REPORT OF THE PROJECTION COMMITTEE

THE Society has seen fit to give official recognition to the importance of motion picture projection and the motion picture projectionist by the appointment of a standing committee on projection.

The personnel of the committee is widely scattered, and several of the members are subject to call to various parts of the country on business of their companies at any moment. For this reason the chairman had to abandon his original idea of having one or two meetings of the committee before this report was made up; for this reason, the report is based entirely upon correspondence, plus such personal touch as it was possible for the chairman to have with the very busy and somewhat overworked men within his physical reach. And finally the writing of the report fell very suddenly and unexpectedly upon one member at practically the last moment.

The foregoing is set forth in order that you may understand, and in the hope that you will excuse the admitted incompleteness of the report. Your committee by no means regards it as a final report, and realizes that the most gracious reception it can hope for is to have the report accepted as an indication of progress, and referred back to the committee for further work in the interim between now and the fall convention.

After due deliberation, and after consultation with the various members of the committee, it was decided to concentrate our first efforts upon the compilation of a statement of what constitutes the fundamenal requirements of the modern projection room. Our decision in this matter was based upon the fact that, though it is true some material has appeared in the trade press as well as that in the Bluebook of Projection, there is not available to the architect (except at the expense of a great deal of time and trouble to himself), a complete, correlated and comprehensive treatise on the requirements of the modern projection room and the fundamental requirements which must be satisfied if results which can adjudged acceptable, according to modern standards, are to be obtained and maintained.

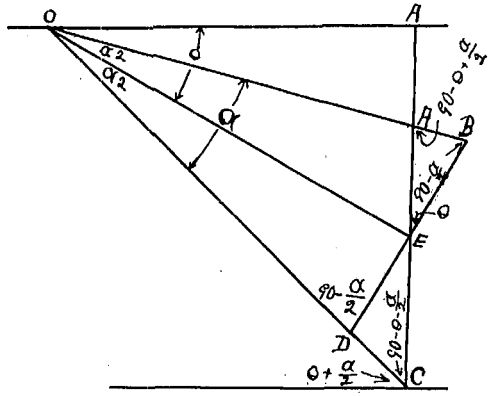
There is great need for such a treatise. The lack of authori-

tative standards to which architects may refer, has resulted in a very large number of designs which are hopelessly inadequate for modern motion picture and sound picture projection.

Your committee therefore selected as the subject for its first report *The Fundamental Requirements of the Modern Theatre Projection Room.* The various requirements will be set forth in their order, together with such recommendations as may seem proper.

Location

It is essential to good projection that the projection room location be such that there will be no objectionable distortion of



the screen image due to the projection angle being excessive, and furthermore it is essential that the projection distance and picture size be so related as to require the use of a lens of such focal length as to combine critical definition over the entire field with reasonable optical efficiency. Your committee realizes that the great variation in theatre auditorium conditions demands considerable elasticity in the matter of projection room location, and therefore recommends:

1. That the relationship between picture size and projection distance be such as to require a projection lens of not less than four and one-half inches, nor more than seven and one-half inches, equivalent focus.

2. That within this range of lenses the projection angle be as nearly zero as is practicable and in no case to exceed seventeen degrees.

The recommendation as to the equivulent focus of the projection lens is based upon the observation of the members of your committee. The decision in the matter of the limiting angle was reached through a mathematical analysis of the situation.

Let us refer to figure 1, below O is the optical center of the projection lens; θ is the projection angle; α is the vertical angle of the divergency of the light beam; AC the height of the projected picture; and BD is the height of an undistorted picture projected the same distange (OE) by the same lens.

Realizing that for a given projection angle, the distortion would be more serious with short focus lenses than with those of long equivalent focus, your committee sought to express the increase in height, of the projected picture due to the projection angle, in terms of this angle and the angle of divergency of the light beam; that is, to express the ratio AC : BD as a function of θ and α.

$$\frac{AC}{BD} = \frac{AE+EC}{BE+ED}$$

Now $AE \sin \alpha/2 :: OE : \sin (90+\theta-\alpha/2)$.

Therfeore $AE = OE \sin \alpha/2 \div \sin (90+\theta-\alpha/2)$.

And $EC : \sin \alpha/2 :: OE : \sin (90-\theta-\alpha/2)$.

Therefore $EC = OE \sin \alpha/2 \div \sin (90-\theta-\alpha/2)$.

Also $BE+ED = 2OE \tan \alpha/2$.

