Viewing Conditions

Foreword

This module, ***Viewing Conditions***, is part of the ***Architecture*** chapter of the document, ***A Best Practices Guide*** published by the ***European Digital Cinema Forum***. It should be read in conjunction with other modules and chapters of the complete guide and in particular the modules on ***Image*** and also in compliance with all valid regulations, especially aspects regarding security, emergency, and accessibility. The aim of this module is, however, to give architects, cinema owners/managers and other people who are involved in the process of planning and designing cinemas some help in the design process. Very special thanks are owed to Rolv Gjestland who has kindly donated much of his text to this guide from his book, ***How to design a Cinema auditorium***, for which we are eternally grateful.

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Principal author	Rolv Gjestland.
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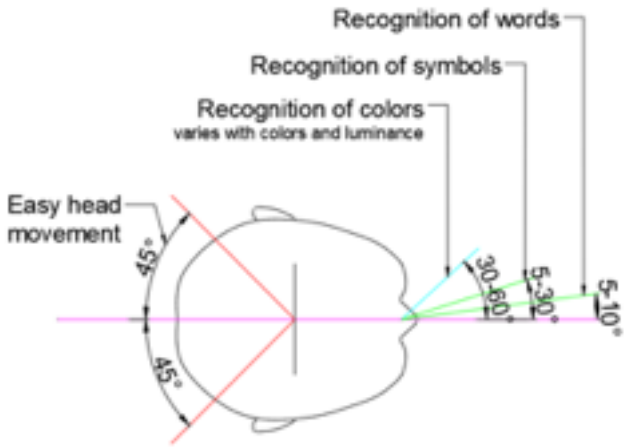
Why this is important

There are laws of nature that cannot be changed like rules of optics, anthropometry etc; not all seats can be perfect; and a complete black room might not look so nice. Designing a cinema auditorium always includes a lot of compromises and this module—and the wider chapter on Architecture—aims to help the reader optimise their investment towards making the best compromises and, therefore, making good cinema auditoriums where the audience can get many good movie experiences.

Screen-to-first-row distance

The maximum picture width limits the distance from the first row to the screen on a 2.39:1 screen. On a 1.85:1 screen, the maximum height might be the limit. Sitting too close to the screen, the human brain will not be able to perceive all the action on the screen and it will not be possible to recognize symbols and read subtitles with only minor head movements. The result is often a bad cinema-going-experience.



Viewing Conditions

Horizontal field of view between the edges on a 2.39:1 screen less than 80° is comfortable, corresponding to a distance from first row (eye) to the screen,

$D_1 \geq 0{,}6 \times W$

where W is the maximum picture width.

Maximum field of view should not exceed 90°, corresponding to

$D_1 \geq 0{,}5 \times W$

See illustration in the ***Seating area*** section below.

Horizontal viewing angles

If the viewer is not seated on the centre axis of the screen, the two-dimensional picture on the screen will look distorted. To a certain degree, the human visual system compensates for this distortion, but it will gradually become worse with increasing angle before it gets unacceptable.

The distortion, n, is given by:

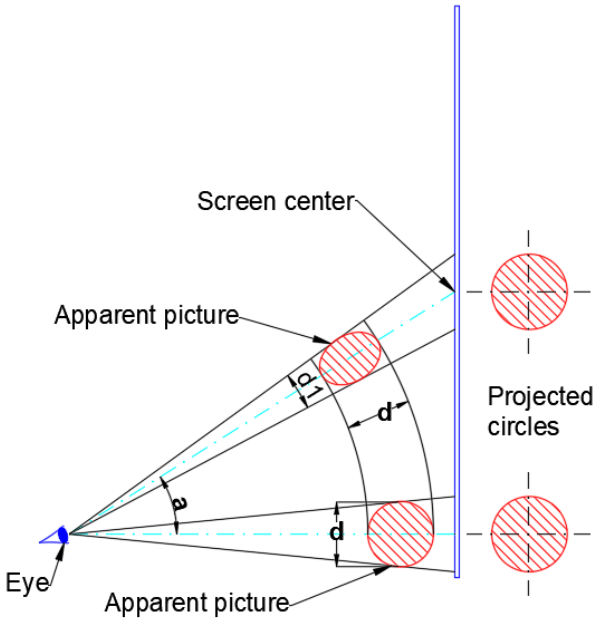
$$n = \frac{d}{d_1} = \frac{1}{\cos a}$$

where:

d = Diameter of circle on screen

d_1= Apparent diameter

a = angle between sightline from eye to screen centre and a perpendicular to the screen



See illustration.

