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San Jose State College Sound Survey of Ventilation System Noise in Speech-Drama Building Addition

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Louis Bourget

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16. ABSTRACT

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Inspection of the ventilation equipment and the general environment were made with the help of Mr. Vern Thornburg of the Division of Architecture.

This report presents:

1. Noise Measurements obtained inside of the fan room on both and low pressure sides of the fan partition; inside the return air shaft; and inside the entry room just outside of the fan room.

2. Ventilation noise measurements in all specific areas of complaint and additional measurements in other classrooms and offices to identify the general noise distribution. (Verification of the amount of noise added by the upper fan room is shown by "fans on" and "fans off" measurements in the complaint areas.)

3. Recommended corrective measures to reduce the present high buildup of noise within both sections of the fan room and the attendant penetration of this noise to classrooms via leakage paths into the return air space above the ceilings, modulation of the delivered air, and excitation of building members.

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State of California
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Division of Highways
Materials and Research Department
November 1961

Your: W.O. 4160GC-13
Our: 100 - S - 6255

Mr. Anson Boyd
State Architect
Division of Architecture
Sacramento, California

Attention: Mr. Preston Roche

Dear Sir:

Submitted in accordance with your request of August 9, 1961, is a report of:

SAN JOSE STATE COLLEGE

SOUND SURVEY OF VENTILATION SYSTEM NOISE

IN SPEECH-DRAMA BUILDING ADDITION

Study by . . . . . Structural Materials Section
Under general direction of . . . . . J. L. Beaton
Measurements by . . . . . Louis Bourget
Report by . . . . . Louis Bourget

Very truly yours,

F. N. Hveem
Materials and Research Engineer

By
J. L. Beaton
Supervising Highway Engineer

LB:lk

cc: Div of Arch. (10)

INTRODUCTION

As requested by the Division of Architecture a study has been made of the ventilation noise in selected areas and classrooms of the second floor addition to the Speech-Drama Building at San Jose State College.

Inspection of the ventilation equipment and the general environment were made with the help of Mr. Vern Thornburg of the Division of Architecture.

This report presents:

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3. Recommended corrective measures to reduce the present high buildup of noise within both sections of the fan room and the attendant penetration of this noise to classrooms via leakage paths into the return air space above the ceilings, modulation of the delivered air, and excitation of building members.

Fortunately, the open areas within the fan room permit access for the installation of damping materials. Most of the acoustical treatment suggested is in the form of acoustical pads. The construction and discreet placement of these pads is carefully described to achieve a significant reduction at the low resonant frequencies of the fan room, which are always difficult to control. In this case, these low frequencies constitute a major part of the problem.

CORRECTIVE RECOMMENDATIONS

The intense noise levels developed within the fan room are due to very high fan (and air) velocities and inadequate acoustical damping of the open air spaces. This leads to strong excitation of all possible room modes from frequencies as low as 28 cps for the 20 foot fundamental and 51 cps for the 11 foot fundamental. Harmonics of these frequencies extend throughout the audible range and are mixed with intense white (hissing) noise generated by the air action across sharp edges and turns. If at all possible, the fan speeds should be reduced at least 25 percent. There is evidence of excessive delivery in many rooms because of the abundance of white noise that is now generated across the diffuser blades at the room outlets. [4,5,6,7]

Recommended acoustical treatment and modifications are shown on Figures 1, 2, and 3. All acoustical pads are of the type shown on Figure 4. The materials recommended and method of fabrication are described.

Pads C1 and D1 (in Figures 1 and 2) should be wide enough so that they may be tied together where they meet at the dividing grille so as to minimize the air gap at this junction. The same comment applies to pads C2 and D2.

In the lower edges of pads G and H will have to be secured to prevent movement.

The diagonal pads K and L, in the return air shaft (Figures 1 and 3), should be mounted with their edges snugly against the walls to minimize air gaps at all pad edge and wall junctions.

