Simulation Tools in Sound Reinforcement: Multichannel Digital Audio Cinema Design

Athens Course UPM94
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Madrid

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DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- The projection of the film (35 mm or digital) can be performed with two screen aspect ratios:

  "*Flat screen*": 1.85:1 (w/h) (0.447"×0,825")

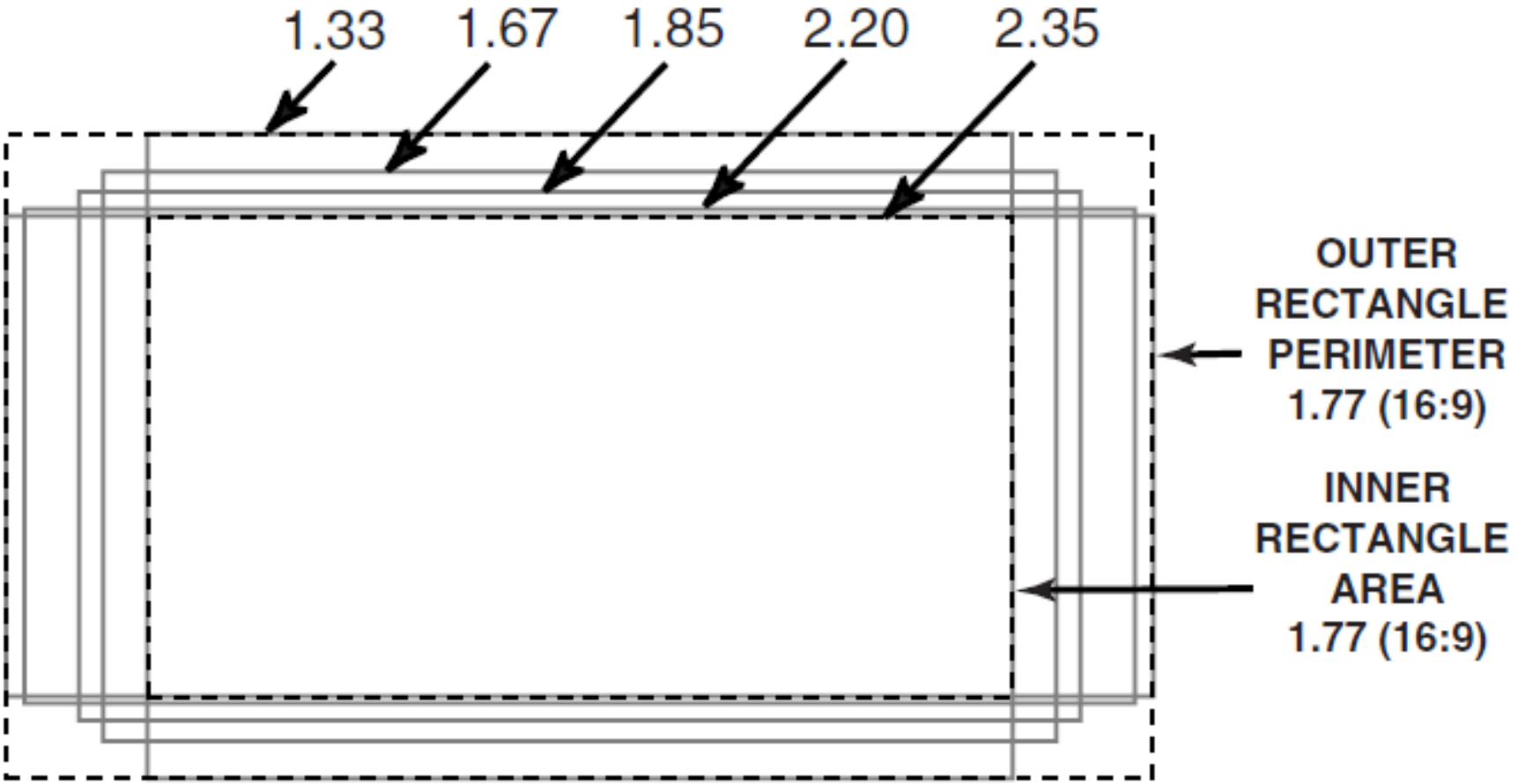
  "*Scope screen*": 2.35:1 (w/h) (0.700"×0.839")

- This parameter will set one of the relationships of size in the movie theater (width/height – W/H - of the wall where the screen will be placed).

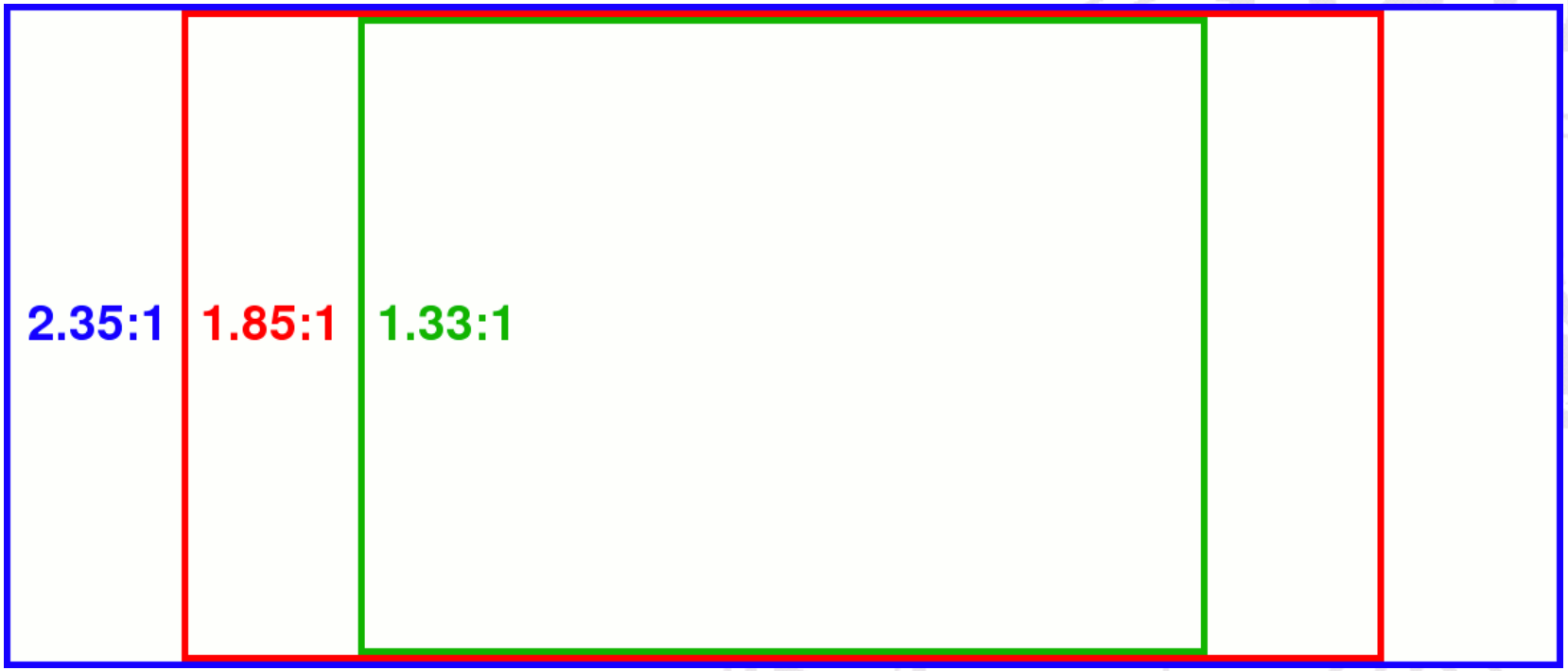
- Try to adjust the screen width to the width of the room.

- The height of the room in the wall of the screen will have a relationship with the height of the scren from 1.5:1 (maximum).

