

COMMITTEE ACTIVITIES

REPORT OF THE PROJECTION SCREENS COMMITTEE*

The first report of the Projection Screens Committee was published in the September issue of the JOURNAL. It was to have been read at the May Convention of the Society but unfortunately the copies shipped to Hollywood by air mail were lost in transit. It dealt with, in some detail, the manufacture, installation, and maintenance of screens, and their light-reflecting and sound-transmitting properties. Curves were given to illustrate the reflection characteristics for the three types: diffusing, metallic, and beaded. Sound requirements and test methods were discussed at length.

It is, of course, our hope to consider screens from every possible angle of interest to the Society. At the present time we are able to report further progress on the program we originally formulated. We have some data on deterioration of screen surfaces, enough to indicate that a serious condition exists. The troublesome problem of determining the optimum illumination for screens has been given considerable attention, and some interesting information on rear projection screens, and incidentally rear projection, has been accumulated. This material follows.

LIGHT REFLECTION

That screens lose their reflective power with use is common knowledge. However, reliable data as to the magnitude of this loss have never been accumulated. We have made a beginning in this direction. The few results we have had the time to obtain indicate the range of variation and the really serious extent of the deterioration.

Our measurements were made with equipment constructed by one of the members of this Committee. The apparatus consisted of a metal tube 4 inches in diameter, holding a lamp operating at a color temperature of 2360°K. Concentric with this first tube, there was a second narrower one with a viewing aperture at one

* Presented at the Fall, 1931, Meeting at Swampscott, Mass.

end, in which it was possible to insert the photometer unit of a Macbeth illuminometer. The light source was an automobile lamp placed so that the angle of light incident upon the screen was approximately 3 degrees with the normal, which was the viewing angle. Between the viewing aperture and the screen was placed a blue filter such as to make the color of the light entering the photometer correspond to 5000°K. The light in the Macbeth comparison lamp was corrected with a similar filter in order to eliminate color difference in making the photometric balance. A battery of five dry cells made the apparatus entirely portable and independent of external power.

Measurements were made in several convenient theaters. The device was placed against the screen which was observed through the photometer inserted in the aperture. Obviously, the data are restricted to only one angle. It is felt that the loss of reflection which occurs at one angle will indicate approximately what occurs at other angles. The results are summarized in the following table. The original values for these screens ranged from 77 to 85 per cent.

Reflection at 3 Degrees from Normal

Sample	Per Cent
A. Broadway Theater (In use 18 months)	45
B. Auditorium; New York, N. Y. (In use occasionally for 3 years)	48
C. Broadway Theater (In use 18 months; lately reprocessed)	70-80
D. Broadway Theater (In use 9 months; reprocessed 3 months)	64
E. Hoboken Theater (In use occasionally 9 months)	80
F. Review Room (In use 9 months)	76

It will be noticed that deterioration is not very consistent. However, we should expect it to vary widely, depending on the conditions surrounding the use of screens. The valuable results obtainable from surface reprocessing are demonstrated by case C. In addition to a possible degradation of picture quality there will be a financial loss accompanying deterioration of reflecting ability. Some idea of the possibilities may be grasped from the following table.

The figures are based on a hypothetical decrease of 20 per cent in reflection, a serious loss. It is assumed as a first approximation that this corresponds to a 20 per cent waste of electric power. Other assumptions are: operation, nine hours daily, and energy cost, five cents per kilowatt hour. These are common conditions.

Type of Lamp	Amperage	Weekly Current Cost	Weekly Loss
Low intensity arc	25	\$ 8.75	\$1.75
Hi-Lo intensity arc	75	26.00	5.20
High intensity arc	120	42.00	8.40

Obviously, if projection occurs only a few hours daily or weekly, the loss is not serious. However, it is not difficult to imagine a case where replacement of a screen would soon pay for itself by the saving of power required for illumination. One example is the theater given as case *A* above, which runs approximately thirteen hours every day. Another case when difficulty arises occurs when the projection outfit is operating at the limit of its capacity and is unable to supply sufficient light to overcome the loss of reflective ability of the screen.

