lens faces the floor. Tighten the slipfitter bolts according to manufacturer's recommended procedure.

b. Measure the distance between the luminaire's center of gravity and the center of the test fixture (in inches); call this "L".

c. Determine the distance from the center of the test fixture to the center of the counterweight using the following equation: (see Figure 2)

$$d = \frac{W * L}{51}$$

where

d = distance between the center of the test fixture and the center of the counterweight (inches).

W = the weight of the luminaire head (pounds).

L = distance between the luminaire's center of gravity and the center of the test fixture (inches).

and 51 = the weight of the counterweight (pounds).

d. Adjust the counterweight's position, then tighten the two 1/2-inch-diameter screws located on the two sides of the weight to 20 foot-pounds torque.

e. Tape the calibrated accelerometer to the luminaire's center of gravity.

f. Turn on the testing machine, adjust the vibrating frequency and displacement until 3.0 g's peak-to-peak (or 1.5 g's peak) acceleration is obtained. Be sure the frequency is kept under the resonant frequency of the test fixture and luminaire.

g. Cycle the luminaire until 2 million cycles are reached or failure occurs, whichever comes first.

h. If failure of the luminaire occurs before 2 million cycles are reached, record the number of cycles at which failure occurred, observe and note the type of failure.

2. Horizontal cyclic loading (critical for ground-mounted luminaires)

a. Reinstall the internal ballast in the luminaire housing.
b. Slide the luminaire onto the test fixture's

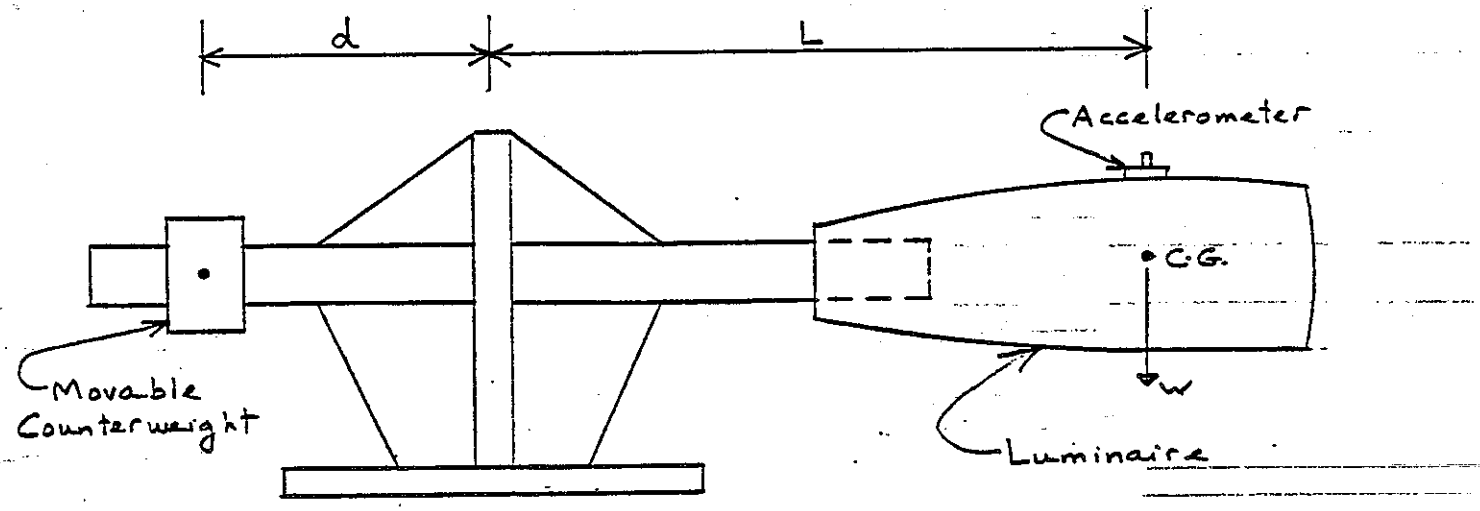


Figure 2. Positioning of counterweight on luminaire fatigue test fixture.

two-inch-diameter mast arm stub. Orient the luminaire head so that the cyclic testing sill simulate movement in the horizontal plane perpendicular to the direction of the mast arm. Tighten the slipfitter bolts according to manufacturers recommended procedure as in E.1.a.

c. Determine the center of gravity of the luminaire, position the counter weight, and attach the accelerometer as previously described in E.1.b through E.1.e.

d. Turn on the vibration testing machine and adjust the vibrating frequency and displacement until a 1.5-g peak-to-peak (or 0.75 g peak) acceleration is obtained.

e. Cycle the luminaire until 2 million cycles are reached or failure occurs, whichever comes first.

f. If failure of the luminaire occurs before 2 million cycles are reached, record the number of cycles at failure and note the type of failure.