Horizontal viewing angle from any seat to the screen centre should be less than 45°.

- Good values: $1 \leq n \leq 1{,}2$ or $a \leq 35°$
- Acceptable values: $1{,}2 > n \leq 1{,}4$ or $35° < a \leq 45°$
- Unacceptable values: $n > 1{,}4$ or $a > 45°$

Another limitation for horizontal viewing angle may be given by the screen type, especially when high gain screens are used.

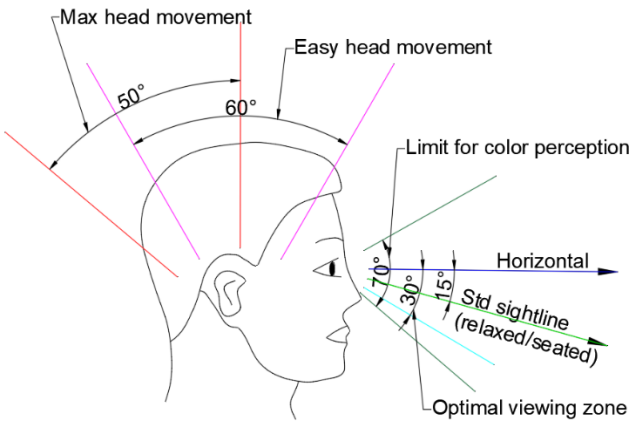
Viewing Conditions

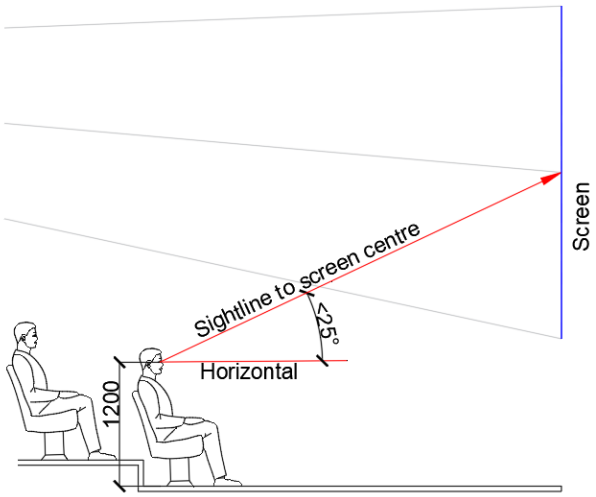
The observed luminance on the screen decrease when the viewing angle increases. More critical with higher gain screens. With silver screens, the maximum viewing angle must be much lower than 45°.

Harkness Screens International Ltd has made a Digital Screen Modeller (calculator) that can be used to find acceptable seating area for various of their screen models and can be found here: ***http://www.harkness-screens.com/digital-screen-modeller/***.

Vertical viewing angles

A relaxed seated person will look 15° down. Comfortable viewing zone is ±15° relative to this sightline. Such a condition is almost never achievable in a cinema auditorium. Chairs with headrest and recliners can help, but still the vertical viewing angle from first row, 1200mm above floor level, to the screen centre should be less than 25° (see illustrations below).





If the vertical angle gets bigger, it will be uncomfortable and can cause neck pain.

Seating outside the screen's edges

Sitting outside the screen's edges will reduce the viewers involvement in the movie and reduce the experience. Up to 5° outside the screen's edge is OK. Angles up to 10° is acceptable. See illustration in the ***Seating area*** section below.