SCREEN ILLUMINATION

Upon the appointment of the Projection Screens Committee, President Crabtree stressed the need for recommendations on the amount of screen illumination required for motion picture presentations. This complex subject has received a great deal of attention in the past, being one of the oldest of projection problems. Much scattered work has been done without the achievement of standardization or a complete realization of the factors involved. Among these factors are included the simplification of studio lighting and printing control as well as projection illumination technic. We will review hastily a few of the facts that are known, before describing a series of tests conducted at the meeting of the New York Section, Friday, September 25, 1931.

Factors that must be considered include visual acuity; flicker; other physiological factors; fidelity of brightness, contrast, and tone reproduction; and auditorium lighting. A complete unraveling of these is impossible but we may analyze them to some extent to obtain a better understanding of the problem.

A picture projected on a plane surface will be seen to consist of a grouping of areas of different brightnesses, that is, it is merely a pattern of contrasts. The relative brightness of the images must be presented much as the subjects are in actuality. For our purposes it is not necessary to discuss so much the relations involved among the areas as it is the intensity of light with which the picture as a whole is to be projected, that is, the absolute values of brightness. We seek to learn how brilliant bright objects must be, how dull the dark subjects may be and yet be discernible.

Obviously it is not possible to reproduce on the screen values of brightness as they occur in nature. To a large extent this is not necessary and often not even desirable. One purpose of a motion picture is to create artificially an impression which will be accepted as a satisfactory illusion of reality. More than that, it aims to convey a story, using its own devices. The brightness element, together with size, depth, and color, is secondary, being subordinate to the story and continuity. Hence, it is not necessary that sky scenes be shown with clouds as lustrous as clouds are, human faces as bright as they are in every-day life, deep shadows as profound as they often are. What is essential is not so much faithfulness to actuality as it is adaptation of illumination to achieve a smooth vivid portrayal of the story. This is fortunate in as much as we possess no light sources capable of producing on a screen brilliancies comparable with those under direct sunlight. Nevertheless there may be some instinctive demand for reasonable fidelity in brightness reproduction.

The pictures on the screen should be easy to see under conditions of illumination existing in theaters. The projected image should be the brightest area in the theater to facilitate concentration. However, in addition to this psychological element, there is another practical requirement. The auditorium should be provided with as much light as is consistent with preserving satisfactory detail in the picture, and the intensity should increase with the distance from the screen. This light should be sufficient to mitigate screen glare and permit easy finding of seats. There should be no sudden change at any point, as sharp contrasts are harmful to the eye. Stray light falling on the screen must be kept to a minimum in order to preserve picture contrast. Clearly, if the stray light should equal the illumination on the screen corresponding to a shadow, the shadow would disappear.

The lower limit of screen brightness should therefore be determined by the light reaching the screen from the auditorium. There is no criterion for the maximum desirable amount of illumination corresponding to the highlights. We do know, however, that with the auditorium in a darkened condition it would not do to have too bright a screen as this would be physiologically harmful.

Desirable screen brightness is dependent on all these variables. Only by analysis of judgments drawn from many observers subject to varied, controlled conditions will it be possible to determine the optimum relations.

In an endeavor to obtain more information on this subject, we conducted our tests at the meeting of the New York Section. This meeting afforded an excellent opportunity in as much as there was present a body of trained men who would readily understand our aims. We did not expect conclusive results from our tests, but regard them as a preliminary step in the investigation. Obviously, a complete study of all the factors would require the time of many men over a period of months.

In these tests we used two projectors, one a hi-lo and one a low intensity arc, setting these to produce known values of screen illumination. Two types of arc were employed to determine whether different color characteristics affect the amount of light judged desirable. There was no illumination in the auditorium other than that supplied by screen reflection. It would have been interesting to vary the lighting also, but the time at our disposal necessitated restriction of the variables. Two reels of film were used, one with a large percentage of brilliant scenes in it, such as outdoor shots, the other consisting of interiors, emphasizing human features and shadows. We wished to learn whether different amounts of light would be found desirable for different types of subject-matter.

The arc light intensity was varied by means of wire filters inserted in the projection machine behind the condenser lens. Four settings were used. The first setting was 68 per cent of the maximum, which was the second setting. The third and fourth settings were 50 and 25 per cent, respectively. The low intensity machine was first used for both reels and was followed by the hi-lo intensity arc. There were present 61 observers, most of whom commented on the projection on questionnaires which were distributed among them. Their findings are summarized in the following table. The brightness values are without film and with the shutter running.