DESIGN AND DIMENSIONING OF A CINEMA THEATRE



DESIGN AND DIMENSIONING OF A CINEMA THEATRE



DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- The number of seats (spectators) that will host must have into account when it comes to sizing up the room. Considered that the average volume of air per seat in a movie theatre should be 5.6 m^3 (200 ft^3). This leads us to the following rule:

Asientos	Volumen
75-125	695 m^3 (25000 ft^3)
125-250	1390 m^3 (50000 ft^3)
250-500	2780 m^3 (100000 ft^3)
500-1000	5560 m^3 (200000 ft^3)

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- The relationship between the length and the width will be maximum 1.65:1.
- Recommendations concerning the length of the room could be the following, always depending on the number of seats:

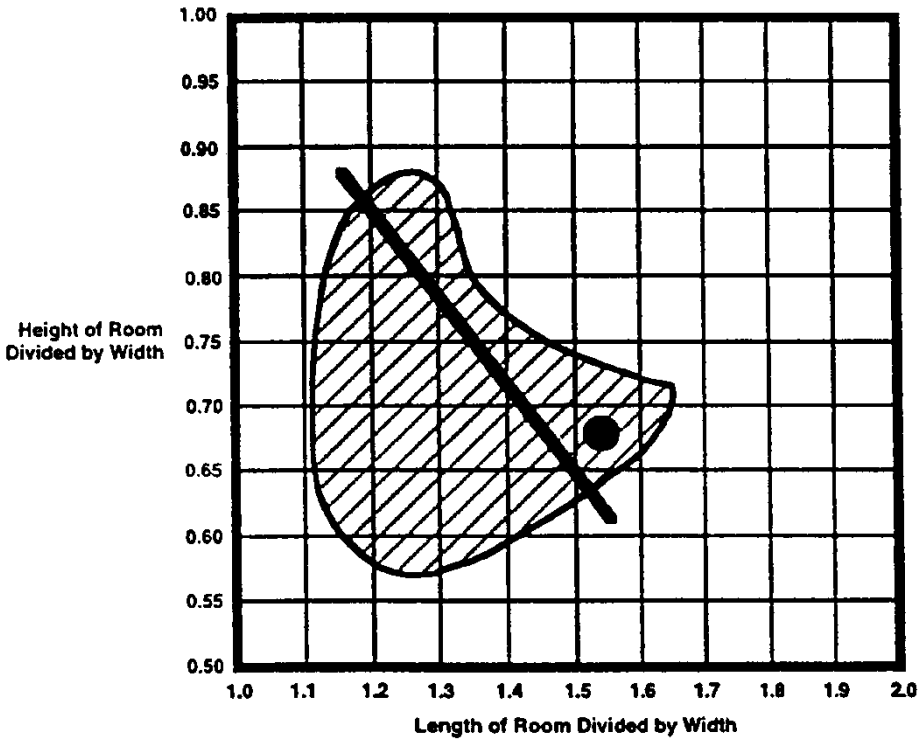
Sala	Asientos	Volumen	Longitud
Pequeña	<200	1275 m^3 (45000 ft^3)	<12 m
Mediana	200-350	2230 m^3 (78750 ft^3)	<21 m
Grande	350-500	3190 m^3 (112500 ft^3)	<30 m
Extra-Grande	>500	<6375 m^3 (225000 ft^3)	<60 m

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

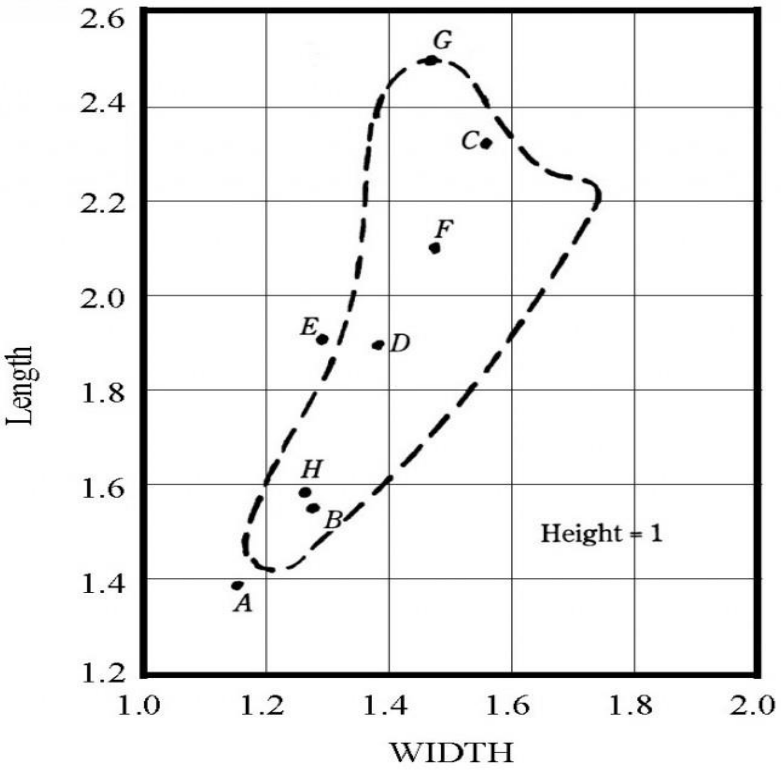
- The height of the screen will be selected according to rule 3 m, 4.5 m, 6 m, 7.5 m, 9 m (10, 15, 20, 25, 30 ft).

	Spectral 240	Spectral 240 MP
Application	Cinema (particularly suitable for polarised 3D systems), Screening Room, Roller Screen and 4D Theme Rides	
View Distance	Minimum of 5mtr (15') recommended on perforated surfaces	Minimum of 1.5m (5')
Maximum Size	USA manufacture 23.77 x 12.19m (78' x 40') Europe manufacture 33m x 11m (108' 3" x 36' 1")	
Perforation Size	Ø1.2mm (0.047")	Ø0.50mm (0.020")
Perforation Density	4.5%	1.7%
Weight	0.50kg/m^2 (0.10lb/ft^2)	