Safety area in front of powerful projectors

There are standards and regulations that limit the seating area in front of projectors with high light output, to avoid eye damage if staring back into the projector beam. The size of the safe area increases with increasing light output and is also affected by lens type etc. This issue has become

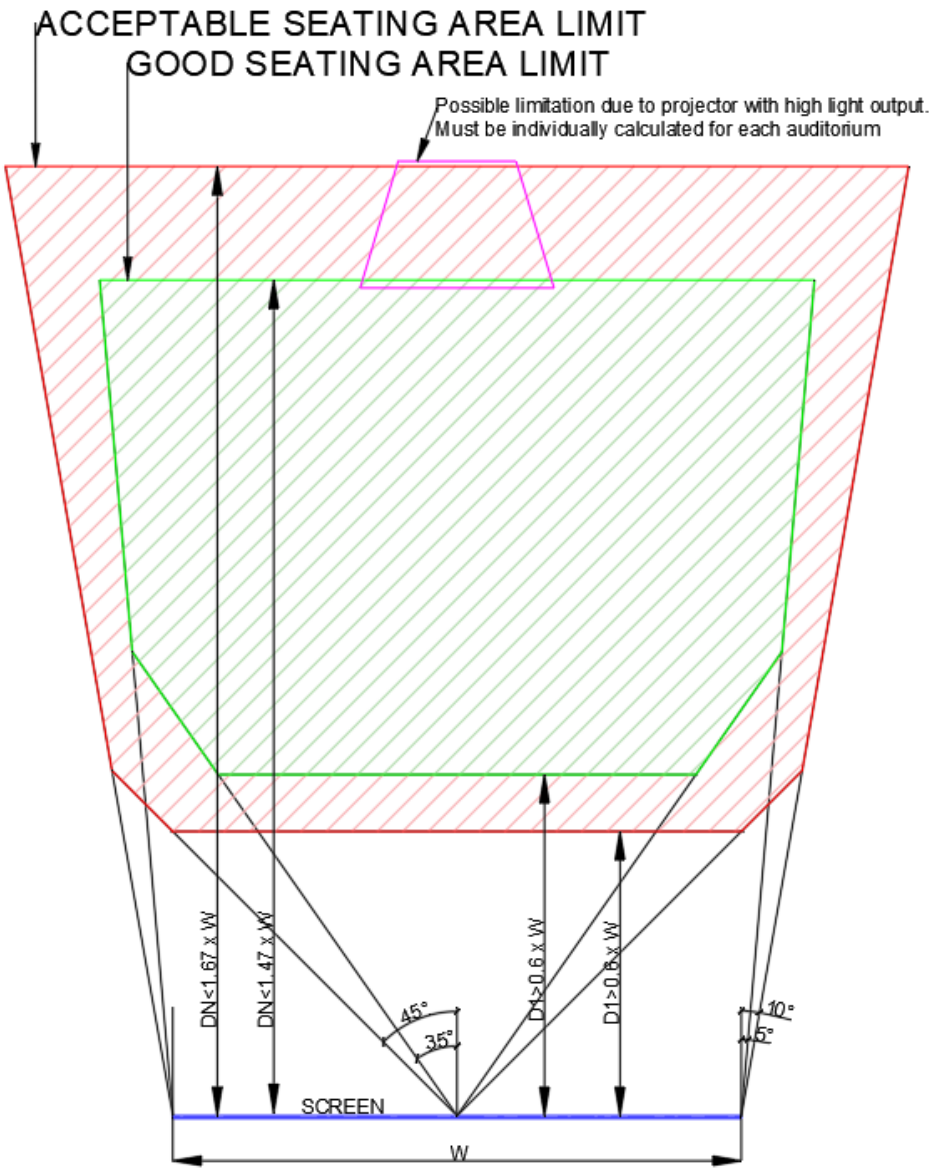
more critical with RGB laser projectors, making it possible to increase the light output for larger screens or increase the luminance level on the screen (High Dynamic Range).

The standard defines a Hazard Distance (HD), which is the minimum safe distance in the front of the lens. The standard also defines a Separation Height (SH), from floor to bottom part of the projection beam. If SH is below 2meters, the area defined by HD must not have any seats and must be labelled as "No Entry" zone.

See illustration in the ***Seating area*** section below.

Seating area

Based on the recommendations given in this chapter, the illustration below shows recommended and acceptable seating area in a cinema auditorium.