Reel 1
Interiors

Reel 2
Exteriors

Low Intensity

Brightness	Foot Lamberts				Foot Lamberts			
	4.7	7	3.5	1.7	4.7	7	3.5	1.7
Glaring	0	3	0	0	10	0	0	0
Bright	2	8	0	0	20	4	0	0
Preferred	9	17	0	1	12	18	0	0
Acceptable	26	25	3	1	16	29	7	0
Dull	18	4	41	12	0	8	39	15
Dark	2	0	14	44	0	0	12	43

Hi-Lo

	Foot Lamberts				Foot Lamberts			
	11.5	17	8.5	4.2	11.5	17	8.5	4.2
Glaring	10	20	0	0	13	6	0	0
Bright	14	14	1	0	20	10	2	0
Preferred	9	12	11	1	7	22	7	0
Acceptable	14	10	18	7	15	16	8	3
Dull	9	1	19	24	0	4	33	20
Dark	1	1	8	24	0	0	8	35

Screen reflection factor: 80 per cent.

Screen size: 9 by 12 feet.

Distance from screen: from 27 to 55 feet.

Viewing angle: 90 ± 30 degrees with screen.

Auditorium illumination: 0.02-0.5 foot candle.

Brightness of screen surroundings: 0.1-0.9 foot lambert.

19 Observers expressed a preference for the color of the low intensity lamp;

17 preferred the hi-lo.

A foot lambert is the brightness of a perfectly diffusing surface illuminated by one foot candle.

Analysis of Results.—Under the circumstances we cannot be too positive in our conclusions from these tests. It will be sufficient to point out tendencies and possibilities. To obtain decisive results it would be necessary to perform repeated and varied experiments lasting over a period of time. Admitting the limitations, we may proceed to interpret the data.

With reel 1 and the low intensity lamp the reactions were just what might be expected. A brightness of 7 foot lamberts was found to be quite acceptable. This reel consisted of views of a string orchestra, the players being dressed in dark, formal clothes. The brightness on the screen was of the same order of magnitude as those existing at an actual performance of such an orchestra. Obviously,

we do not know that this value would have been preferred to a higher one, which our facilities did not permit.

The results obtained with this reel and the high intensity lamp are in fair agreement with those for the low intensity. A brightness of 17 foot lamberts is too great for such an indoor scene projected in a darkened auditorium. A value between 8.5 and 11.5 is indicated as perhaps the most acceptable.

Reel 2 consisted of comparatively brilliant outdoor scenes. It was shown after the reel of indoor scenes and it is supposed that the first reaction of the audience was to pronounce the illumination bright. After sufficient time had elapsed for ocular accommodation, a greater brightness was found acceptable and, in the case of the high intensity lamp, preferred. The light intensities on the screen were naturally far below those at which the original scenes would have been viewed.

One conclusion is that it is necessary to vary the light intensity for different types of prints, although it is theoretically possible to select one light intensity and maintain it by recording scenes on a sliding photographic scale, each value of brightness to have a definite constant position on this scale. The optimum value of brightness according to these tests should be a compromise between the extremes of 7 and 17 foot lamberts, the mean of which is 12. This is somewhat higher brightness than is customary.

REAR PROJECTION

Historical.—Rear projection is not new; it has been used for fifteen years in Germany, France, and England. In this country we are all familiar with the small projectors used in public places for advertising, demonstration, and stock quotations. Application to the theater was delayed by two difficulties: one, the lack of a suitable translucent material, and the other, of an efficient distortionless wide angle lens. Within the past six months several small theaters have opened in New York to show newsreels and short subjects on a rear projection screen.