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

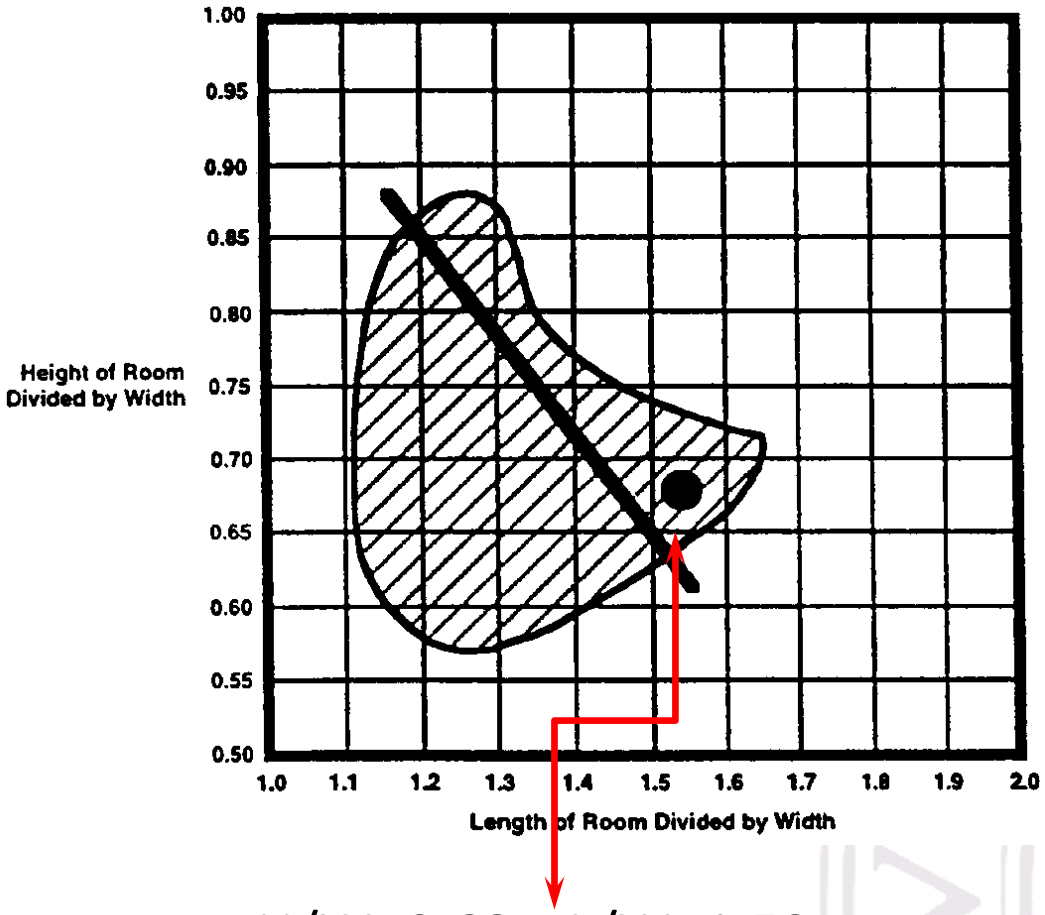


Cinema sizes relations



Bolt area

DESIGN AND DIMENSIONING OF A CINEMA THEATRE



Wp/Hp=2.35/1

Hp/Wp=1/2.35=0.426

H/Hp=1.5/1

H/Wp=1.5x0.426=0.639

L/W≤1.65/1

H/W=0.68 L/W=1.53

Volumen ≤ HxLxW Volumen = 5.6xNº butacas

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

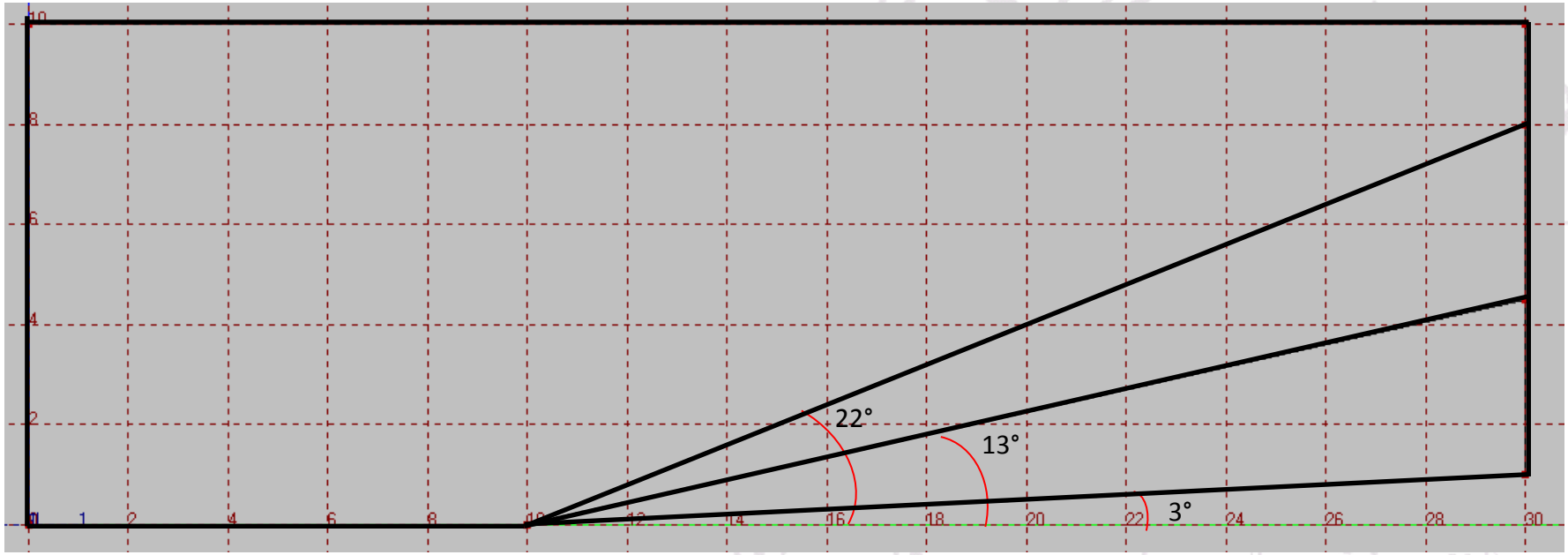
SMPTE Engeneering Guideline E 18-1994

Items to check:

- Open plan area, without elements that hinder vision.
- Slope of the room.
- Spacious seats.
- Horizontal field of view (horizontal angle).
- Vertical field of view (vertical angle).

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- There are three types of rooms: the traditional room (< 5 ° inclination), the room in slope (< 15 ° tilt) and the room type Stadium (< 25 ° inclination).



DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- In the first of room the floor is a continuous slope and each row of seats is between 6 " and 8" above the previous (16-20 cm).

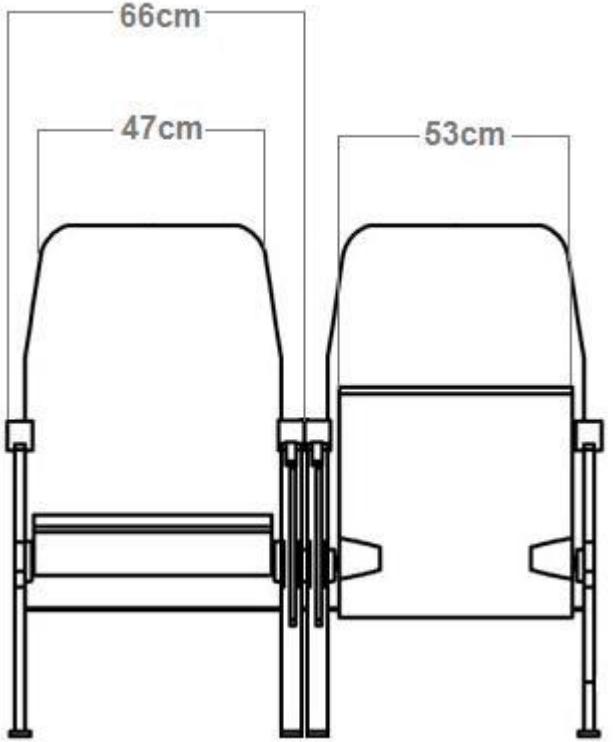
- In the second and third type of rooms seats are placed on terraces which allows that each row is between 12" and 15" above the previous (30-40 cm).

- The room seats should be placed in parallel lines following the shape of the screen (not actually). The minimum width of the seats must be 20"(51 cm) and the separation between rows must never be less than 36" - 38"(91-97 cm).

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

Spacious seats: Standard

- Width 50,8 cm.
- Space between rows 91,44 cm.
- Parallel rows facing the screen.
- Lined with absorbent material.
- Same absorption with and without spectators.
- Individuals and armchairs.