Then
$$\frac{AC}{BD} = \frac{\dfrac{OE \sin \alpha/2}{\sin (90+\theta-\alpha/2)} + \dfrac{OE \sin \alpha/2}{\sin (90-\theta-\alpha/2)}}{2OE \tan \alpha/2}$$

$$= \frac{OE \sin \alpha/2}{2OE \tan \alpha/2 \sin (90+\theta-\alpha/2)} + \frac{OE \sin \alpha/2}{2OE \tan \alpha/2 \sin (90-\theta-\alpha/2)}$$

$$= \frac{\cos \alpha/2}{2 \sin 90+(\theta-\alpha/2)} + \frac{\cos \alpha/2}{2 \sin 90-(\theta+\alpha/2)}$$

$$= \frac{\cos \alpha/2}{2 \cos (\theta+\alpha/2)} + \frac{\cos \alpha/2}{2 \cos (\theta-\alpha/2)}$$

$$\frac{AC}{BD}=\frac{\cos \alpha/2}{2(\cos \theta \cos \alpha/2+\sin \theta \sin \alpha/2)}$$
$$+\frac{\cos \alpha/2}{2(\cos \theta \cos \alpha/2-\sin \theta \sin \alpha/2)}$$
$$=\frac{\cos \theta \cos^2 \alpha/2}{\cos^2 \theta \cos^2 \alpha/2-\sin^2 \theta \sin^2 \alpha/2}$$

Inverting and simplifying

$$\frac{BD}{AC}=\cos \theta-\frac{\sin^2 \theta}{\cos \theta}\tan^2 \alpha/2.$$

Now the maximum permissible amount of distortion is a matter on which there seems to be considerable range of opinion. Your committee feels that in recommending 5% as the maximum permissible increase in picture height, it is erring on the side of laxity rather on that of rigidity, and is particularly anxious to hear discussion of this matter by the Society.

Proceeding for the moment on the basis of 5%:

$$\cos \theta-\frac{\sin^2 \theta}{\cos \theta}\tan^2 \alpha/2=0.9524$$

and
$$\cos^2 \theta-\sin^2 \theta \tan^2 \alpha/2=0.9524 \cos \theta$$
$$\cos^2 \theta-\tan^2 \alpha/2+\cos \theta \tan^2 \alpha/2=0.9524 \cos \theta$$
$$\sec^2 \alpha/2 \cos^2 \theta-0.9524 \cos \theta-\tan^2 \alpha/2=0.$$

This puts the equation in the quadratic form, and the solution for cosine is of course

$$\cos \theta=\frac{0.9524 \pm \sqrt{0.9524^2+4 \sec^2 \alpha/2 \tan^2 \alpha/2}}{2 \sec^2 \alpha/2}.$$

Taking account of the minus sign before the $\sqrt{}$ results in imaginary values so only the positive sign will be considered. Calculations (by 10″ slide rule) are tabulated below thru the range of objective lenses recommended in this report.

Lens E.F.	BD	tan θ/2	tan²θ/2	sec²θ/2	2 sec²θ/2	4 sec²θ/2 tan²θ/2
4	17.0	0.085	0.00722	1.00722	2.01444	0.0290
5	13.6	0.068	0.00463	1.00463	2.00926	0.0186
6	11.3	0.0565	0.00319	1.00319	2.00638	0.01285
7	9.7	0.0485	0.00235	1.00235	2.00470	0.00942
8	8.5	0.0425	0.00180	1.00180	2.00360	0.00721

E.F.	Log Cos θ	θ
4	9.97924 − 10	17° 35′
5	9.97901 − 10	17° 40′
6	9.97893 − 10	17° 42′
7	9.97870 − 10	17° 44′
8	9.97887 − 10	17° 44′+

Thus it becomes apparent that thru the range of focal lengths recommended, the percentage of increase in picture height is practically influenced only by the projection angle, the percentage being approximately equal to the "secant minus one" of the projection angle. The present standards of the Society set the maximum projection angle at 12°, corresponding to an increase in picture height of about 2.5%. Thus we see that the distortion has doubled for a 40% increase in projection angle, and it becomes exceedingly apparent that it is a serious thing to add even as much as two degrees to the projection angle when designing a theatre; this should never be done except for the most urgent reasons, and never merely to obtain architectural symmetry in a part of the theatre which the audience seldom sees.

The sidewise location of the projection equipment should be so graded as to favor those projectors which have to produce the most sharply defined images. This consideration should place the motion picture projectors as closely as possible to the center line; but one must also take into consideration the increasing practice of simultaneous operation of stereopticon, effect projector and motion picture projector in order to secure special and very beautiful effects; this loses much of its beauty if the images are not very closely matched. These considerations have led your committee to classify its recommendations regarding transverse location of equipment as follows.

For the installation of either two or three motion picture projectors, stereo and effect projector, with or without spot lamps and flood projector, we recommend that the axis of projection of the motion picture projector nearest the stereo be at right angles to the horizontal axis of the screen.

For installations of three motion picture projectors, with or without spot lamps, we recommend that the axis of projection of

the center projector be at right angles to the horizontal axis of the screen.