Ceiling V (Figure 2) should be built as a standard ceiling to seal off the unused portion of the return air shaft and reduce noise penetration to Rooms 224 and 226.

The lead (metal) liner X along the lower south side of the fan room (Figure 1) reduces noise penetration into the return air space above the rooms.

Instructions on Figure 2 recommend means for reducing noise penetration via the return air openings in Rooms 224 and 226.

The desirability of a softer floor covering for the hall in the area adjacent to hearing test rooms 256 through 262B is indicated but is not related to the ventilation noise problem

COMMENTARY ON TEST RESULTS

The sound level measurements are shown on Chart A in the approximate order of intensity. Naturally, the highest levels are generated inside the fan room which unfortunately is partly recessed several feet below the roof level. This permits somewhat more noise radiation into the return air space between roof and room ceilings than would normally be expected.

The noise levels are highest in the rooms immediately under the fan room, namely Rooms 224 and 226 which are specific areas of complaint.

Room 224 is presently being used for storage and probably can best serve only for that purpose, but the recommended corrective measures will affect this room so as to reduce noise leakage into Room 226.

The measurements in Rooms 224 and 226 are shown for fans "on" and "off" and indicate a difference of about 19 dba and 14 dba respectively. The lower figure represents the building conduction noise from other sources including another equipment room on the floor below, which is not part of the building addition problem. This lower noise level represents a nonreducible minimum that can only be approached, but not met, with the best of corrective measures. It is interesting to note that a drop of 15 dba represents about a three to one noise reduction to a human observer at these reference levels and a 9 dba drop represents an apparent reduction of about two to one.

The classrooms 223 and 231 exhibit lower but excessive noise values for classrooms indicating that the entire eastern side of the building is affected by the general problem. Desirable levels for classrooms are usually stated as 35 to 40 dba[1,2] but are very difficult to achieve with high velocity air exchange systems as found in this building.

Noise levels drop significantly at the ends of the north and south wings to acceptable values except for the rather demanding requirements of the hearing and audiometric test rooms 256 through 262B.[3] Room 262B was checked with the fans "on" and "off" for comparison purposes. The differential of 9 to 11 dba indicates that a significant amount of the noise comes from the upstairs ventilation system. A moderate noise reduction will occur when room 262B is completed. The acoustical lining materials had not been installed at the time of test. Room 256 includes information on heel impact noise from a woman walking in the hall, past the door, during a portion of the test. Some type of softer floor covering for the hallway in the immediate area of rooms 256 through 262B would reduce this type of noise to innocuous levels.

Measurements are also shown for the west end of the north wing in rooms 202 and 203. These levels are indicated as adequately quiet for offices.

CONCLUSIONS

If the corrective recommendations are adopted as outlined, including a 25 percent reduction of fan speed, the measurable noise reduction should be as follows:

Fan room, high pressure area	12 to 15 decibels
Fan room, low pressure area	7 to 10 decibels
Return air shaft	8 to 11 decibels
Room 224	8 to 10 decibels
Room 226 and all other rooms in east section	8 to 9 decibels
Hearing test rooms	6 to 8 decibels

These figures imply that the noise levels, to a human observer, will drop to about 50 percent of the present condition in the eastern portion of the building and to about 60 percent of the existing level (a drop of 40 percent) in the hearing test rooms. These lower noise levels should serve to terminate the present complaints

If the fan speeds are not reduced as recommended, the amount of white noise now generated at the diffuser outlets in the classrooms will remain at the present high level. The low frequency rumble will also tend to be 2 to 3 decibels higher. The net effect is that the measurable noise reduction will be 2 to 3 decibels less effective than indicated by the above figures and some complaints may persist.

REFERENCES

1. Knudsen, V. O. and C. M. Harris, Acoustical Designing in Architecture, Table 10.3, pg. 221. New York, John Wiley & Sons, Inc. 1950.

2. Beranek, L. L., Revised Criteria for Noise in Buildings, NOISE Control (periodical), January 1957, Subscription Department, 57 East 55th Street, New York 22, New York.