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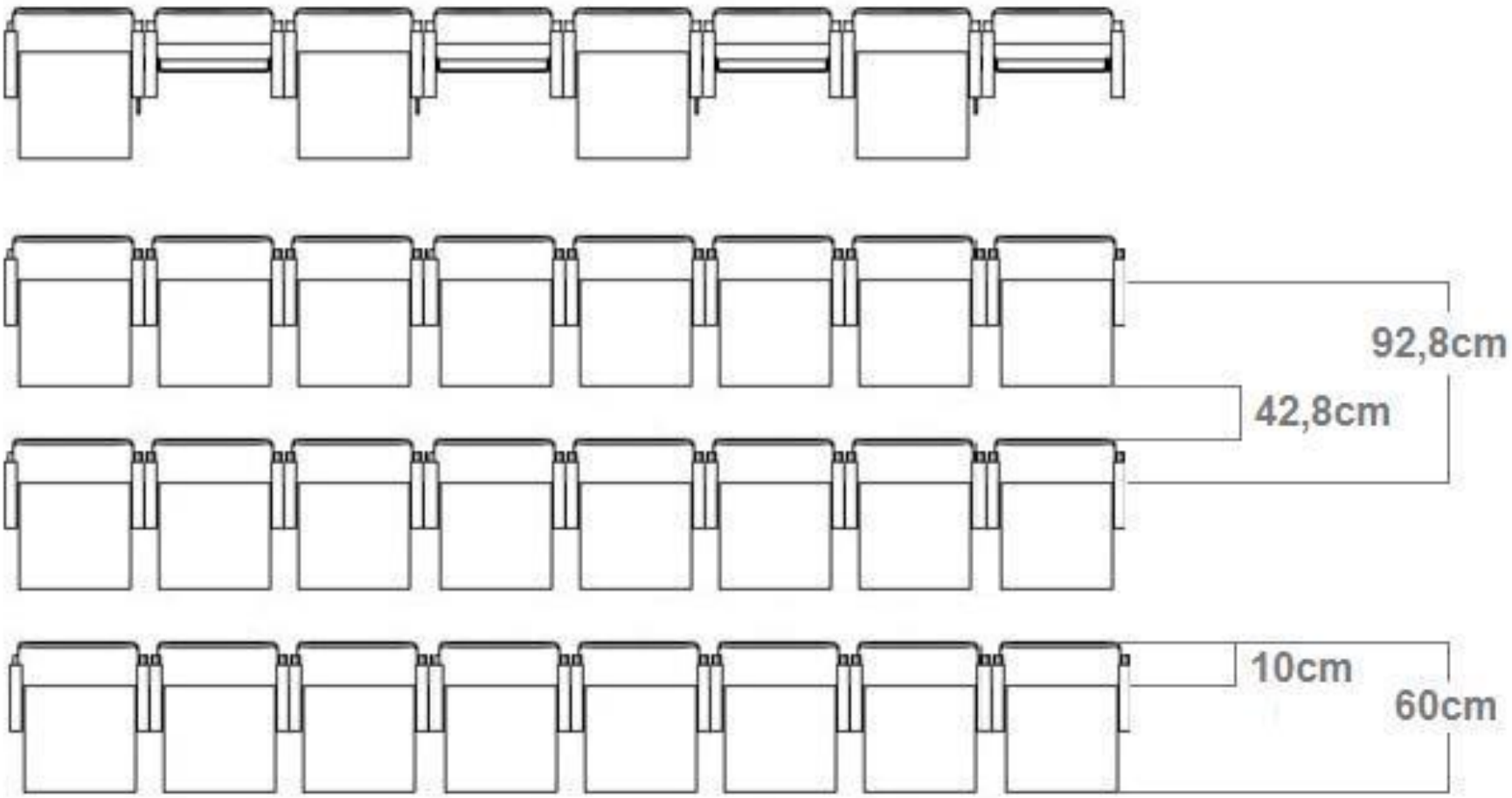
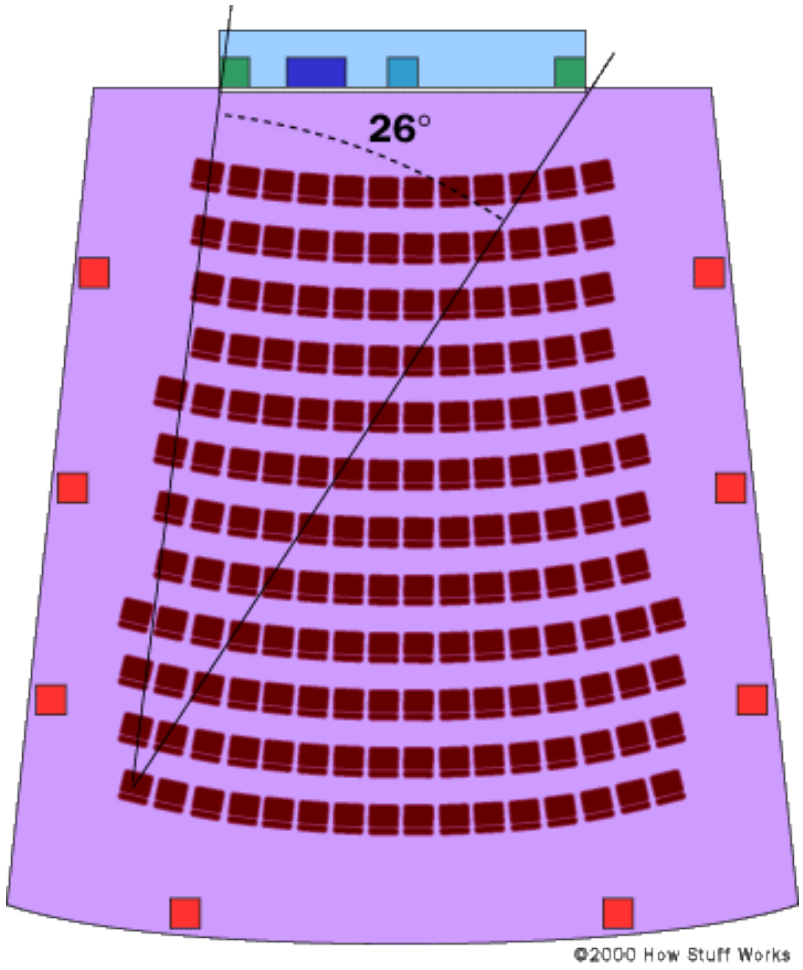
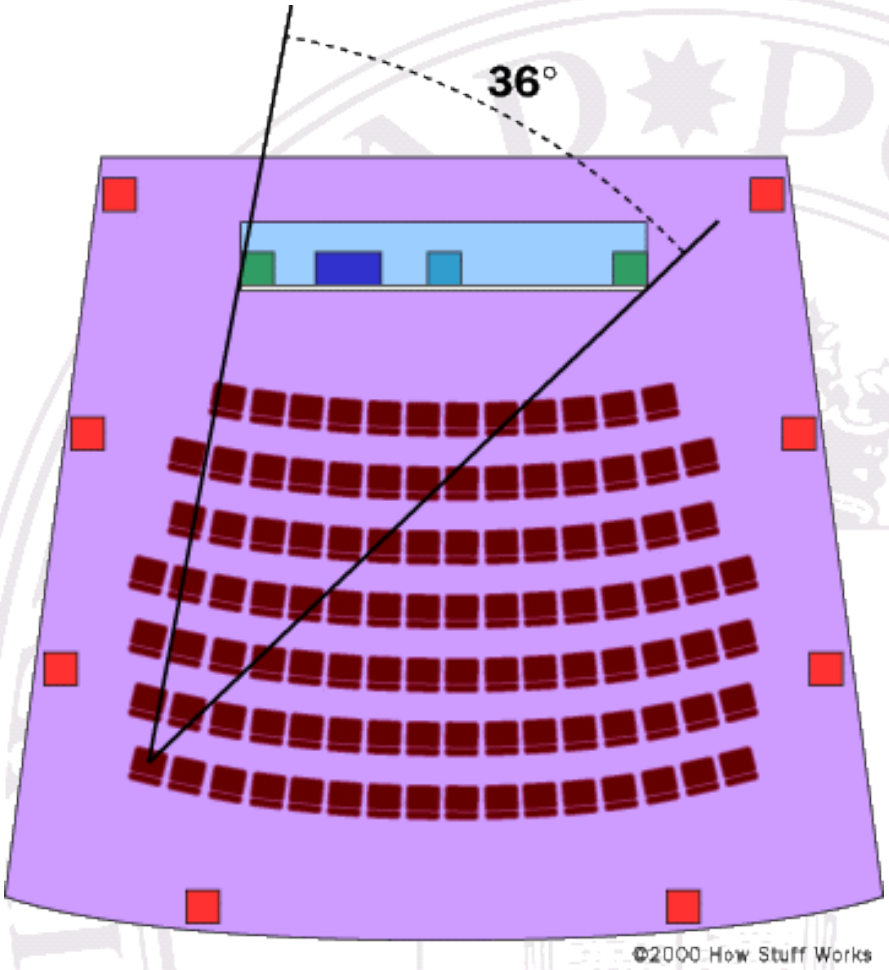


DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- Check the horizontal viewing angle from the last row (26 ° - 36 °) positions.
- Check the horizontal viewing angle from the front row (< 80º).
- Check the vertical viewing angle from the front row (< 35º).

DESIGN AND DIMENSIONING OF A CINEMA THEATRE





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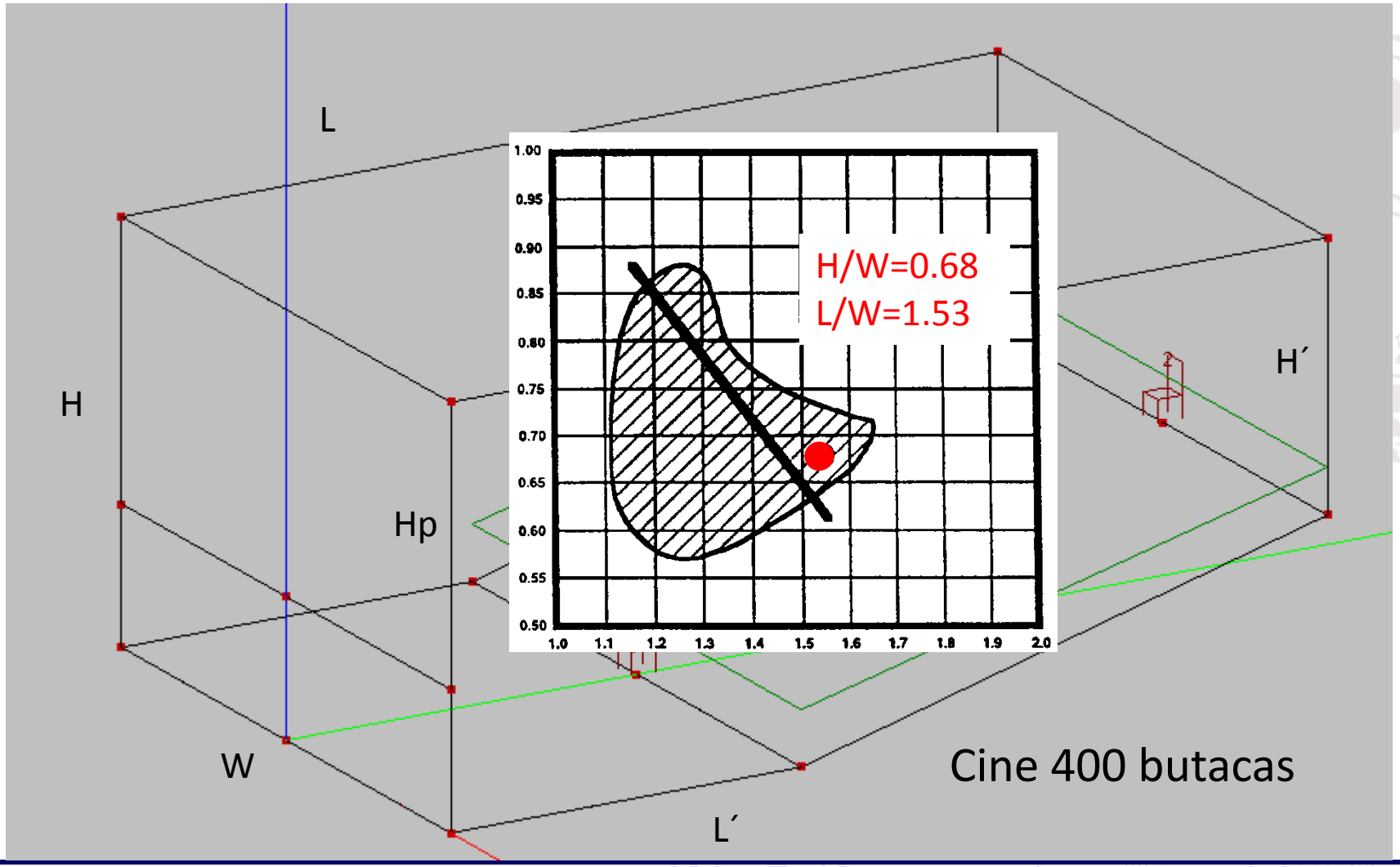


