Technical Report Documentation Page

1. REPORT No.
Lab. Authorization No. 100-S

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE
Report of a Survey of Traffic Noises in Buildings Adjacent to Freeway Ramps in San Francisco

5. REPORT DATE
January 1957

6. PERFORMING ORGANIZATION

7. AUTHOR(S)
Hannibal, L.S. and Louis Bourget

8. PERFORMING ORGANIZATION REPORT No.
Lab. Authorization No. 100-S-6092

9. PERFORMING ORGANIZATION NAME AND ADDRESS
State of California
Department of Public Works
Division of Highways
Materials and Research Department

10. WORK UNIT No.

11. CONTRACT OR GRANT No.

12. SPONSORING AGENCY NAME AND ADDRESS

13. TYPE OF REPORT & PERIOD COVERED

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Introduction

This survey was requested by District IV in order to settle a debatable question raised by the Board of Education of the city of San Francisco in reference to traffic noise that might be developed by the proposed freeway ramps adjacent to the John Seet Grammar School on McAllister and Gough Streets. The subsequent report (Exhibit II in Appendix) was adequate to settle the immediate questions raised by the school board concerning traffic noise.

However, to our knowledge no previous investigations have been conducted by the California Division of Highways regarding the sound level intensities of freeway traffic noise which may penetrate frame and reinforced concrete buildings adjacent to highway structures, -- and for that reason the information gained in the survey is here presented in greater detail.

The findings indicate as a general observation that traffic noises represent no problem within adjacent buildings which are substantially constructed, have sealed windows, and have received acoustical treatment on the ceilings typical of modern business offices. Noise levels within frame structures from motor vehicle traffic is nominally slightly higher. Diesel trucks can be a definite nuisance when passing such a structure.

A reinforced concrete structure having glass brick windows picks up the least noise from outside traffic . The glass brick results in a low transmission of sound due to their mass and rigidity.

17. KEYWORDS
Lab. Authorization No. 100-S-6092

18. No. OF PAGES:
28

19. DRI WEBSITE LINK
http://www.dot.ca.gov/hq/research/researchreports/1956-1958/57-18.pdf

20. FILE NAME
57-18.pdf

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

REPORT
OF
A SURVEY OF TRAFFIC NOISES IN BUILDINGS ADJACENT TO FREEWAY RAMPS IN SAN FRANCISCO

January 15, 1957

State of California
Department of Public Works
Division of Highways
Materials and Research Department

January 15, 1957

Lab. Authorization
No. 100 - S - 6092

Mr. J. P. Sinclair
Acting Assistant State Highway Engineer
Division of Highways
San Francisco, California

Dear Sir:

Submitted for your consideration is:

REPORT

of

A SURVEY OF TRAFFIC NOISES IN

BUILDINGS ADJACENT TO FREEWAY

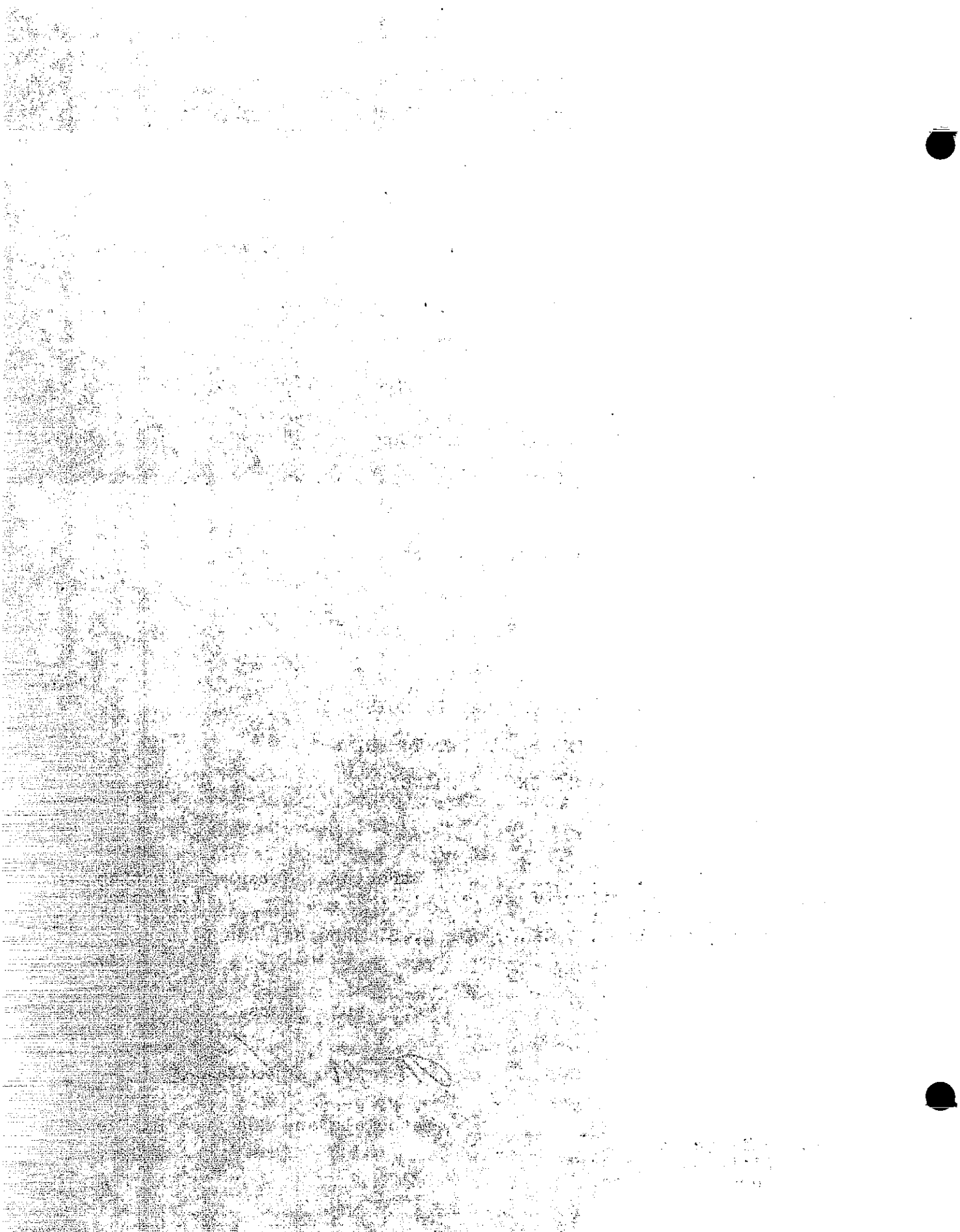
RAMPS IN SAN FRANCISCO

Study made by . . . . . Structural Materials Section
Under general direction of . . . . . J. L. Beaton
Work supervised by . . . . . L. S. Hannibal
Report prepared by . . . . . L. S. Hannibal and L. Bourget

Very truly yours,

F. N. Hveem
Materials and Research Engineer

cc: EWithycombe
District Engineers
Department Heads



A SURVEY OF TRAFFIC NOISES IN BUILDINGS ADJACENT TO FREEWAY RAMPS IN SAN FRANCISCO

INTRODUCTION

This survey was requested by District IV in order to settle a debatable question raised by the Board of Education of the city of San Francisco in reference to traffic noise that might be developed by the proposed freeway ramps adjacent to the John Swett Grammar School on McAllister and Gough Streets. The subsequent report (Exhibit II in Appendix) was adequate to settle the immediate questions raised by the school board concerning traffic noise.