3. Cox, J. R., How Quiet Must It Be To Measure Normal Hearing? NOISE Control, January 1955.

4. Same as Reference 1. Figures 13.2, 13.3; pgs. 276, 277.

5. De BOTHEZAT FANS Bulletin A-78, Controlling Ventilation Noises, par. H, pg. 12 and Fig. 3, pg. 30.

6. Goldman, B. G. and G. C. Maling, Noise From Small Centrifugal Fans, NOISE Control, November, 1955.

7. Allen, C. H., Noise From Air Conditioning Fans, NOISE Control, January, 1957.

SOURCES OF CUSTOM MADE ACOUSTICAL PADS

Western Asbestos Company
230 Acoma
North Sacramento
WAbash 2-4714

Fibreglas Engineering & Supply
1041 Fee Drive
North Sacramento
WAbash 2-5467

Goodwin-Cole Company
1315 Alhambra Blvd.
Sacramento
GLadstone 2-6641

Cal-Acoustics
2212 Evergreen
North Sacramento
WAbash 5-0732

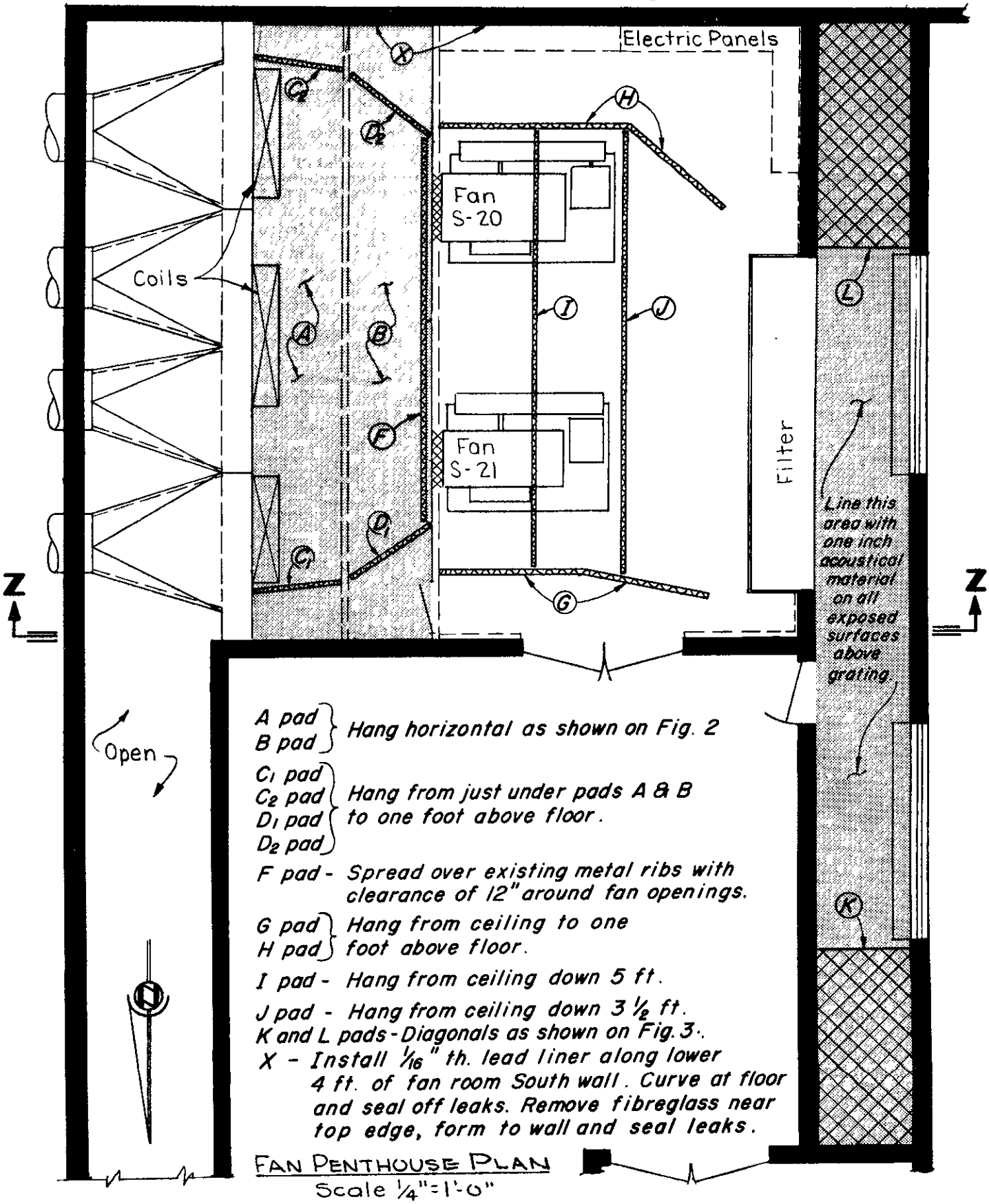
SAN JOSE STATE COLLEGE SPEECH-DRAMA ADDITION
SOUND LEVEL MEASUREMENTS IN SPECIFIC LOCATIONS
(* Areas of Particular Complaint)