Mechanics.—There are several possible materials for use as rear projection screens. The more common are dental rubber, treated silk, ground glass, celluloid, and a gelatin composition. The last is one which is being used on a large scale. Glass screens have a satisfactory transmission characteristic but the large sizes are heavy and difficult to protect. Celluloid screens would be satisfac-

tory if it were not for their fire hazard. All rear projection screens have the disadvantage that large uniform areas of material must be used. They differ from front projection screens in this respect, for the latter are sewed together from strips of standard width. The process of manufacture of the gelatin screen is as follows:

On a heated table is poured a hot gelatin solution, over which is stretched smoothly a fine silk fabric which is pressed into the gelatin. The combination is allowed to cool slowly about twenty-four hours, and is then placed on a rack to dry for seventy-two hours. Care must be taken to keep water from touching the screens as the composition is soluble in water. The screens may be cleaned with alcohol. They can be furnished in any desired color but at present a slight bluish tint is standard.

Installation.—It may be of interest to point out several facts about the installation of rear projection apparatus as it is done in the new small theaters. Standard apparatus is used, two machines being mounted about 8 feet behind the screen at an angle of 45 degrees with each other and $22\frac{1}{2}$ degrees with the screen normal. Each lens is approximately 7 inches off the screen axis.

The width of screen that is possible is determined by its distance from the projection lens. The rule is that 1 foot of width is possible for every foot of separation between the screen and the 1-inch focal length lens that is employed, 8 feet in this case.

There is a general impression that film as projected over these machines must be reversed. This is not so, as a prism is employed to reverse the image on the screen and to bend the light rays through an angle of $22\frac{1}{2}$ degrees. The prism is mounted immediately ahead of the negative projection lens.

The screen is mounted about 5 inches above the head of an observer in the first row. This makes possible the installation of a horn or baffle loud speaker beneath and on a line with the screen. It must be pointed out that this position for the speaker is not quite correct for furnishing the proper illusion, which, however, is yet acceptable in the front rows to the ordinary observer. At the rear of the theater the effect is quite good, in as much as the auditorium is small and sound mixing helps create the correct impression.

One advantage of the rear projection installation may be pointed out. It requires less vertical space and no specially dimensioned auditorium. Hence it is possible to employ as theaters enclosures similar to small stores.

Light Transmission.—The light transmission may be varied to meet different requirements. We have already seen that transmission may be made to favor any particular color. It also may be made to give several different types of distribution. By proper processing, the distribution is made more uniform, and hence satisfactory for viewing at wider angles. It must be expected that there will be an additional loss of contrast as compared with front projection because of the introduction of another translucent surface, which adds to the flare effect.

Illumination.—Since the screen is light transmitting, the light intensity in the auditorium can be considerably higher than in the ordinary theater during a performance. It has been stated that the auditorium is illuminated to about 30 per cent of average theater full lighting. Nevertheless, it is necessary to take precaution to keep light from falling on the screen, in as much as there is some slight reflection from the surfaces. High auditorium illumination means that confusion in seating is practically eliminated. For types of theaters where patrons are continually passing in and out, it is very desirable to have considerable light. However, it must be remembered that a partially lighted auditorium tends to prevent patrons from "living" through a feature presentation, since it makes one too conscious of his immediate surroundings. In a theater showing newsreels and short subjects, this is not objectionable.

For much of the above information on rear projection we are indebted to Mr. W. Mayer and the Trans-Lux Movies Corporation.

S. K. WOLF, *Chairman*

D. S. DE'AMICIS	W. F. LITTLE
F. M. FALGE	A. L. RAVEN
H. GRIFFIN	C. TUTTLE

DISCUSSION

PRESIDENT CRABTREE: The work of this Committee points the way in which a committee can do real research work. They did not have to have a research laboratory in which to make these tests. They used the available research laboratory, which was the membership of the Society. I congratulate the Committee on this pioneering effort in coöperative research.

It is very interesting to find that it seems to be necessary to have a greater screen brightness for the outdoor shots than the indoor ones. On second thought, it is reasonable. Probably the matter could be taken care of by giving a uniform flash exposure to the interior scenes, or they could be printed a little heavy.

With reference to the brightness test I should like to point out that the figures show approximately ten foot candles as the minimum desirable brightness of a picture. In previous years we have made numerous tests of screens, and find that

the average lies between three and five foot candles; and with low intensity light sources, three foot candles. In the studio laboratories where prints are analyzed by the studio personnel, intensities of about thirty foot candles are used—ten times the intensities used in the theaters. This is the cause of dark prints and the troubles that go with them, such as overloading. Dirty screens also require overloading, causing additional loss of picture quality.