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The findings indicate as a general observation that traffic noises represent no problem within adjacent buildings which are substantially constructed, have sealed windows, and have received acoustical treatment on the ceilings typical of modern business offices. Noise levels within frame structures from motor vehicle traffic is nominally slightly higher. Diesel trucks can be a definite nuisance when passing such a structure.

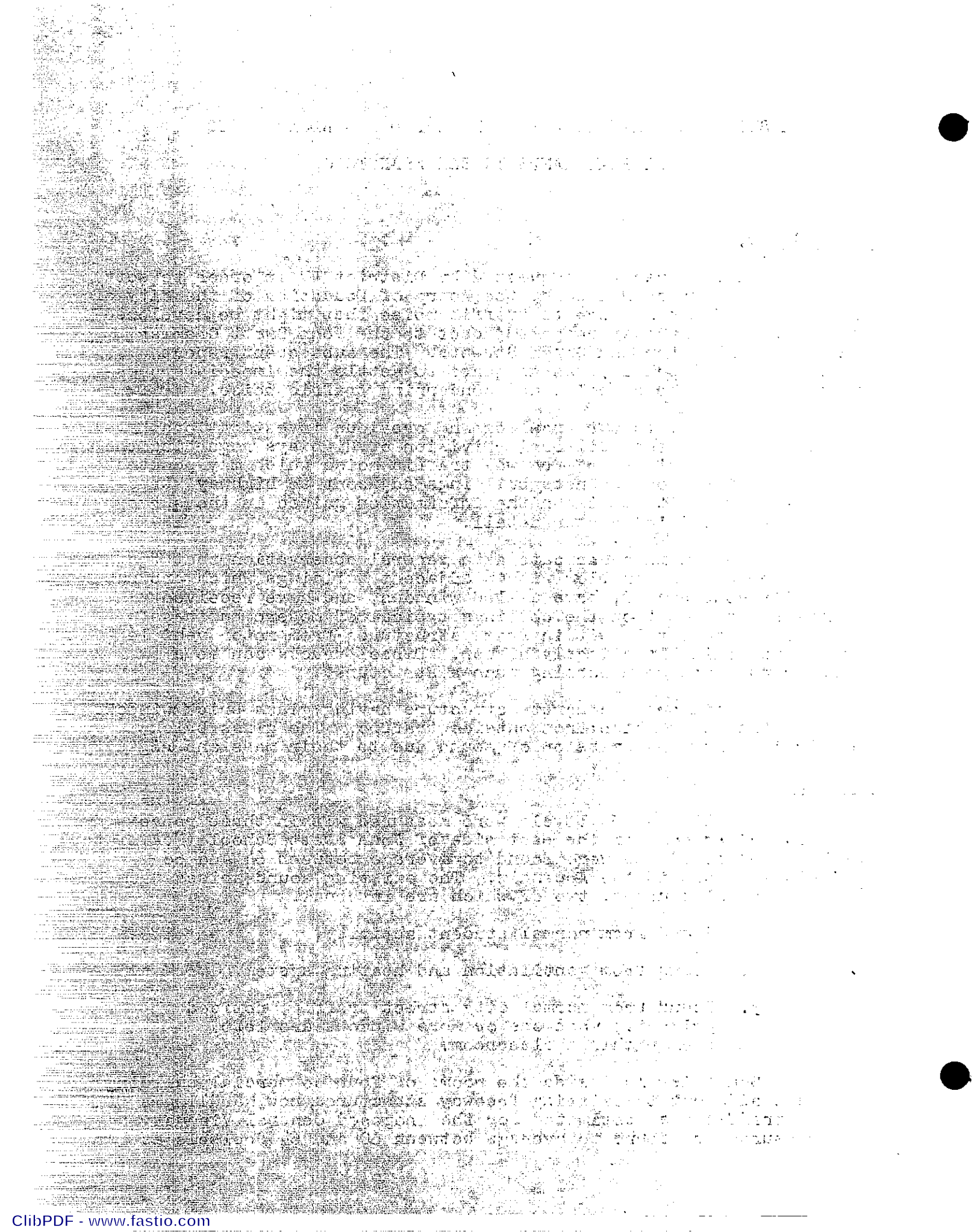
A reinforced concrete structure having glass brick windows picks up the least noise from outside traffic. The glass brick results in a low transmission of sound due to their mass and rigidity.

SUMMARY

Existing sound levels were measured within three representative classrooms on the east side of John Swett School (McAllister and Gough Streets) and were found to average between 64 and 68 decibels as shown in the Appendix. The existing sound arises from three principal sources, two of which are internal.

1. Sound from normal student activity.
2. Sound from ventilation and heating system.
3. Sound from normal city street traffic, noticed primarily when one or more windows are left open within a classroom.

Sound levels inside the rooms of four commercial buildings which are adjacent to existing freeway structures, now handling a greater traffic than estimated for the proposed Central Viaduct, were measured and found to average between 60 and 64 decibels as



shown in the Appendix. The windows in these buildings are normally shut, and the measurements were made under comparative conditions, namely at a distance of about 12 feet from a closed window or windows and in a room adjacent to freeway traffic.

It is to be noted that sound levels in typical buildings of concrete or masonry construction are not affected by freeway traffic noise to any noticeable extent when open windows are not present. The noise generated internally by heating and ventilation systems and by normal activity of personnel and office equipment provide the dominant background sound level. Acoustical treatment of the ceiling using commercial grades of acoustical tile add much to the ear comfort when working in such structures. However, the benefit of acoustical treatment is derived mostly by attenuating internally generated noises.

Glass brick, due to its rigidity and mass, materially attenuates externally generated noises. In buildings using glass brick in lieu of windows, the infiltration of sound from freeways is more prone to penetrate the structure at other points such as air intake ducts or through a light roof structure.

In reference to the concern over traffic noise in the John Swett School, the Division of Architecture personnel examined the structure and found it sufficiently substantial to permit replacing the existing windows with glass brick, which would exclude both traffic noise and visible distractions created by the freeway ramps.

They also examined the heating and ventilation equipment at the John Swett School and reported it capable of meeting the needs of the school under conditions of permanently closed windows on the entire east and south sides of the structure.