For installations comprising two motion picture projectors only (or with the addition of spot lamps), we recommend that their axis of projection make equal and opposite angles with the horizontal axis of the screen.

In certain special cases it will be highly desirable to locate the projection room in (not on) the front of the balcony. In such cases a careful check of the balcony construction should be made to insure there being no shifting of the axis of projection as the balcony fills and empties. Ventilation of a projection room so located, becomes more of a problem than in the case of the more common locations; but it is of much greater importance. This will be treated later.

Dimensions

(Size of Room)

The size of the room may vary rather widely, according to the amount of equipment it is intended to install; but in width, the wise exhibitor will make ample allowance for possible additional equipment. This is just as important as it is to install wiring sufficiently in excess of immediate needs to take care of demands which may be made in the future. It is an expensive thing to be obliged to rebuild the room, or to tear out the wiring in order to put in larger wires. At the time of construction, neither a bit of added space or somewhat larger wires requires any very serious additional outlay.

In the matter of front to back depth, there must be sufficient space to leave at least a thirty six (36′) inch passageway clear of everything between the lamphouse controls and whatever may be against the rear wall. This amount of space is necessary for the comfortable handling of the equipment. The necessary depth may be ascertained by the architect by taking the over-all projector length of the modern projector, setting it in horizontal position at sixty-three inches, adding one foot to that measurement (or eighteen inches, if the projection angle will be a very heavy one), and thirty-six inches plus the depth of whatever equipment it may be intended to place back of the projectors against the rear wall. In fact, it is best to allow three feet for the latter, whether the present intent is to install anything there or not; this would make a total

of five feet three inches, plus six feet, or eleven feet three inches as the minimum front to back depth.

In the matter of ceiling, seven and one half feet should be the absolute minimum. In excess of that, the more the better.

As to width, that is a mooted question. But there must, for the best results, be ample space, between projector (both motion picture and other sorts) to permit of free movement. Where the projection distance and picture size is such that a sharp picture may be obtained all over the screen with a four and one-half foot spacing lens (center to lens center of motion picture projectors) that distance should be the minimum. However, conditions may be such that this would be impractical; but under any condition there must be no less than a three and one-half foot spacing, lens center to lens center. In fact, this may be the rule under all conditions for all but the motion picture projectors.

Of course space must be allowed for the amplifying panel etc., which would be done in the future, whether sound is to be immediately installed or not.

This is not designed to be anything more than a general discussion of dimensions. Your committee hopes, in the future, to take that item up in more complete form.

Construction

Your committee conceives the fundamental requirements of projection room construction to be:

(a) The room must be thoroughly fireproof.

(b) It must be as nearly as possible sound proof, because of the fact that in addition to the unavoidable noise incidental to machinery in operation, we now have added the necessity for conversation between the augmented projection staff, the additional noise created by certain types of sound equipment, and rising above this, the output of the monitor horn.

(c) The material should have as low specific heat as possible to prevent its becoming a "storage reservoir" for heat.

(d) In some cases the weight will have to be considered if the building structure supporting the projection room is not amply strong. In this connection your committee desires, without recommendation, to point out that for wall construction, hollow tile eight inches or more in thickness set in rich mortar strongly tempered

with cement, and covered with a smooth, hard finish plaster fulfills all of the above requirements better than any other material.

The Floor Slab should support the projection equipment without the slightest vibration, and be of a material which will not wear away and form dirt or dust. We therefore recommend that the floor slab be of concrete of approved mixture, not less than six inches thick, covered with an approved top dressing of cement and covered with battleship linoleum or rubber tile firmly cemented to the floor slab. This linoleum or tile should be laid after all plastering, painting, wiring, etc., has been completed, but before any of the projection equipment has been installed. Before the projection equipment is installed the linoleum should be thoroughly cleaned and waxed to prevent it absorbing oil from the machinery. Incalculable damage has been done to projection machinery and to sound film by the fine dust rising from uncovered projection room floors; such stone floors belong to the stone age, and have no place in the modern projection room. Aside from their injurious effect upon equipment they have the effect of unduly fatiguing those who must stand constantly upon them, thus reducing their alertness and lowering their efficiency, two things which no theatre can afford to have happen to its projection staff.

Conduits, Outlets and Anchors

In the modern projection room there is the necessity for so many electrical circuits that it is both unsightly and highly impractical to run the conduits on the surface. They must be built into the walls, floor and ceiling. It is also essential that all electrical cal outlet boxes, ventilation ducts, anchor bolts, etc., be exactly located prior to the construction of the room, and that the faces of all outlets be located flush with the surface except in special cases where there is good reason for doing otherwise.