MR. FARNHAM: In connection with the data on reflection factors of screens, the figure of eighty per cent appears to be very high. I should like to ask if that is absolute reflection, *i. e.*, incident light to total reflected light or is it the ratio of reflected light after a period of use to that of a new screen?

MR. WOLF: The measurements of reflection factor were made as soon as the process was completed; each time a comparison was made with the standard.

MR. FALGE: It happens to be the brightness at the normal which is in question rather than the total reflection value.

MR. FARNHAM: That is an extraordinarily high value, and that is why I asked.

PRESIDENT CRABTREE: Have the experiments of the Committee, Mr. Wolf, gone far enough that we can begin to think of recommending a standard of screen brightness?

MR. WOLF: The data collected at the demonstration at Bell Laboratories proves more or less conclusively that there are certain limits to be considered. We cannot say definitely what they are, but they probably lie between seven and thirteen foot candles. We definitely believe that any picture having a brightness less than seven foot candles is certainly too dull; and any picture having a brightness greater than thirteen foot candles is glaring and disagreeable to look at.

PRESIDENT CRABTREE: Can any one explain why a value of thirty is used in the screening room?

MR. FALGE: In an article published by Mr. Huse some time ago, describing some tests of Hollywood screening rooms, he gave the value as thirty foot candles. It is expected that the intensity will always be high in the screening rooms, unless deliberate attempts are made to keep it within reason, because the picture is always small and the light intensity is greater than in the average theater.

PRESIDENT CRABTREE: Were Mr. Huse's measurements strictly comparable with yours? In other words, has the Committee first of all found a method of getting an absolute measure of this reflection value? Does your figure of ten correspond with a similar figure in Hollywood?

MR. FALGE: I think you will find considerable variation among the figures that have been collected; but I think it is sufficiently important, even with an error as great as twenty-five per cent, to show that the values in the theater differ considerably from those in the studios.

MR. FARNHAM: As a result of some work that I did a number of years ago on screen brightness, I found that there is also a relation between the picture size and the screen brightness. Smaller screens should be brighter for the same projected picture, so that whatever intensities we recommend for the studio viewing rooms, they must be corrected for the size of the picture.

PRESIDENT CRABTREE: That was also observed when we were making wide-film experiments. We did not need as great a brightness as with the smaller pictures.

MR. GAGE: May I ask if the foot candles are measured with a machine sta-

tionary with the shutter open, or with the shutter running and with no film?

MR. WOLF: We have data under all conditions. In preparing the tests we made measurements both with the shutter standing still and with it in operation. We made the measurements, also, of auditorium illumination and other quantities. The screen reflection factor was eighty per cent, and the size of screen was nine by twelve. The auditorium illumination varied from 0.2 to 0.5 foot candle. The amperage of the high intensity arc varied from 7 to 4.2; of the lower intensity, from 7 to 4.7.

PRESIDENT CRABTREE: What were the limits of variation due to screen size? Do you recall, Mr. Farnham?

MR. FARNHAM: The smallest screen used was approximately four feet and the largest twenty-two feet, a linear ratio of one to five and one-half. However, the ratio of brightnesses was more nearly two or three to one, the smaller picture requiring the higher intensity, but it was by no means an inverse ratio.

PRESIDENT CRABTREE: Suppose a value of seven were required for a twenty-foot screen, what would be the value for a four-foot screen? Would it be greater than thirteen?

MR. FARNHAM: As near as I can recall, the smaller picture would require two to three times the intensity ratio.

PRESIDENT CRABTREE: Is the Committee considering the effect of screen size?

MR. WOLF: Yes, it is; but sufficient time was not available.

PRESIDENT CRABTREE: If any of you are in New York I would recommend that you visit one of the Trans Lux theaters where pictures are projected from the rear of the screen. The most amazing thing is that the brightness level in the theater is as high as it is in this room, and yet the picture is adequately bright.

MR. GAGE: With a small screen close by or a large screen far off, both subtending the same angle to the eye, and with the same foot candles of illumination would not this give equally desirable results on both screens? If so, it is necessary to relate the distance of the observer to the screen size rather than simply say that a twenty-foot screen requires so many foot candles, and a thirty-foot screen so many foot candles, *etc.*

PRESIDENT CRABTREE: That would depend on the opacity of the atmosphere.