We concurred with the recommendation of the Division of Architecture that these window apertures be closed with glass brick. Such treatment will provide reduction of exterior sounds to such an extent that noise from the proposed Central Viaduct will be lower inside the classrooms than the present sound levels from normal city traffic.

In contrast, the level of traffic noise in the play yard will be considerably higher, probably comparing to that found in the Folsom Street play yard at the Bessie Carmichael School. However, such noise was not found inconvenient at the latter school.

As a general observation, the occupational noises generated within both the John Swett and Lincoln Schools could be materially reduced by acoustical treatment within the rooms. The poor operation of an ancient forced-air system and lack of acoustical treatment in the Lincoln School has created a serious employment problem due to noise. The freeway on-ramp has been blamed for this but as shown by the sound level meter most of the traffic noise was observed to originate with Harrison Street traffic, entering the structure via open windows.

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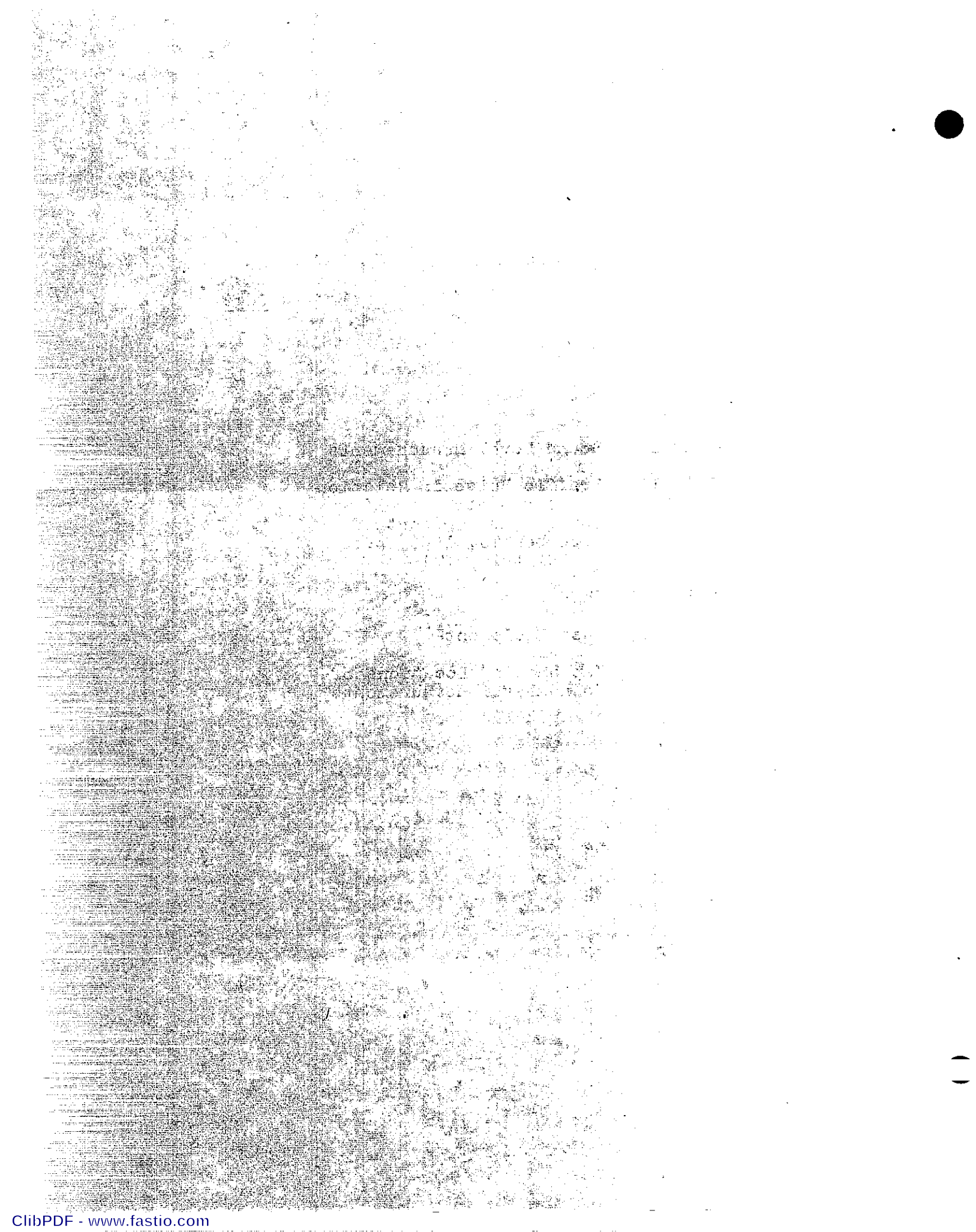


APPENDIX

SOUND LEVEL MEASUREMENTS (PRESENT CONDITIONS) DEC. 17, 195

1. John Swett School Classrooms - McAllister and Gough Streets

This is a 3-story reinforced brick structure with wood joist floors. The building was erected in 1914 and later modified to conform to the Field Act.

Location	Sound Level	Comments
Room 106	66 to 70 db. average	Room occupied, one window open
Room 102	70 to 76 db. average	Loud trucks on McAllister St. one window open
Room 204	64 to 68 db. average	Room occupied but quiet
	62 to 66 db. average	Room occupied but quiet. No open windows

Sound levels taken in Rooms 102 and 204 are derived principally from student activity throughout the building and from the forced air ventilation and heating system. These are existing levels under normal occupation.