Location	Weighting Network A	B	C	Comments
Fan Room. High pressure side of partition.	99-100	103-105	106-108	Needs acoustic treatment.
Fan Room. Low pressure side of partition.	92-94	95-97	99-101	Ditto. See text.
Inside return air shaft near access.	89-90	90-92	93-95	Ditto. Also seal off lower unused portion of shaft.
Entry Room, adjoining Fan Room.	78-80	83-86	88-90	No treatment required.
*Room 224 storage below Fan Room.	57-59 (38-40)	68-70 (52-56)	77-80 (60-64)	Fans ON Fans OFF
*Room 226, acting and practice.	52-54 (38-40)	63-66 (52-56)	71-74 (60-64)	Fans ON Fans OFF
Hallway outside 226 and 224	51-53	64-66	73-76	Noisiest hall area (below Fan Room)
Classroom 223 across hall from 224	51-54	61-64	70-72	Considered High for classroom.
Room 231, S.E. corner	52-54	60-62	70-72	Considered high for classroom.
*Room 262B. Hearing test room (acoustic material not installed).	33-36 (24-25)	51-56 (42-44)	64-68 (54-56)	Fans ON Fans OFF
*Room 256 Audiometric testing.	31-33 ((40))	54-57 -	58-62 ((66))	---Heel noise in hall indicates need for soft floor covering from 256 past 262B (Fans OFF, same as 262B)
Room 259 across hall from 260, Drs. Hadley, Smith, and Powell	38-40	48-50	59-62	Quiet for an office.
Room 202, end of north corridor	41-43	58-50	57-59	Ditto.
Room 203, Dudley Moorhead across from 202.	38-40	48-50	58-60	Ditto.