DESIGN AND DIMENSIONING OF A CINEMA THEATRE

H/W = 0.68 V = 5.6m^3 x Nº Seats

L/W = 1.53 V $\leq$ H x L x W

Cinema 400 seats $\Rightarrow$ V = 5.6m^3 x 400 = 2240m^3

V $\leq$ H x L x W = 0.68 x 1.53 x W^3 = 1.04 x W^3 $\Rightarrow$ W = 12.9m

We take: W = 13m; H = 9m; L = 20m

W/Hp=2.35/1 $\Rightarrow$ Hp = 5.5m

H/Hp=1.5/1 $\Rightarrow$ H = 8.25m

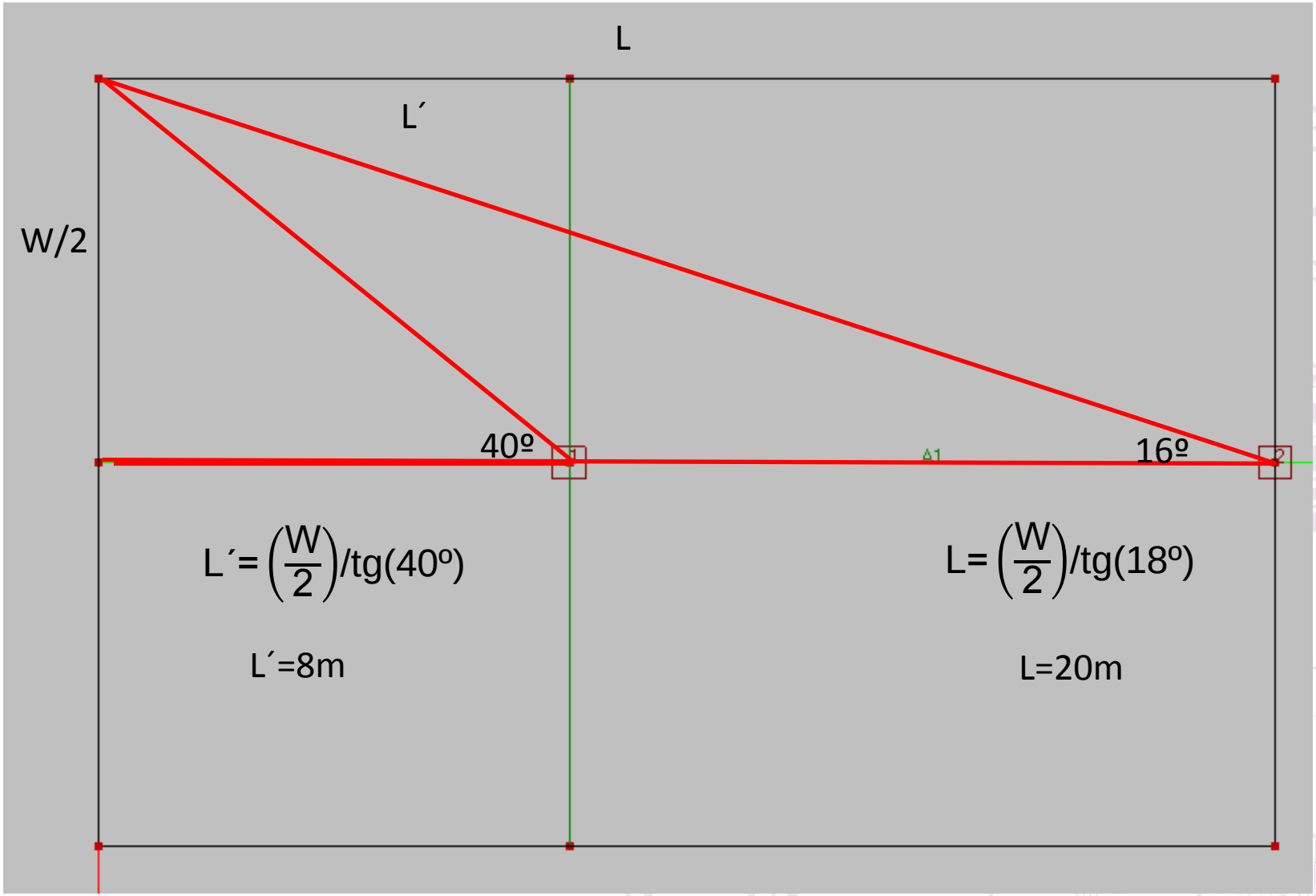
Horizontal Angle front row $\leq$ 80º

Horizontal Angle last row $\leq$ 36º

Vertical Angle front row $\leq$ 35º

Slope = 12º - 15º