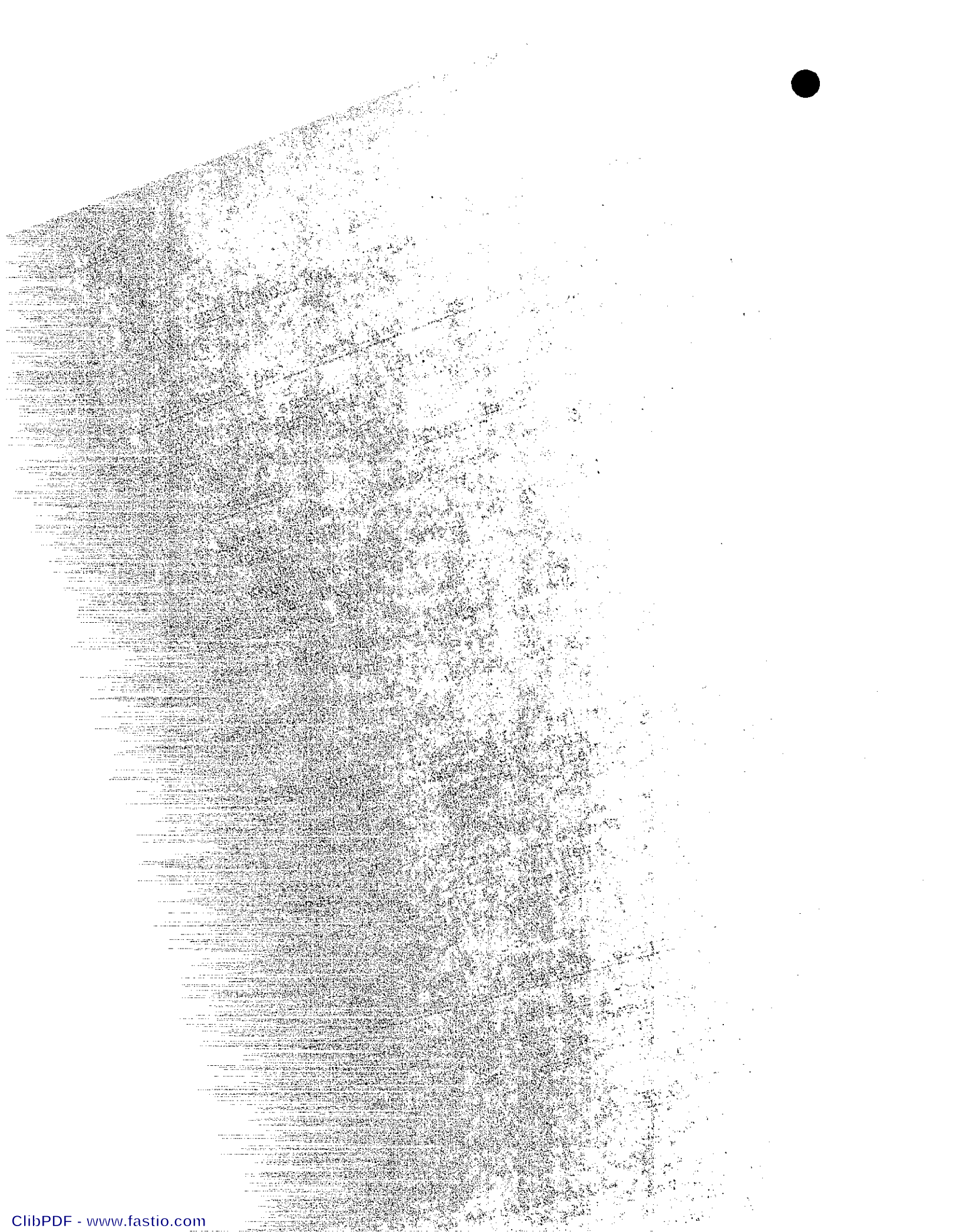
Noise conduction from one floor to the other through the wood floor framing was quite pronounced. Room 106 illustrates the effect of leaving one window open, which faced McAllister Street. During each test the students within the room were most cooperative in remaining extremely quiet.

Glaser Bros. Bldg., 855 Harrison Street, San Francisco, Calif.

This reinforced concrete building is about 20 feet from an existing freeway ramp. Measurements were taken inside a second floor office adjacent to the ramp and at a distance of 12 f... rom closed windows fronting on the ramp. The ceiling ... vered with acoustical tile.

SOUND LEVEL

ees of this off... 58 to 63 db...
freeway ...
lmost ...



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2. Glaser Bros. Bldg., 855 Harrison Street, San Francisco, Calif.

This reinforced concrete building is about 20 feet from an existing freeway ramp. Measurements were taken inside a second floor office adjacent to the ramp and at a distance of 12 feet from closed windows fronting on the ramp. The ceiling was covered with acoustical tile.

SOUND LEVEL

58 to 63 db.

Employees of this office were in no way distracted by noise from the freeway. The sound level in this office was observed to be almost entirely from internal occupational activity and the heating and ventilating system.

3. Patterson Pacific Bldg.

The reinforced multi-story concrete structure is near the First Street ramp to the Bay Bridge and is bordered by the ramp on three sides.

SOUND LEVEL

60 to 64 db.

Measured at a distance of 12 feet from closed windows within the 4th floor office to the building.

4. Schmidt Lithograph Company, 499 Second Street, San Francisco, California.

This reinforced concrete building is about 15 feet from the main on-ramp to the Bay Bridge. Measurements were taken in a 4th floor office nearest to ramp and about 12 feet from closed windows facing onto the ramp.

SOUND LEVEL

60 to 64 db.

5. Union Oil Company Building

This reinforced concrete structure is located immediately adjacent to the on-ramp which carries all Bay Bridge truck traffic to the East Bay. Glass brick windows are used in that portion of the newer structure which faces the bridge ramp. The ceilings were treated with acoustical tile.