Rewind Room

This room is for storing, rewinding, inspecting, repairing and assembling film. It should open directly into the main projection room, and if possible into the screening room as well. Every possible precaution in design, finish, equipment and ventilation to make this room clean and dust-free is justifiable when one considers the delicate nature of the sound track on modern sound film. Size will vary with conditions, but your committee regards eight feet by ten feet

as representing the minimum acceptable dimensions unless storage cabinets for film and records are built into the walls of the room.

Battery Room

If battery operated, sound synchronizing equipment is to be installed, there must be a thoroughly ventilated room, sufficiently large to accommodate these batteries and their charging equipment, conveniently adjacent to the main projection room. Batteries, in charging, give off gas and vapors which are inflammable and have a corrosive action on human tissues and on most metals. Hence the absolute necessity for ventilation. This room should be at least six feet wide by eight feet long with suitable shelving for the batteries.

Motor Generator Room

In modern practice, it is fundamentally essential that there be a well ventilated room adjacent to the main projection room for housing the resistance units or the motor generator, whichever be employed. Here, as in the projection room, construction should be fireproof, and all conduit etc. should be built into the walls, floor and ceiling—not run on the surface. Size will vary greatly with the type of installation. The fundamental requirement is that ample space and light be provided around each unit. In certain types of sound equipment, a motor generator unit replaces almost all of the storage batteries. In such cases, more motor generator space must be provided, but the battery room can be reduced to a ventilated cabinet in the motor generator room.

Wash Room

It is fundamentally essential, regardless of the type, class or size of theatre, that, adjacent to, and opening directly into, the main projection room, there be a room of suitable dimensions equipped with wash basin and toilet, with running water. To this equipment, many progressive exhibitors have added a shower bath which, while not a fundamental necessity, is a most excellent dividend paying equipment, especially in warmer climates. The wash room is an absolute necessity now that sound film has arrived, because dirty, oily hands are mortal enemies to sound film or disc records.

Observation Ports And Fire Shutters

The size and position of all ports are matters governed largely by local conditions. The main factors to be considered are type of

equipment, size of theatre and projection angle. Fundamentally, port requirements are very simple. The projection port should permit the projection of an image to any part of the theatre required of that particular projector. In the case of the spot-lamps, flood-lights, stereopticon, and effect projectors, and at least one motion picture projector, this will include the entire front of the auditorium. The observation port should permit the projectionist to have full view of this area from normal operating position beside the projector in question. Satisfying these requirements is a simple matter, but calls for careful checking of all dimensions. In some cases it will be necessary to cut the ports with their walls flaring outwards if the projection room walls be excessively thick. The fundamental requirement of port shutters is that they surely, quickly and quietly close all ports within a few seconds of the inception of any film fire. We respectfully recommend the system of shutter suspension and semi-automatic control adopted by the state of Pennsylvania, or that employed by the Chicago division of Public Theatres Inc.

Ventilation

Projection room ventilation has two separate and distinct functions. First, it must exhaust all of the hot gases from the arcs, remove foul air from the room, and maintain comfortable temperature at all seasons of the year. Second, it must be capable of exhausting all fumes from burning film, in the event of a film fire, as fast as they are formed.

The first requirement is best met by two independent systems: one for the room in general; the other, directly connected to the lamp houses. In the cases of the spot-lamps, stereopticon and effect projectors, this direct connection may not be practical; but for the motion picture projectors and the floodlights it is absolutely necessary. The room ventilation system should be capable of making a complete change of air in three minutes. The lamphouse ventilation system should be capable of keeping the temperature of the air in the vent pipe eight inches above the top of the lamphouse at not more than 350 degrees F.

It is very doubtful if, for taking care of the fumes from a film fire, it would be unreasonable to recommend a system having a capacity of 5,000 cubic feet per minute. It should be capable of maintaining the barometric pressure in the projection room during

the fire substantially below that of the auditorium so that none of the inevitable crevices will exude any traces of smoke or flame.

Your committee realizes that this section of the report is far from complete, and intends to go more thoroughly into the matter of ventilation in the time between now and the next meeting of the Society, treating the matter somewhat in the manner of stack loss problems in power plant engineering.

Now after all bare, physical, fundamental requirements have been taken care of, there still remains a vitally important one which is often overlooked—though it is just as fundamental as those of a more definite nature. The audience sees the picture and other projected effects seated amid the most finished and luxurious surroundings that architects and artists can create. Now if the projectionist views the same picture and effects framed by a dirty, oil spattered unplastered wall festooned with a serpentine maze of conduit etc., can his mental attitude be the same, can his standards of judgment be as high as those of the audience, no matter how conscientious he may be? Never! This psychological stimulus of fine surroundings is a truly mighty force. It is ample justification for the best finished projection suites that any architect can conceive. The man who is not susceptive and responsible to these things has no place in the modern projection room.

F. H. RICHARDSON, *Chairman*

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