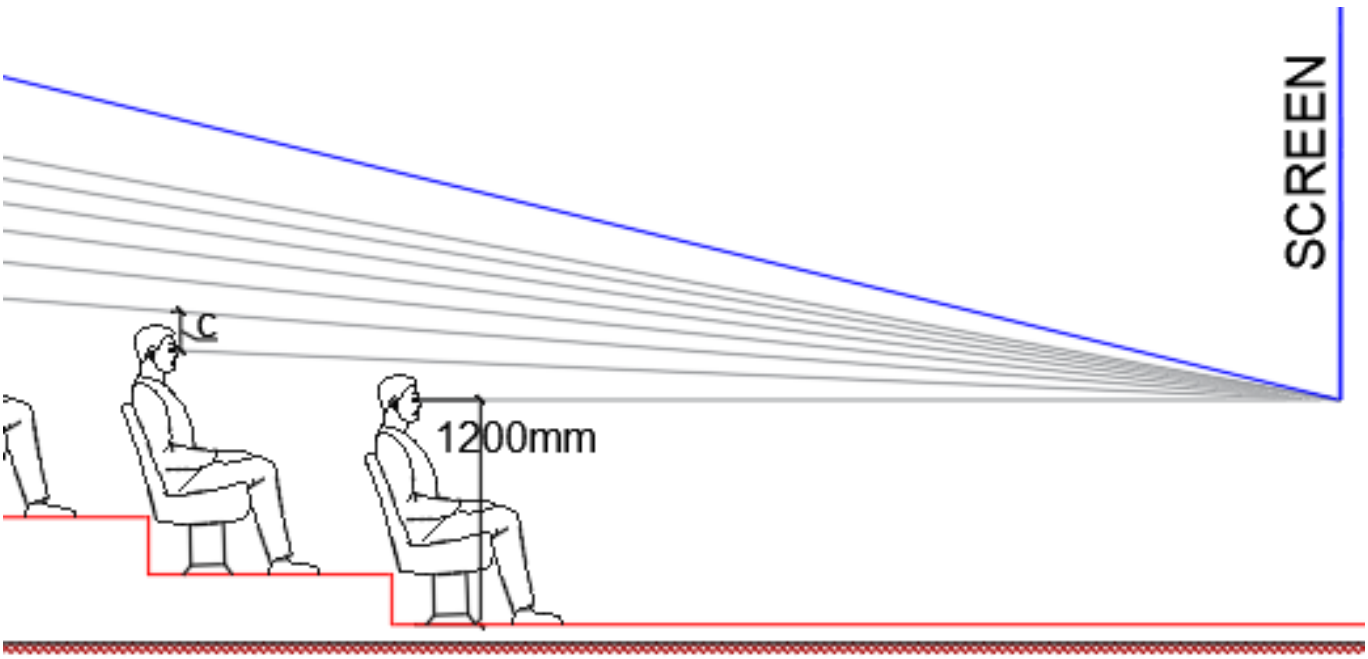
Sightline clearance

In a cinema, everyone should see the whole picture. To achieve that, the auditorium must be designed to give acceptable sightline clearance from every seat.

It is common to use 1200mm as reference height from floor to eye for a seated person.

The sightline clearance, c, (see fig below) must cover situations where a taller person sits in front of a lower.

- Good values: c > 200mm
- Acceptable values: 150 < c < 200mm
- Poor values: 120 < c < 150mm
- Unacceptable values: c < 120mm



If all risers have equal heights, the sightline clearance decreases with increasing distance from the screen. To get acceptable sightline from the last rows, the risers might be very high, and the total height of the stadium will be very big. That will again lead to larger projection angle and increased image distortion (keystone). The sound reproduction will also suffer.

The best solution is to design individual riser heights for each row, calculated to give equal sightline clearance for every row. Alternatively use lower risers for the first group of rows, larger for the next group etc.

This is the formula to calculate the optimal auditorium slope:

$$Y_n = X_n\left(\frac{Y_1}{X_1} + c\sum_{n=1}^{n}\frac{1}{X_n}\right) - c$$

where:

n = row number (n=1 for Row 1 etc)

X_n = Distance from screen to row n

Y_n = Difference in height between eye level on Row n and picture bottom level

c = Sightline clearance

To improve the sightline for small children, the cinema might offer individual seat cushions children can borrow.

Your notes