RECOMMENDED ACOUSTICAL TREATMENT

Figure 1

Speech-Drama Building Addition
San Jose State College

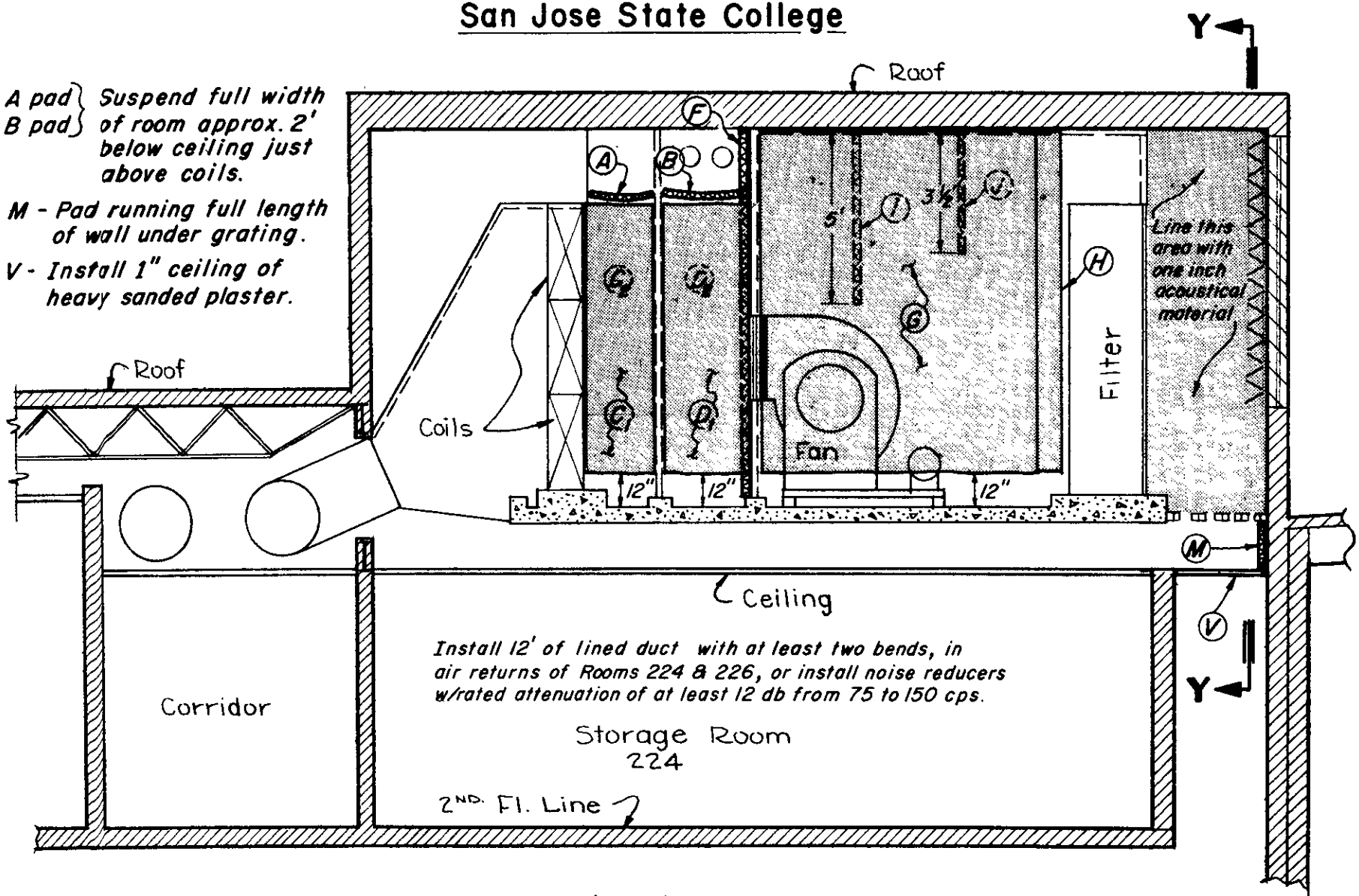


FAN PENTHOUSE PLAN
Scale ¼"=1'-0"