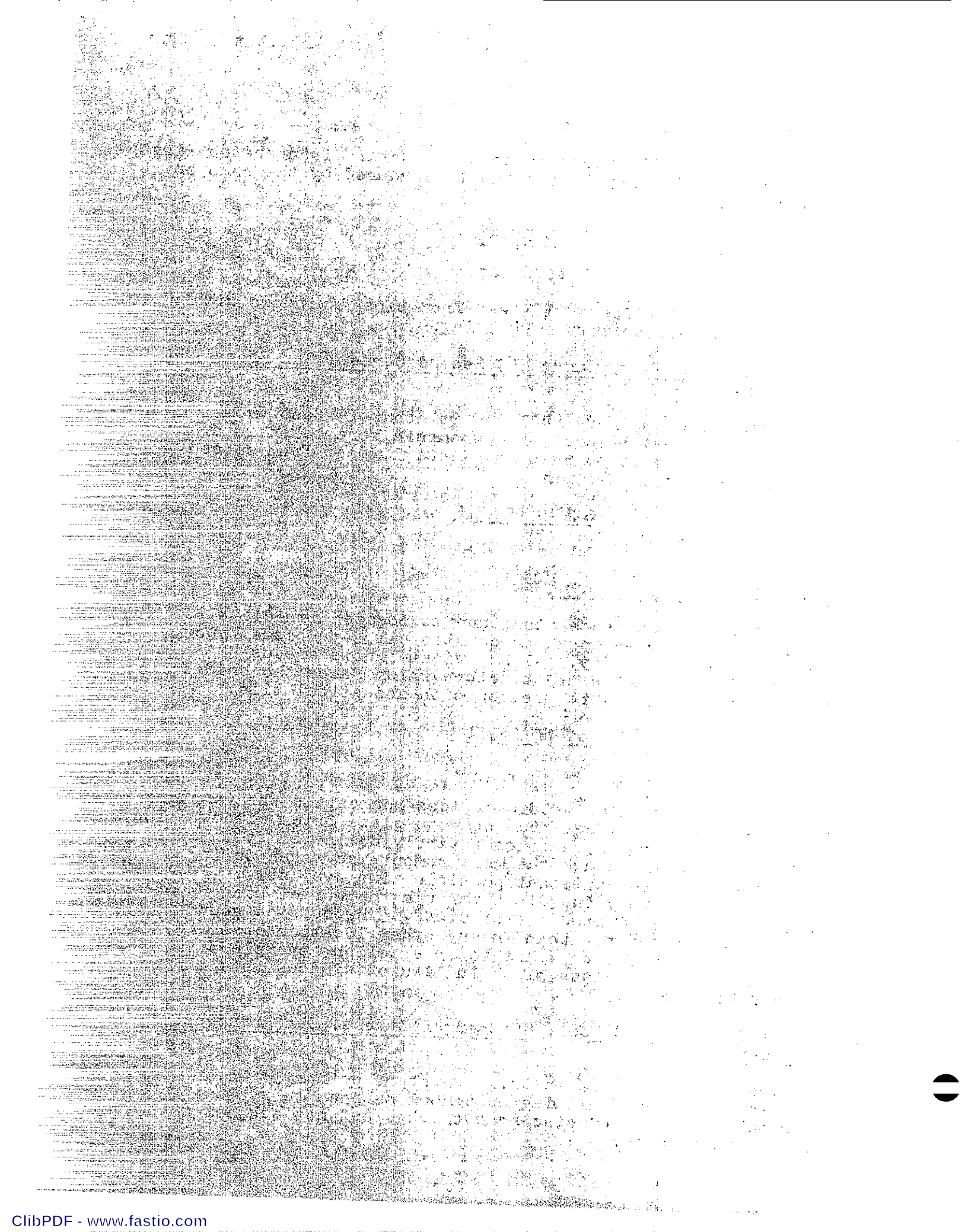
SOUND LEVEL

66 to 68 db.

Measurements were made within offices nearest to the ramp and at a distance of 12 feet from nearest glass brick window. The sound level was observed to be entirely dominated by internal office noise even though the measurement was taken during a lunch period at the quietest possible time available. Freeway noise was completely inaudible through the normal background sound level of a limited office staff. The outside sound levels are far greater than in any other location observed, being from 88 to 96 db. This is an excellent example of a building employing glass block in lieu of windows as a barrier to traffic noise.

6. Bessie Carmichael School, 55 Sherman Street, San Francisco, California

Measurements were made in this structure primarily as an example of a frame building or school subject to typical metropolitan traffic noise from trucks, but not subject to freeway ramp noise.



SOUND LEVEL

61 to 65 db.

These measurements were taken inside an empty classroom with windows closed during a recess or play period when outside sound levels were unusually high but were coming from a direction where a blank wall faced the play yard. A second set of measurements, taken after recess on the side porch overlooking the yard area facing Folsom Street (which is subject to heavy traffic), gave readings of 70 to 76 db. Occasional peaks at 88 db. occurred with diesel trucks.

7. Lincoln School, 824 Harrison Street, San Francisco, California

This is a one-story frame structure with stucco exterior and interior which faces Harrison Street and a ramp to the skyway. The unit was erected about 1911.

Location	Sound Level, Comments
Main Front steps facing street (125 feet from C. L. of street)	76-80 db., normal 80-88 db., loud trucks passing
Room #1, vacant	60-64 db. (window closed) 77 db. with traffic
Room #6, occupied	64-70 db. (windows open) 76-80 db. with traffic 82 db., truck passing

A wood frame structure such as this building is prone to pick up more street noise than a reinforced structure, but the noise is not serious unless the windows are open. An adequate supply of tempered air to the various rooms would eliminate the need of keeping the windows open for ventilation and in turn would eliminate many of the complaints regarding street noise at this institution.

8. Board of Education Assembly Room, 3rd floor, School Administration Building.

Noise level of occupied room at 9:00 P.M.: 62 db.

This illustrates a non-distractive background noise level typical of large modern rooms employing forced draft ventilation and occupied by a quiet audience of 50 or more people.