DESIGN AND DIMENSIONING OF A CINEMA THEATRE



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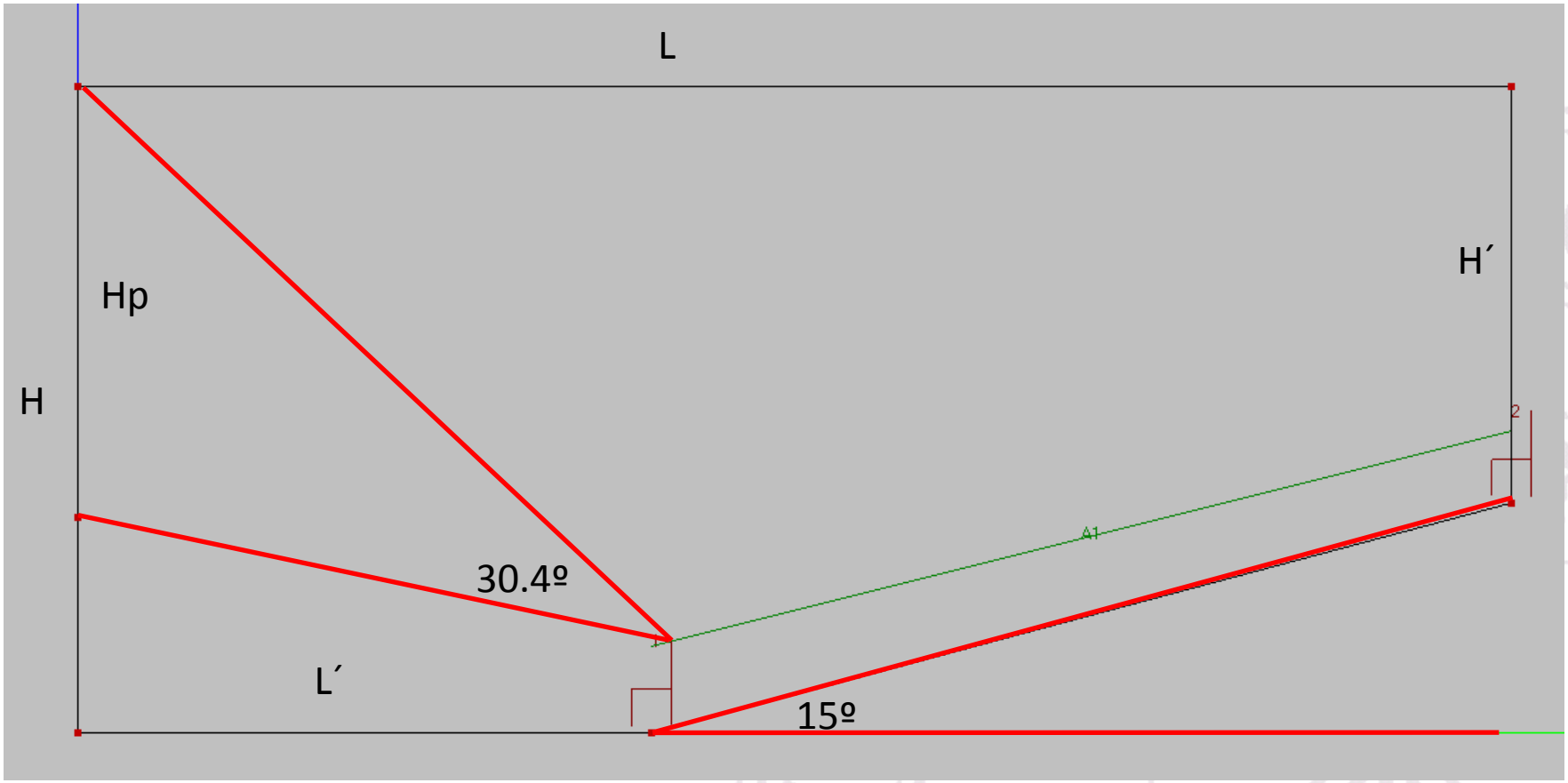
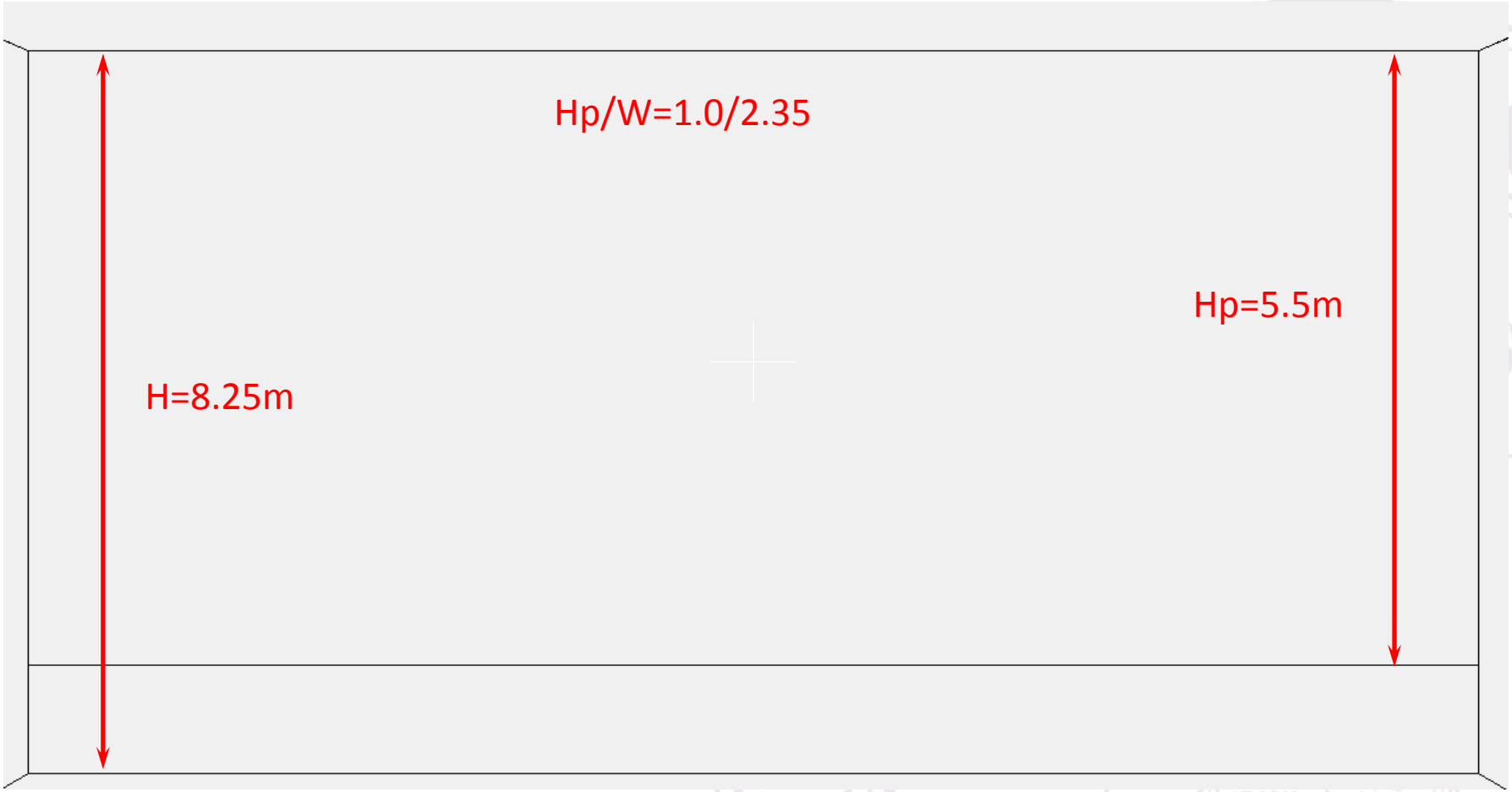


$$(H-H') = (L-L') \cdot tg(15^{o}) \qquad H-H'=3.2m$$

DESIGN AND DIMENSIONING OF A CINEMA THEATRE



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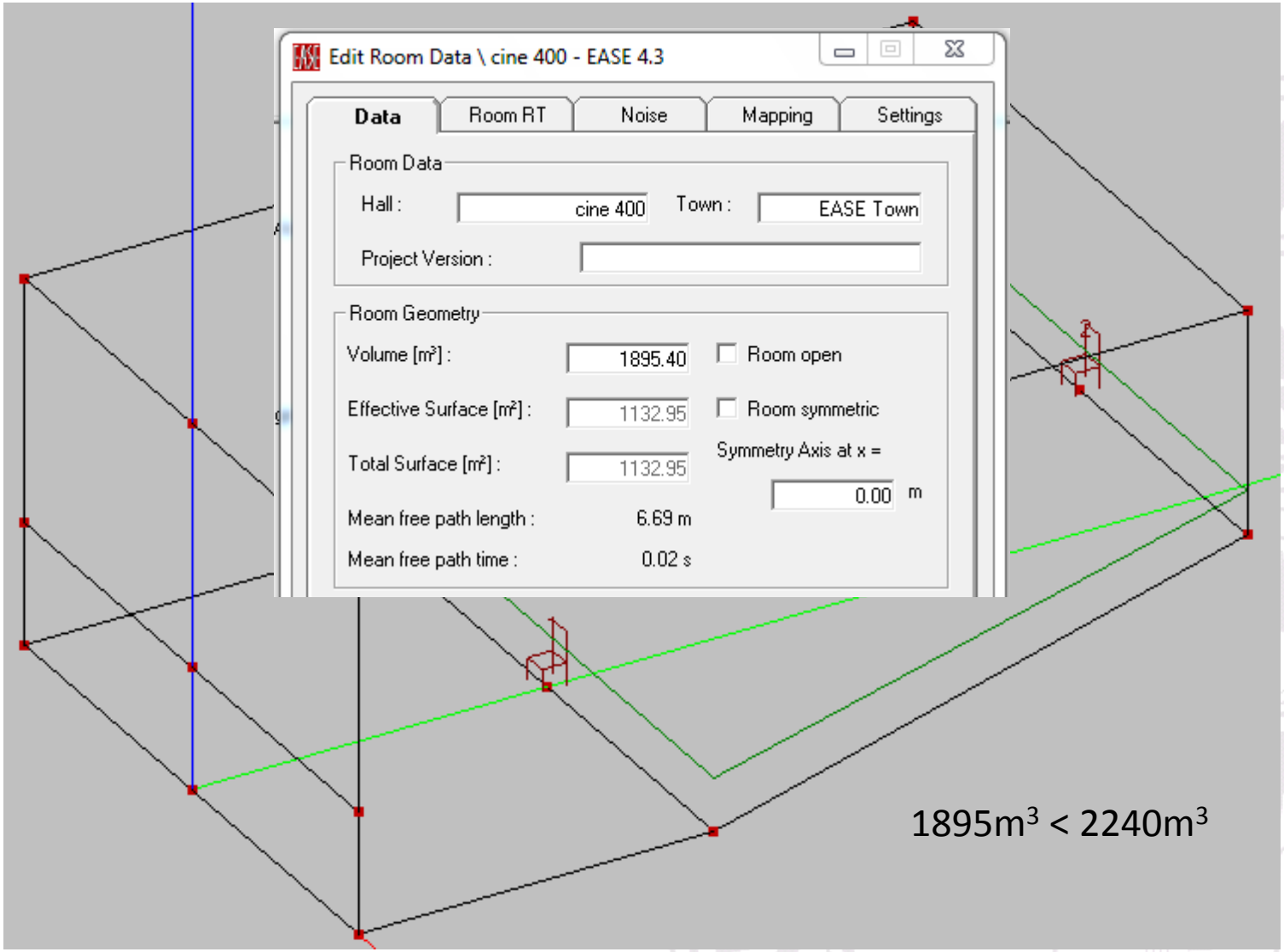


DESIGN AND DIMENSIONING OF A CINEMA THEATRE

Options:

- Increase the height H.
- Increase the length L.
- Increase the width W.