F. ALTERNATE TEST PROCEDURE

Some manufacturers determine the acceleration level by measuring the luminaire displacement and frequency. This can be done using the following equation:

$$g \text{ value} = 0.0511\ Df^2$$

Where:

g = peak acceleration in terms of gravity or "g's" (this g is peak and is equal to half of g peak-to-peak).

D = Displacement (peak-to-peak) at the center of gravity (inches).

f = Frequency of vibration in cycles per second (Hertz).

G. REPORTING OF RESULTS

Report test results from vertical cyclic loading on Form T.L. .....(see Figure 3); If the slipfitter clamping bracket or bolts fail, note the type of failure and include it in the remarks portion of this form.

Report test results from horizontal cyclic loading (perpendicular to the direction of the mast arm) on Form T.L..... (see Figure 4.).

Also note any parts of the luminaire which have failed or show signs of failure in the Remarks column.

TRANSPORTATION LABORATORY
LUMINAIRE FATIGUE LIFE DATA SHEET

MANUFACTURER _____
LUMINAIRE MODEL NO. _____
DATE TESTED _____

Drawing of Specimen

TEST NO.	TORQUE ON SLIPFITTER BRACKET BOLTS (FT-LBS)	TEST ACCELERA-TIONS g's (Pk-to-Pk)	TEST FREQUENCY (HZ)	NO. OF CYCLES TESTED WITHOUT FAILURE	DISPLACE-MENT OF C.G. OF LUMINAIRE/ TEST TABLE (INCH)	R E M A R K S

Figure 3. Vertical cyclic load test results of luminaire.

TRANSPORTATION LABORATORY
LUMINAIRE FATIGUE LIFE DATA SHEET

MANUFACTURER_____
LUMINAIRE MODEL NO._____
DATE TESTED_____

TEST NO.	TORQUE ON SLIPFITTER BRACKET BOLTS (FT-LBS)	TEST ACCELERATIONS g's (Pk-to-Pk)	TEST FREQUENCY (HZ)	NO. OF CYCLES TESTED WITHOUT FAILURE	DISPLACEMENT OF C.G. OF LUMINAIRE/ TEST TABLE (INCH)	Drawing of Specimen R E M A R K S

Figure 4. Horizontal cyclic load test results of luminaire.

PART II. DETERMINATION OF THE AMOUNT OF PERMANENT SET FOR SLIPFITTER CONNECTORS

A. SCOPE

The procedure to be used for determination of the amount of permanent set of slipfitter connectors when clamping bolts are tightened are described in this Part II.

B. APPARATUS

1. 2-inch-diameter mast arm slipfitter tube

2. Torque wrench

3. Dial indicator to measure with an accuracy of 0.001 inch.

4. Luminaire, bracket and bolts

C. TEST PROCEDURE

1. Measure the initial shape of unused bracket to determine reference readings for critical bracket locations most apt to yield.

2. Assemble and torque mounting bolts on the slipfitter clamping bracket to 10 foot-pounds each (four 3/8-inch-diameter bolts are normally used).

3. Remove the bracket assembly and remeasure the used bracket to determine the permanent set of the bracket at critical locations determined in C.1.

D. PRECAUTIONS

Brackets shall not be permitted to bottom out against the top of mounting bosses when the bolts are tightened.

Brackets which have bottomed out may show misleading results - small permanent set measurements.

E. REPORTING OF RESULTS

Report test results on Form T.L. .....(see Figure 5).

TRANSPORTATION LABORATORY
SLIPFITTER CONNECTOR PERMANENT SET DATA SHEET

MANUFACTURER_____
LUMINAIRE MODEL NUMBER_____
SIZE AND NUMBER OF MOUNTING BOLTS_____
CLAMPING BOLT TORQUE
(EACH) FOOT-POUNDS_____
DATE TESTED_____
THICKNESS/GAGE OF STEEL IN CLAMPING BRACKET(S)_____

POINT ON BRACKET	INITIAL MEASURE-MENT (INCH)	FINAL MEASURE-MENT (INCH)	PERMANENT SET (INCH)	R E M A R K S

NOTE: INCLUDE PICTURE/DESCRIPTION OF CLAMPING BRACKET(S)

Figure 5. Permanent set test results of a luminaire slipfitter clamping bracket.