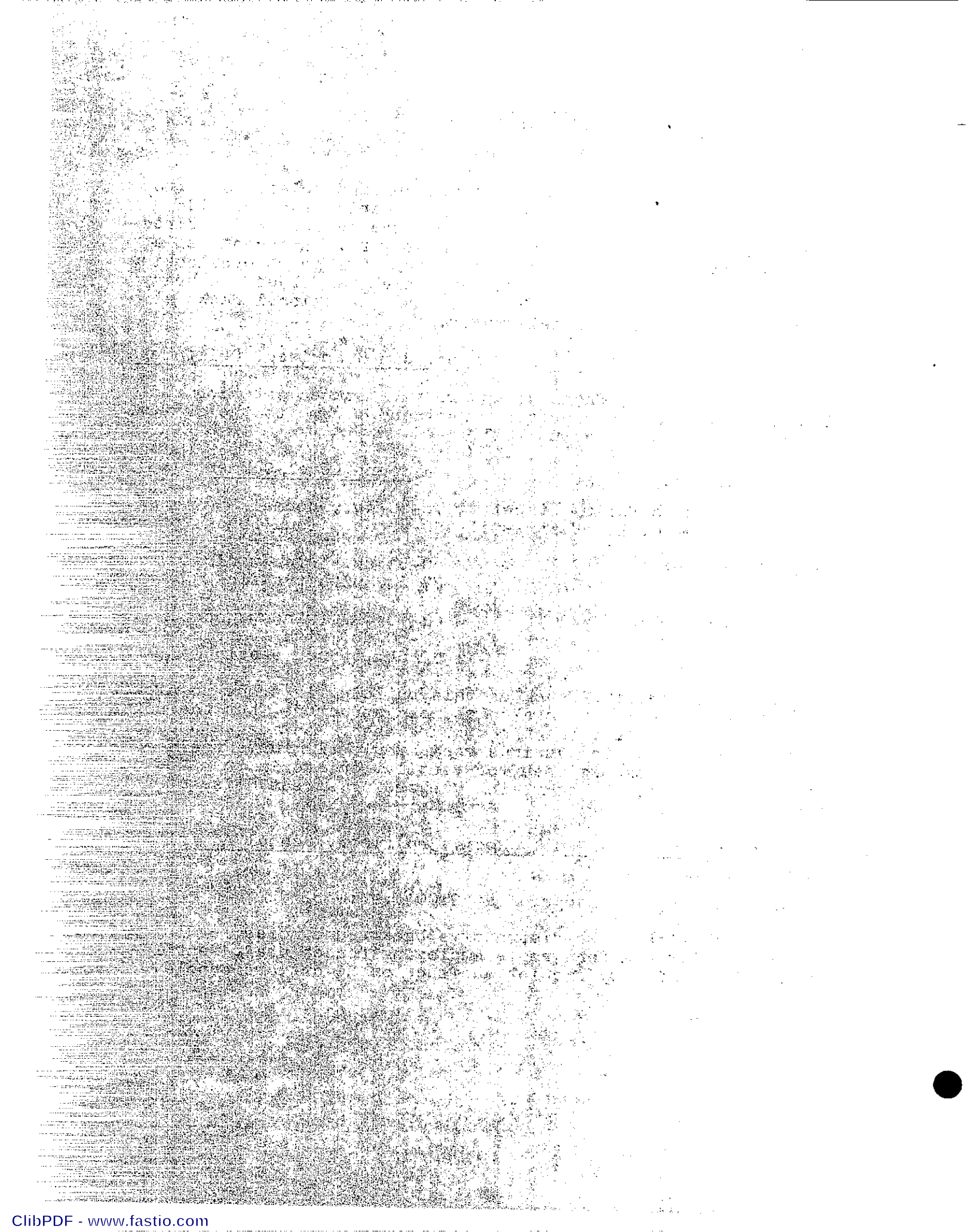


Exhibit II

IV-SF-2-SF
4RT242
No. 15772

To: Mr. John S. Daniels

From: Louis Bourget and L. S. Hannibal

Subject: Traffic Noise in Relation to John Swett School

At the request of John S. Daniels, Metropolitan District Right of Way Agent, a noise level survey was made December 17, 1956, at the John Swett School and at four commercial buildings located in close proximity to existing freeway ramps to determine the effect of freeway noise within these buildings.

Our findings indicate that the noise level now produced in these existing commercial buildings is less than the noise levels now present in the John Swett School classrooms.

Should the recommendations made by the State Division of Architecture be carried out, the anticipated noise level from traffic within the classrooms should be from 2-3 db. less than which now exists.

It is recommended that the State's planned alterations for the John Swett School be adopted.

In support of our above conclusions, the following sound level studies were made:

1. John Swett School

   Existing sound level measurements were made in occupied classrooms.

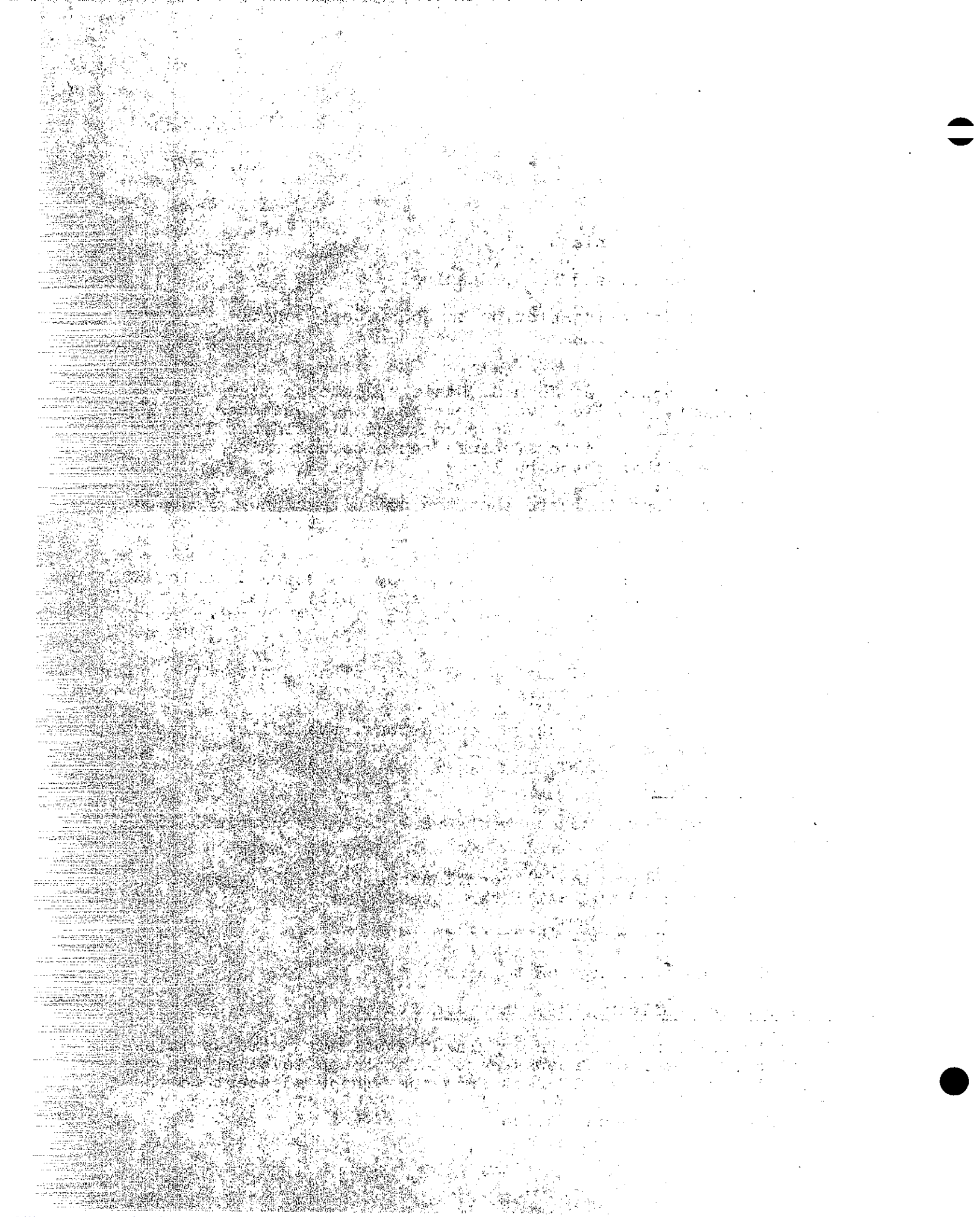
   Room 106, (one open window) normal range 66-70 db. - extreme 76 when trucks passed on McAllister Street.

   Room 102 - normal range 64 to 68 db.

   Room 204 - normal range 62 to 66 db.

2. Glaser Bros. Building, 855 Harrison Street

   Concrete building with single glazed steel sash windows (closed) located 20 feet from freeway ramp. The sound level within the room at a distance of 12 feet from the window adjacent to the freeway was 58-63 db. The employees of this office were in no way affected by freeway noise.



3. Patterson Pacific Building

The First Street ramp to the Bay Bridge borders this building on three sides.

A concrete structure with single glazed steel sash windows (closed). Noise level within room at a distance of 12 feet from the windows adjacent the freeway ramp is 60-64 db.

4. Schmidt Lithograph Company, 499 Second Street

This building is located about 10 feet from the main on-ramp to the Bay Bridge.

Sound level measurements obtained in center of 4th floor office nearest ramp was 60-64 db. The noise from the on-ramp of the Bay Bridge in no way distracted the personnel of this company.

5. Union Oil Company Building

This building is immediately adjacent to the on-ramp for the Bay Bridge. It is necessary for all the trucks going to the East Bay to pass over this ramp. Traffic noise measured outside the building was 88-94 db. with peak noise of 96 db.