MR. WOLF: We did find a difference in the reactions of viewers as they moved away from the screen. But the brightness is the same whatever the distance may be.

PRESIDENT CRABTREE: Not if there is absorption, and the air is full of smoke.

MR. WOLF: That effect is not appreciable.

PRESIDENT CRABTREE: I urge the Committee to push forward the experiments as rapidly as possible, because I am anxious that our Society should be the first to propose a definite standard of screen brightness with the necessary qualifications due to the various factors involved.

ORGANIZATION OF PROGRESS COMMITTEE WORK

For three years the past-chairman of the Committee has assisted in the preparation of the semi-annual report, and it has occurred to him that a résumé of the program of organization may be of some value

to future chairmen. The following notes represent a description of the plan of organization of the work of the Committee.

Membership of the Committee.—It is very important in selecting members of the Committee to choose men who are representative of various departments of the industry. Such phases of the industry should include: film manufacture, lens design, camera work, and sound recording technic, studio illumination, laboratory processing, sound reproduction, theater construction and operation, and applied cinematography. Besides representatives in the United States, men should be selected from each country or part of the world where a well-developed motion picture industry exists, as well as where research on cinematographic problems is in progress.

The widely separated geographical position of the members of the Committee makes it unfeasible to hold meetings so that all the committee work must be handled by correspondence. Each member should be instructed carefully relative to the scope of the field which he is to cover in his semi-annual report to the chairman. It is very desirable to distribute the abstracting work of the Committee members, and separate journals which are pertinent to the nature of their own work should be assigned to each member.

The reports from Committee members may be composed of any one of the following types of information:

- (1) Abstracts of journals.
- (2) Personal appraisals of conditions in their specific field.
- (3) Answers to specific questions asked by the chairman.

A combination of classes (1) and (2) is the most valuable. The Committee members should realize that information that may sound commonplace to them because of their nearness to the source may be of outstanding interest to other branches of the industry.

Work Preliminary to the Preparation of the Report.—The past-chairman of the Committee has found a card file to be the most helpful means of coördinating the many hundreds of details which require final mention in the report. The contents of this file are assembled from three sources, namely: (1) clippings from one or more photographic abstract bulletins such as the *Monthly Abstract Bulletin* of the Kodak Research Laboratories, which contains patents as well as journal abstracts; (2) abstracts and summaries prepared by committee members; (3) miscellaneous data obtained from sources other than those mentioned under (1) and (2). One valuable source of

information on trade news is the weekly report of the Motion Picture Division of the U. S. Department of Commerce, Washington, D. C.

From past experience it has been found that illustrations comprise a valuable addition to the Progress Report, particularly during its presentation. The interest of the audience may be heightened considerably by the judicious use of lantern slides. A special effort should be made to secure illustrations of new equipment developed in foreign countries. Short motion picture films of significant developments may also be used as a valuable adjunct of the report during its presentation, as was shown at the Washington Meeting of the Society in May, 1930.

Preparation of Final Report—All reports from the different members of the Committee should be in the chairman's hands not later than one month before the date of the meeting at which the report will be presented. When these are received, every item of value should be card-indexed and filed so that, as far as possible, all data to be used in the report is on cards. It is not feasible in some cases to transfer the information but the reference to it should be prepared so that the data may be located with the least possible loss of time.

When all available data have been filed according to a definite classification, the actual writing of the report should be started. All references may be made most easily at the time that the material is written up, rather than after the writing has been finished. When the first rough draft has been typed, the report should be edited for the principal items of progress or "highlights" which are to be read at the meeting. These highlights should not comprise more than 20 per cent of the total report, and sufficient copies (usually about 30) should be mimeographed for the use of the Publicity Committee.

The general introduction to the report giving a broad summary of progress should be written last, after a clear impression has been secured of all the significant developments in the report. Courteous acknowledgment should obviously be made to all sources of information and illustrations apart from those actually supplied by Committee members. Care should be taken that proper credit is given under each illustration published with the report.

If the work of the Committee is carried out conscientiously and thoroughly, this report should become an increasingly valuable compendium of technical information on the motion picture industry throughout the world.

G. E. MATTHEWS, *Past-Chairman*