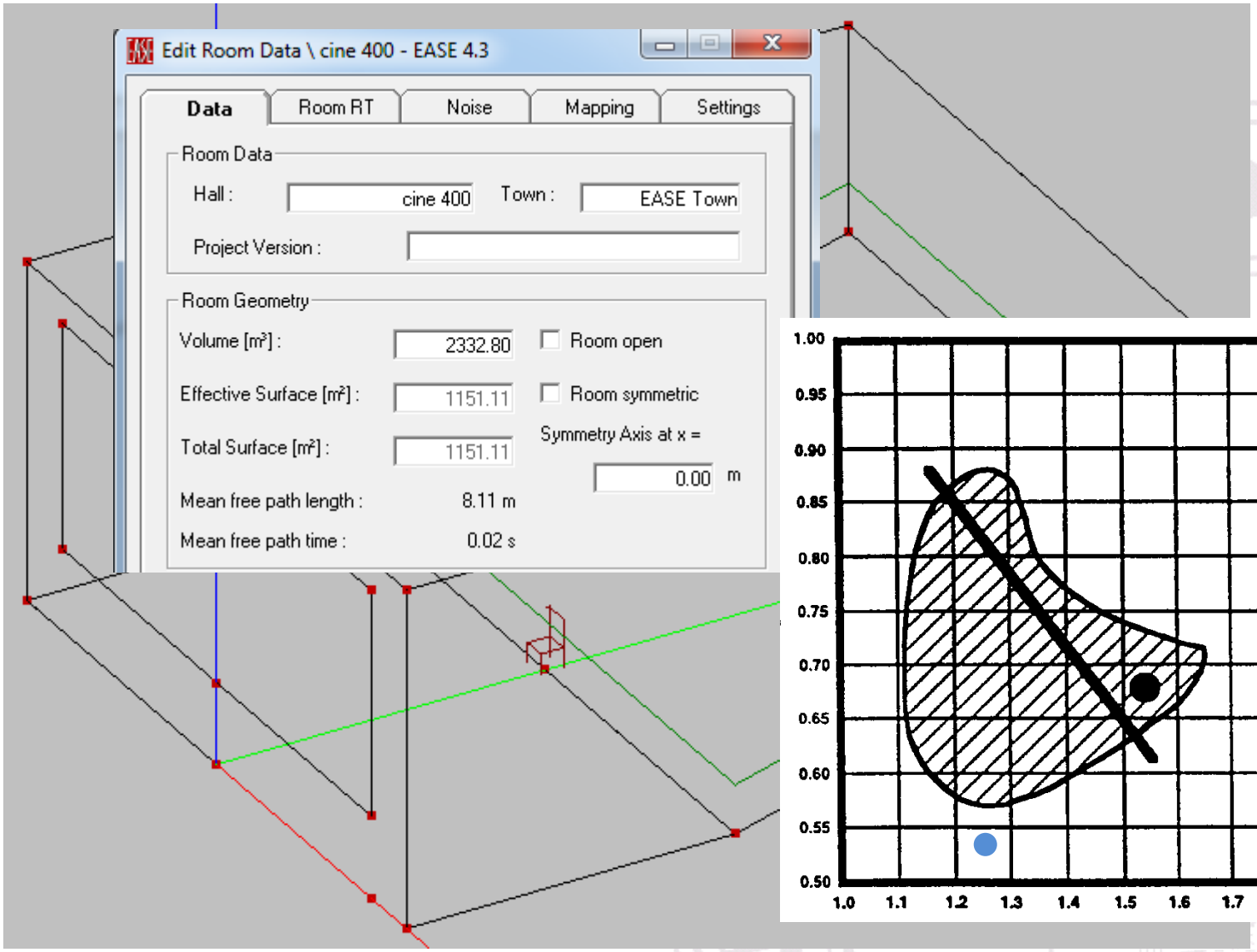
Without increasing the width or the height of the screen, to keep the aspect ratio 2.35: 1 and vertical and horizontal viewing angles..

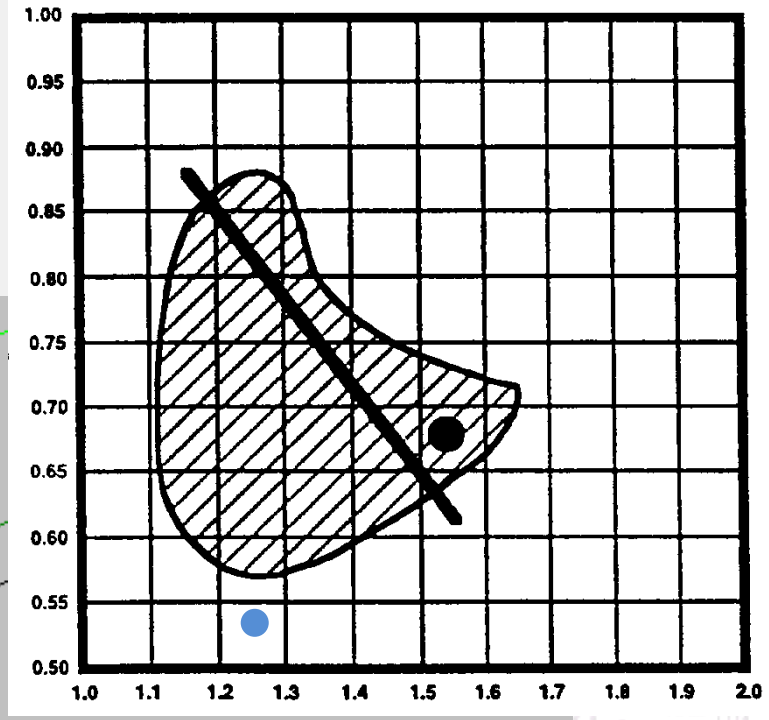
The best option is to increase the width of the room in 3 meters, so W = 16 m.

The new aspect ratios of the room:

$H/W = 8.5/16 = 0.53$ $L/W = 20/16 = 1.25$

DESIGN AND DIMENSIONING OF A CINEMA THEATRE





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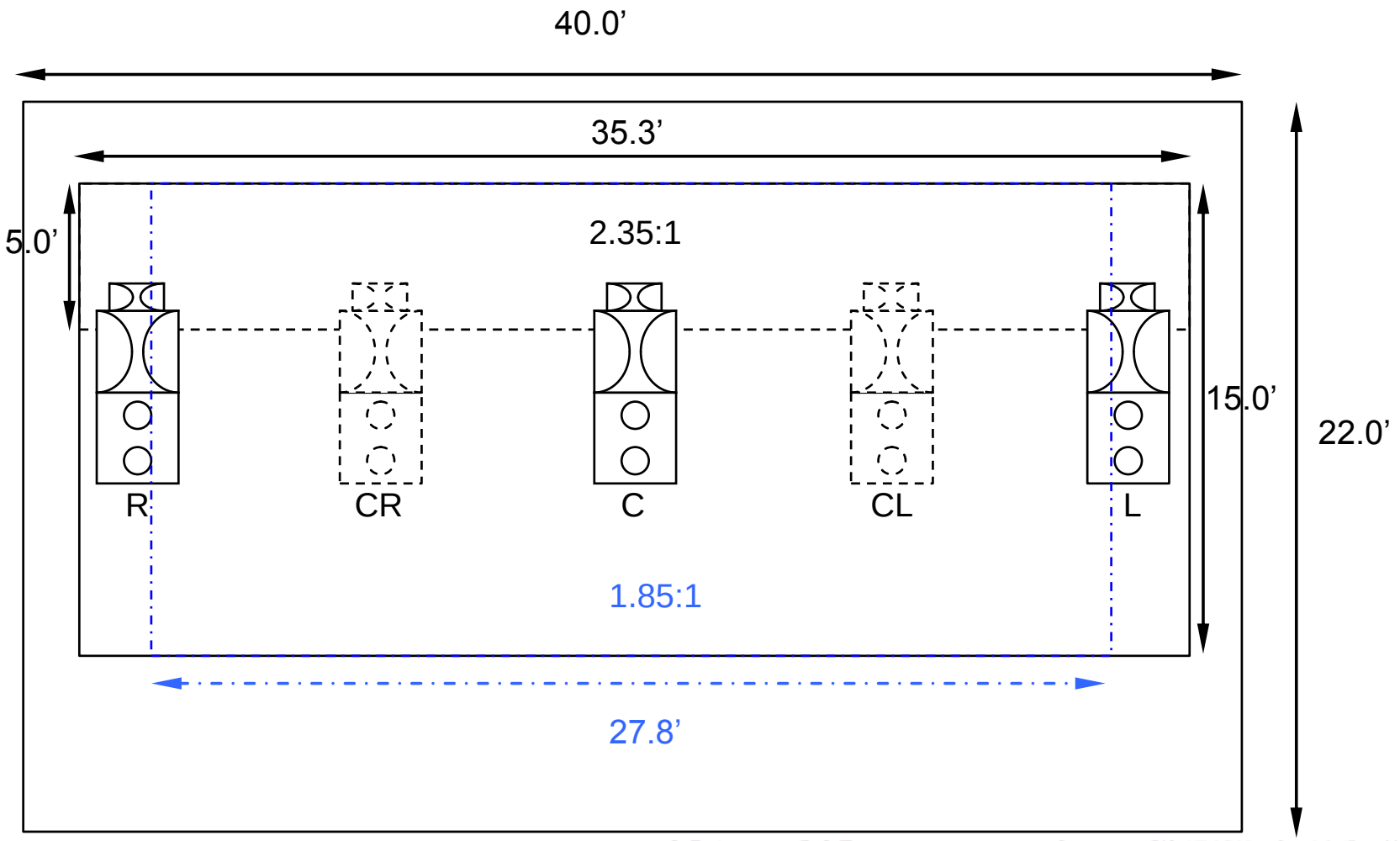

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

Screen

- The side ends curved toward the audience.
- Prevents "pin cushion" effect.
- Caused by the difference of distances that have to take the light from the projector to the side ends and the center of the screen.
- In this way you get light to travel the same distance to any point on the screen in the horizontal dimension.
- Try to use the entire width of the room.