The wall of the Union Oil Building adjacent to this on-ramp has glass brick which is the same material prescribed for the John Swett School. It was found that noise levels from traffic were reduced to such an extent within the building that they were entirely masked by the internal office noise which ranged from 66-68 db.

This is the best example of a noisy freeway structure which is adjacent to a building employing glass block in lieu of window glass as a sound barrier to reduce traffic noise. The noise from this ramp is far greater than that anticipated from the ramp proposed for the John Swett School.

6. Bessie Carmichael School, 55 Sherman Street near Folsom Street

Folsom Street is heavily travelled by industrial trucks. The present exterior traffic noises on Folsom Street will exceed any contemplated freeway traffic adjacent to the John Swett School. Sound measurements made in the yard on the Folsom Street side gave intensities of between 70-76 db. with peaks of 88 db. Sound level measurements made within the classroom were 61-65 db.

Louis Bourget
Associate Electronics Engineer

L. S. Hannibal
Senior Mechanical Engineer

LSH/LB

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3. Handbook of Noise Measurement
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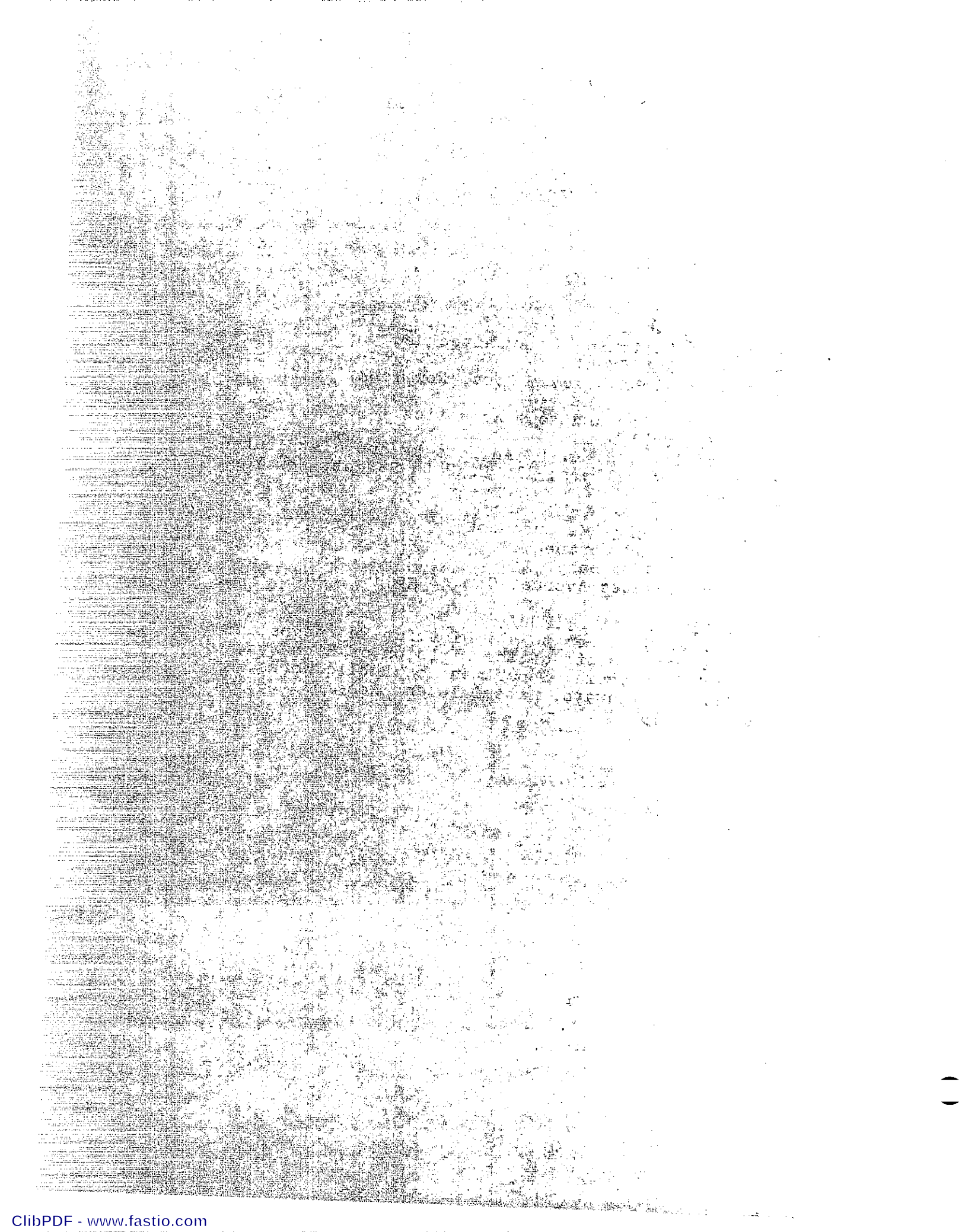
275 Massachusetts Avenue, Cambridge 39, Mass.

4. General Information, FNH/9
From Mr. F. N. Hveem to all District Engineers and Heads of Departments of the Division of Highways, State of California, Department of Public Works, Division of Highways, Materials and Research Dept., August 2, 1957