RECOMMENDED ACOUSTICAL TREATMENT

Speech-Drama Building Addition

San Jose State College



Section Z - Z

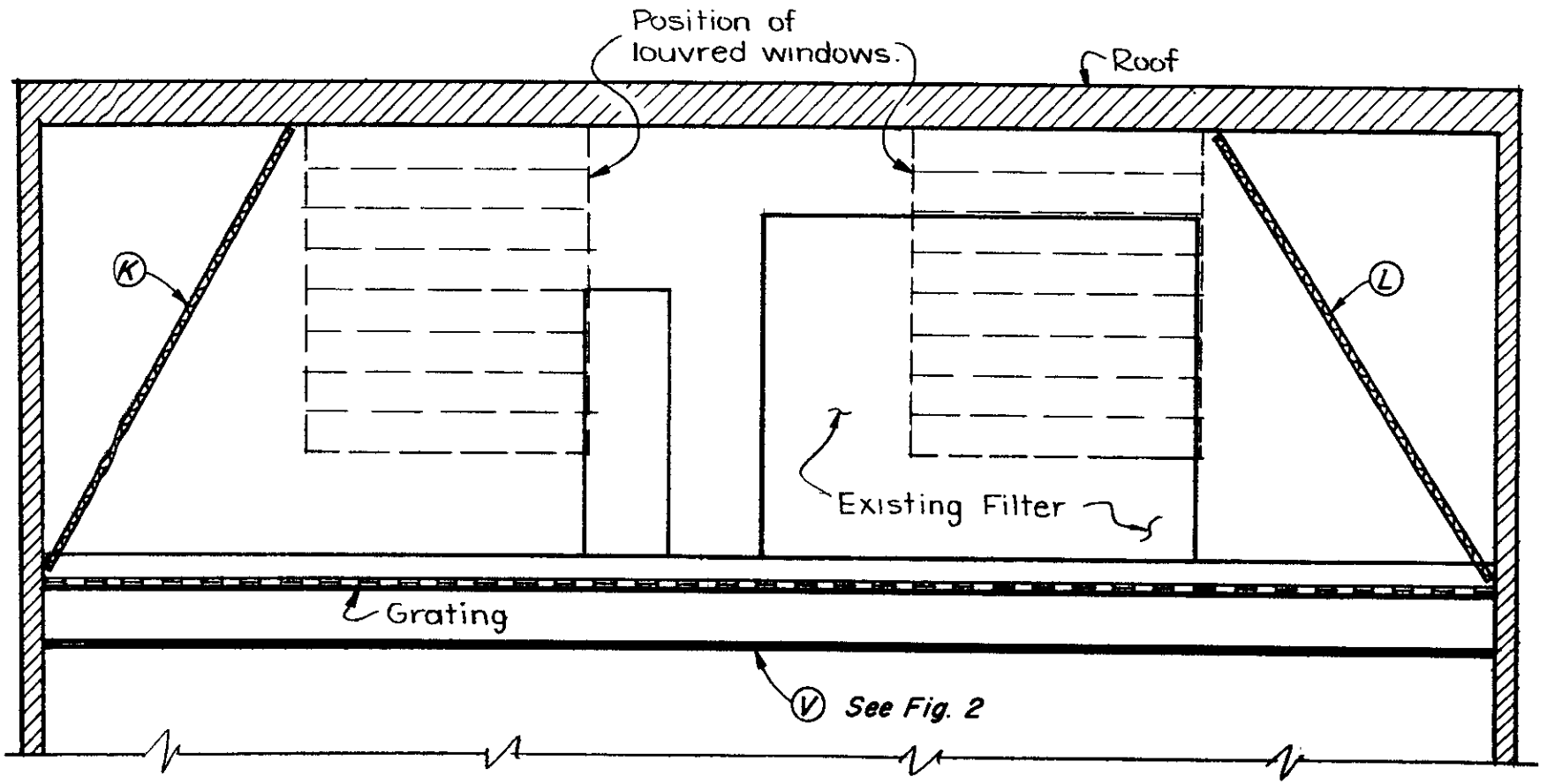
Scale ¼" = 1'-0"

