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SCREEN LUMINANCE DATA SHEET

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The perceived brightness of a projection screen is affected by many factors:

- light output from projector lamp source
- light lost in the projector reflected by mirrors or passing through lenses and through the port glass
- distance from the projector to the screen
- reflectivity (gain) of the screen
- viewing angle towards the screen

Over time, some of these factors can change (e.g. lamp power diminishes with life; screens become dusty) and this can reduce reflectivity. Higher power lamps diminish light output more quickly than lower power ones. When the projector is first set up, it will be optimised. Over time, misalignments can develop, which can reduce light output. The set-up of the projector needs to be reviewed periodically. Another factor in screen luminance is the amount of ambient light falling on the screen. This can also affect the contrast of the projected image. In cinema, ambient light is not usually a significant factor but in many other applications it can be.

Screen luminance

In cinema conditions, the SMPTE standard for screen luminance is nominally 16 ft. lamberts (55 candela per m²) at screen centre, with a minimum of 12 ft. lamberts and a maximum of 22. The corners and sides of the cinema screens should be at least 75% and 90% respectively of the centre and not less than 10 ft. lamberts. Screen luminance is measured using a photometer. Light output is measured in lumens. Reflected light is measured in ft. lamberts (or candela per m²). One lumen falling on 1 sq. ft. of screen will give 1 ft. lambert of reflected light, if the screen reflectance (gain) level is 1. So-called "gain" screens have higher reflectance levels than 1. Knowing the lumens output from a projector, it is possible to calculate screen luminance in ft. lamberts

Note: For digital projection, the luminance standard is reduced to 14 ft. lamberts (48 cd/m²).

Example:

output – light loss ÷ screen area x gain = luminance
(lumens) (%) (sq. ft.) (foot lamberts)

10,000 - 10% ÷ 900 x 1.0 = 10 FL

Different aspect ratios

In cinema, aspect ratios are changed according to the format of the film being shown. For 35mm film movies this is usually cinemascope 1:2.35 or widescreen 1:1.85. For digital video projection the aspect ratio can also be 16:9 or 4:3. The aspect ratio can have a significant affect on the perceived brightness level, as the effective screen size changes with different aspect ratios and the light output can also change significantly from the projector.

Gain Screens

Gain screens create brighter images according to the level of gain, by directing more of the incident light back to the audience (with matt white 1.0 screens, some of the light is reflected to the walls, floor and ceiling). Gain is measured using specific equipment according to international standards. Typical screens are available with gain levels of 1.4 or 1.8 (respectively 40% and 80% brighter than matt white 1.0 gain screens). This gain measurement is made on axis (i.e. at 90° to the screen). At an angle, the gain level (and therefore screen luminance) diminishes. This effect is usually not significant until the viewing angle reaches 25° from the axis, and the loss of luminance can be minimised by curving the screen. For most cinemas, seats are within the 25° viewing angle so this is not a problem. Gain screens are very useful, particularly in big auditoria, to achieve adequate luminance. They can also enable smaller lamps to be used, often giving significant savings over the life of the screen. It is usually beneficial to use gain screens when screen width is over 11m.

Rear projection screens

In ambient light conditions, rear projection screens can be useful to minimise the reduction of the brightness caused by light falling on the screen. Screen luminance calculations can be made in the same way as for front projection screens by considering the transmittance factor of the screen. (Transmittance is measured using a similar method to measuring gain on front projection screens).

Example:

output - light loss ÷ screen area x transmittance = luminance
(lumens) (%) (sq. ft.) (foot lamberts)

10,000 - 10% ÷ 500 x 0.8 = 14.4 FL

In dark conditions, 16 ft. lamberts are desirable. With ambient light, more light output will be needed but this will vary with the degree of ambient light

References:

- SMPTE 196M-2003 : screen luminance
- British Standards Institute: BS5550-7.2.5:1980 gain measurement
- Measuring screen gain in cinema: Harkness data sheet DS-073