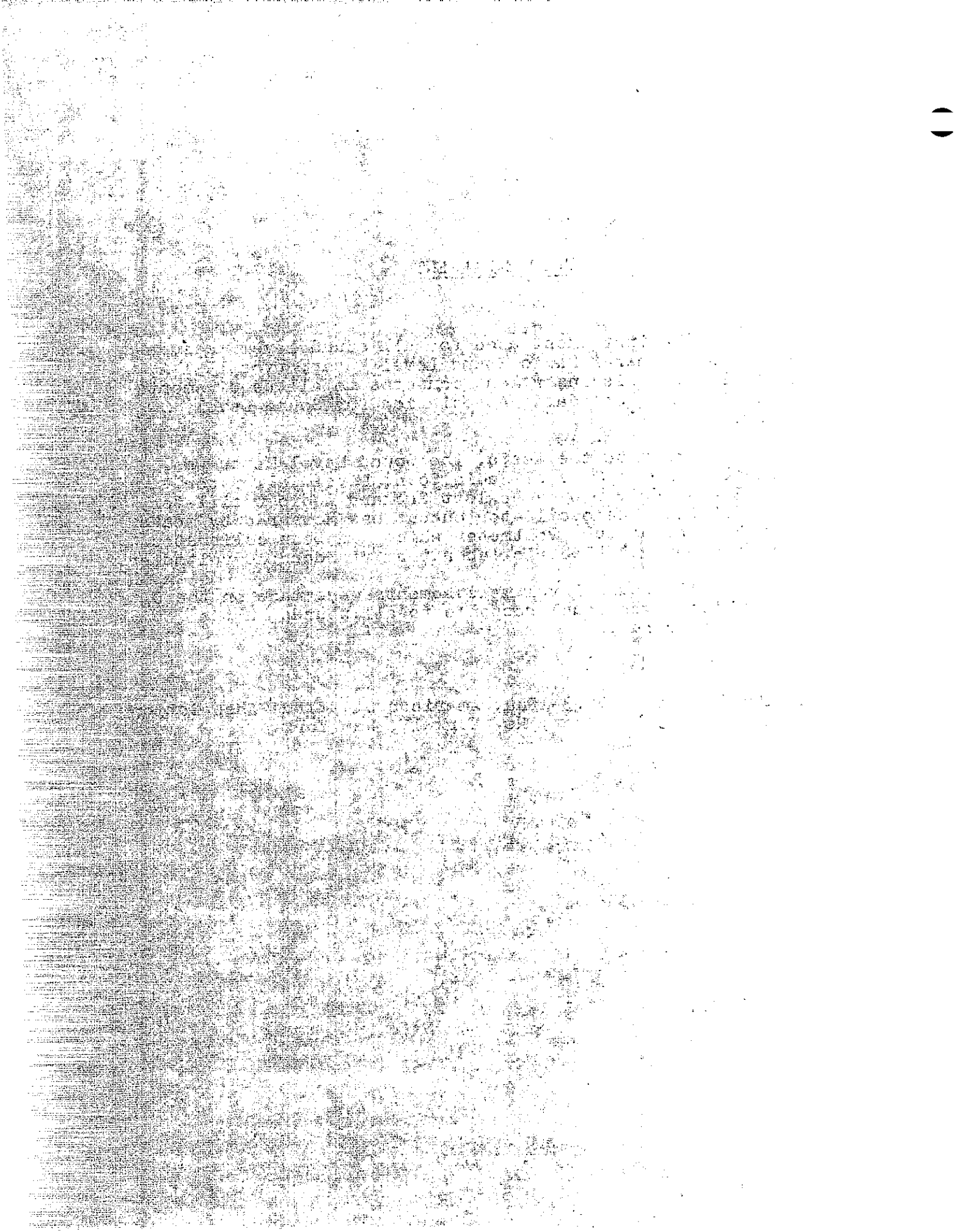
TEST EQUIPMENT

The instrument used for all sound level measurements was a General Radio Sound Level Meter, type 1551-A, Serial 1299. This instrument conforms to all requirements of the American Standards Association for Sound Level Meters.

Prior to the tests, the Sound Level Meter was calibrated from a General Radio Sound Level Calibrator, Type 1552-A, driven by a Hewlett Packard Audio Oscillator, Model 200 CD. The oscillator output was measured by means of an RCA vacuum tube voltmeter which had been calibrated against a General Electric laboratory standard AC voltmeter.

All sound level measurements were made on the C scale which gives equal response to all sounds in the acoustic spectrum.

1. Publication Z 24.3-1944, American Standards Association, 70 East 45th Street, New York 17, New York.



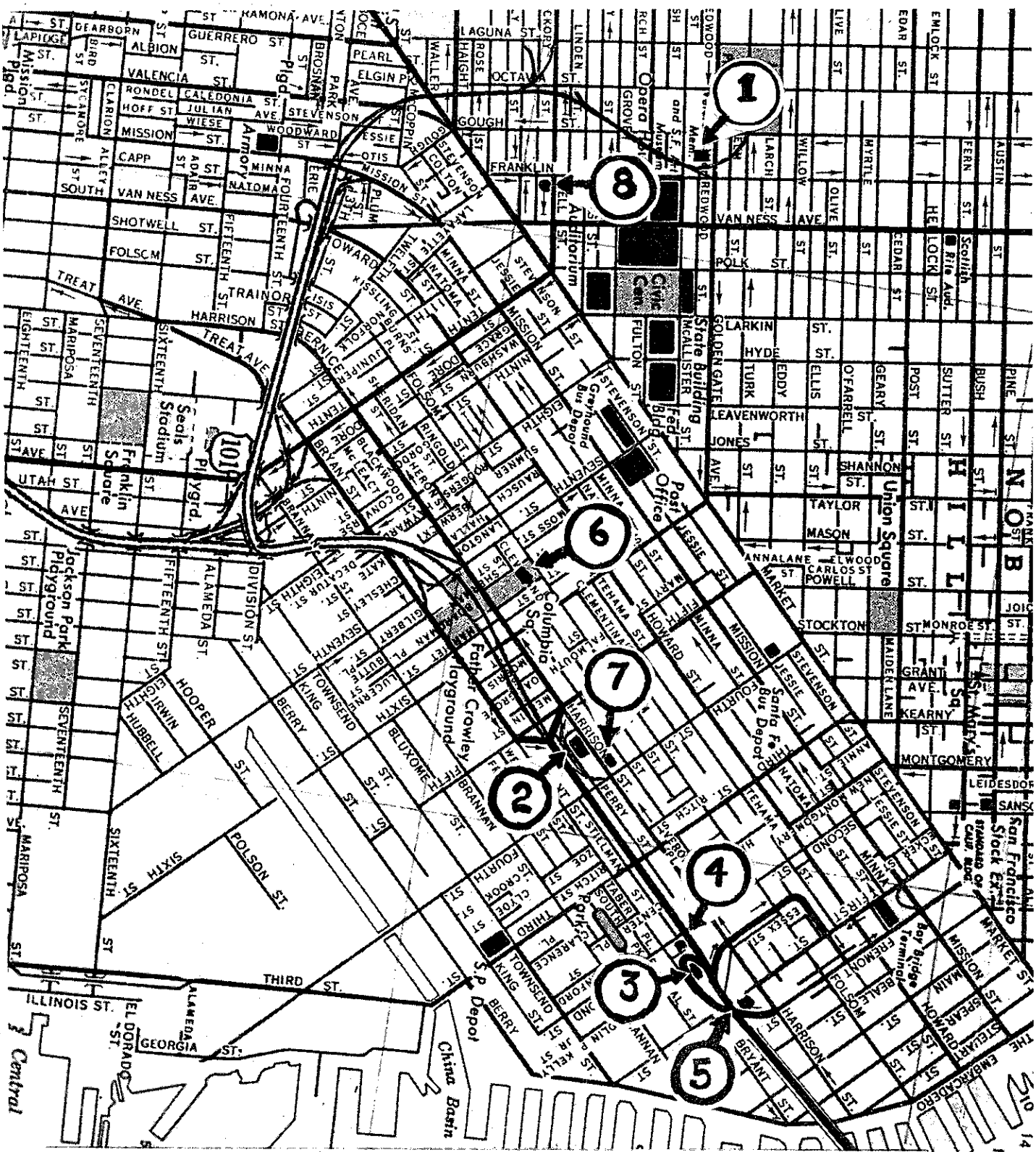


EXHIBIT V

MAP SHOWING LOCATIONS OF SOUND LEVEL MEASUREMENTS

Refer to Exhibit I for identity of Buildings