Figure 2

RECOMMENDED ACOUSTICAL TREATMENT

Speech - Drama Building Addition

San Jose State College

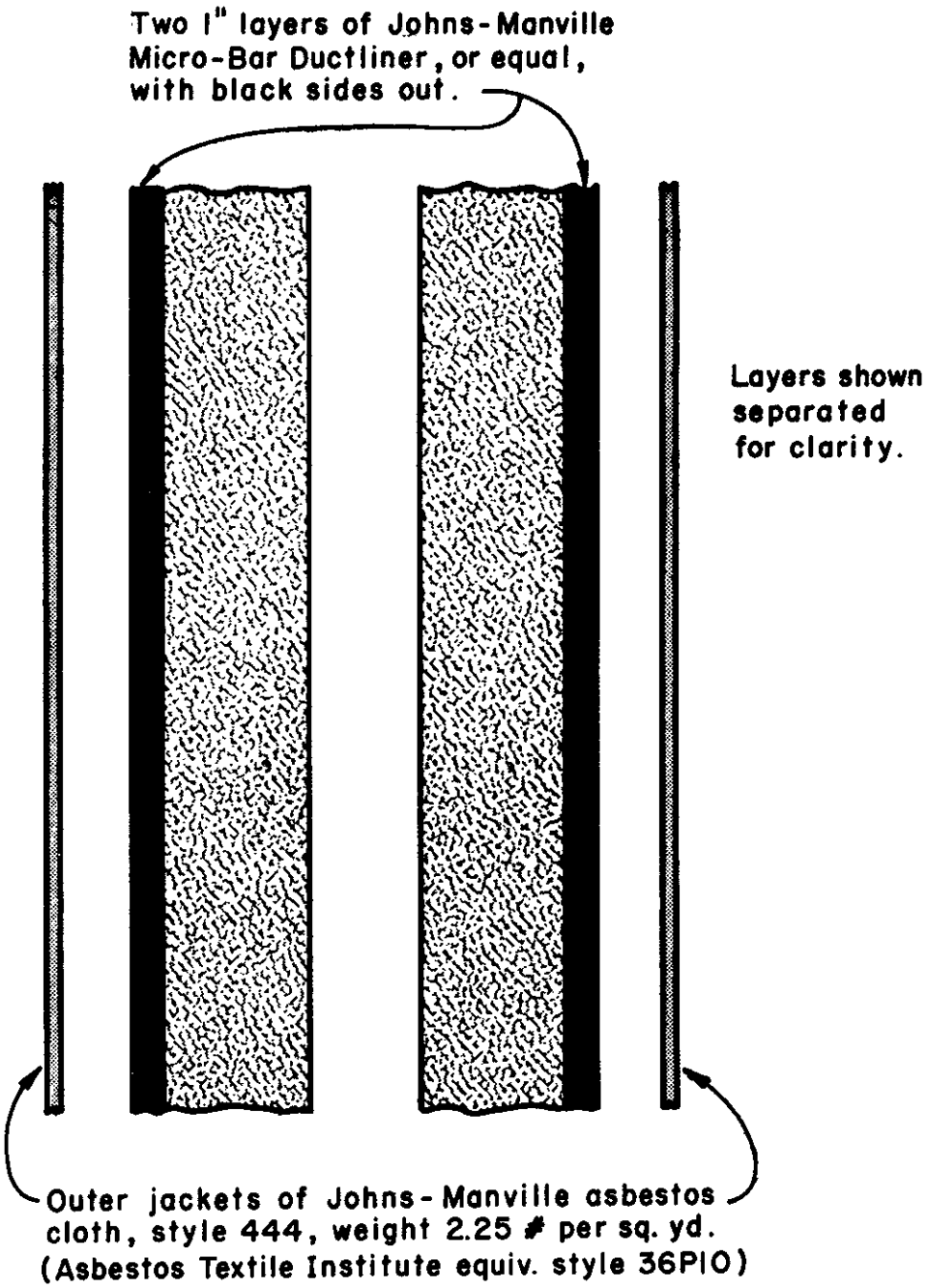


Section Y - Y

Scale 1/4" = 1'-0"

Figure 3

ACOUSTICAL PAD CONSTRUCTION
(Typ. const. of pads lettered A thru. M)



Outer sewn edge of pads shall be an overlap of the asbestos material and shall have metal ferrules every 12 inches (or as desired) for mounting.

Supporting hardware and ties at the discretion of the Division of Architecture.