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

Screen

- Relationship of height 1:1.5 (screen:room).
- Distance from the screen bottom to the floor from 1.22 to 1.83 meters (not allways).
- Small distance from the screen top to the ceiling to avoid reflections on the ceiling.
- Always white for not to modify the colors of the film.
- Heavy and perforated material.
- The front speakers will be located behind the screen $\Rightarrow$ filtering effect in high frequency.

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

Distribution of the room:

- It must not distract or hinder the projection.
- Architecture that helps viewing.
- Dark colors, preferably black.
- It is recommended that Hall exit of the room is not behind the screen.
- Corridor's access never stalls in the center of the audience.
- All speakers in black and without edges and reflective elements.

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- The cinema screens are made of white vinyl with perforations that allow the sound coming from the screen channels.
- They are grouped into four categories depending on the amount of light reflecting:

  White matte: <5% reflectivity

  Perlescent: 15% reflectivity

  Solvered: 30% reflectivity

  Cristal: >40% reflectivity

- It can also be specified from the screen.

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- The gain is a measure of the reflectivity of any display or projection surface. Gain factor represents the proportion of light reflected from the screen compared with the reflected light of a standard white screen.

- A screen with a gain of 1.0 will reflects the same amount of light as a white screen. A screen gain 1.5 will reflect 50% more light than a white screen. A grey screen with a gain of 0.8 will reflect 80% of the light to a white screen.

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- According to the gain, the screens are classified:

  Standard white matte: gain of 1.0

  High contrast grey: gain between 0.7 and 1.1

  White high contrast: profit between 1.1 and 1.5

  High gain without high contrast: gain between 1.3 and 2.0

- The gain is specified for different angular deviations measures of the center of the screen.

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

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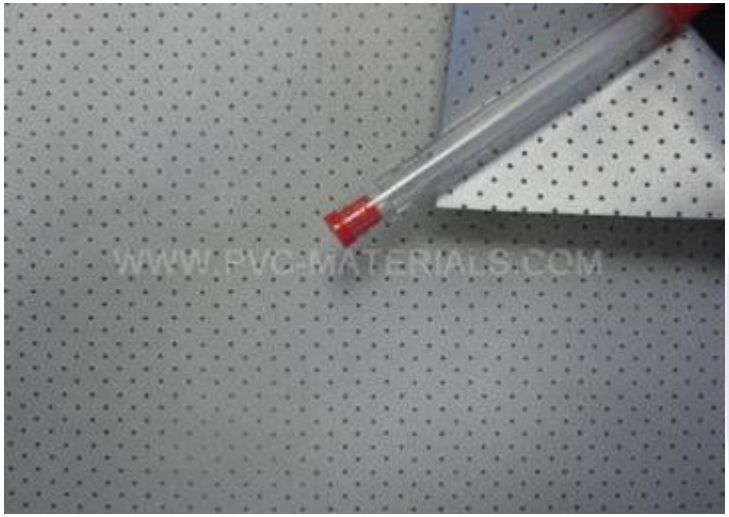
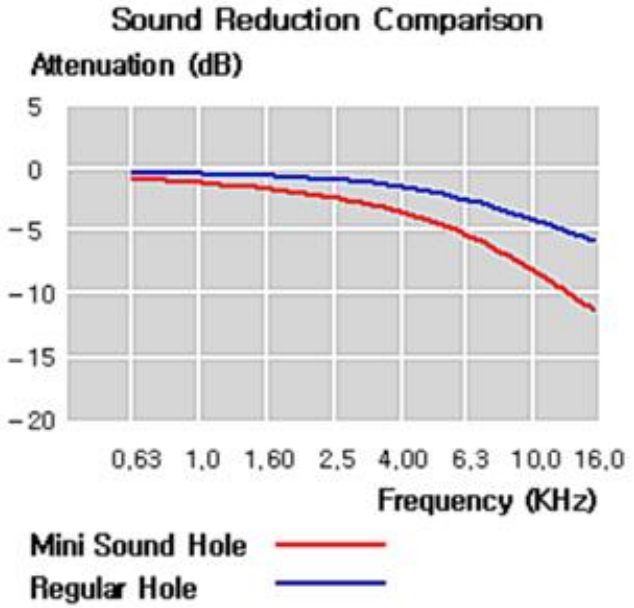
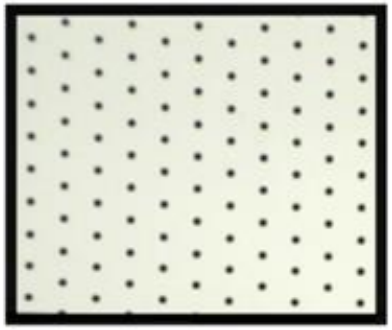


DESIGN AND DIMENSIONING OF A CINEMA THEATRE

SOUND REDUCTION COMPARISON

Perforation Form	Hole Size	Open Area
Regular Hole	1.1mm	5.01%
Mini Sound Hole	0.6mm	5.09%



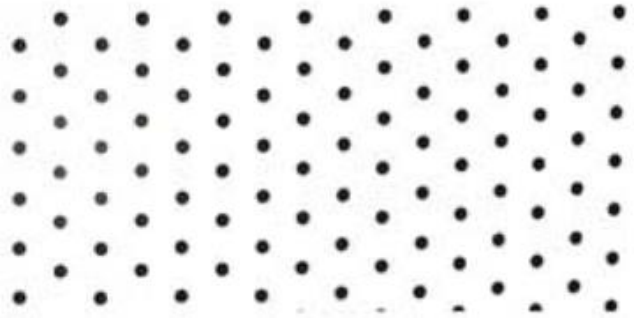


SP Regular Sound Hole
(1.1mmØ)

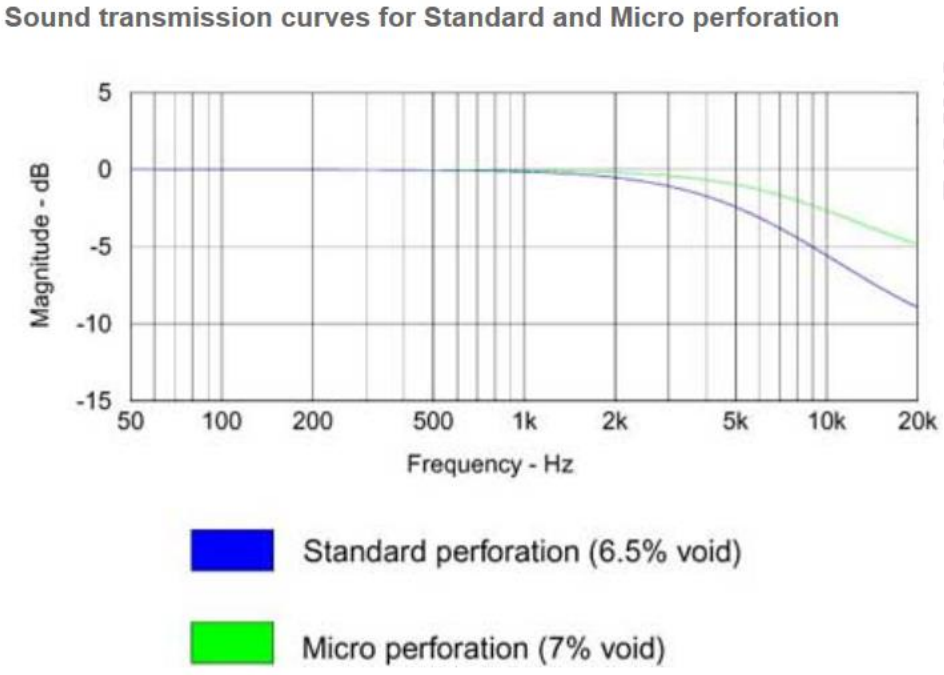
SP Mini Sound Hole
(0.6mmØ)

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

Standar perforation: 6.5% void
Hole Diameter: 0.054in / 1.37mm



Micro perforation: 7% void
Hole Diameter: 0.032in / 0.80mm



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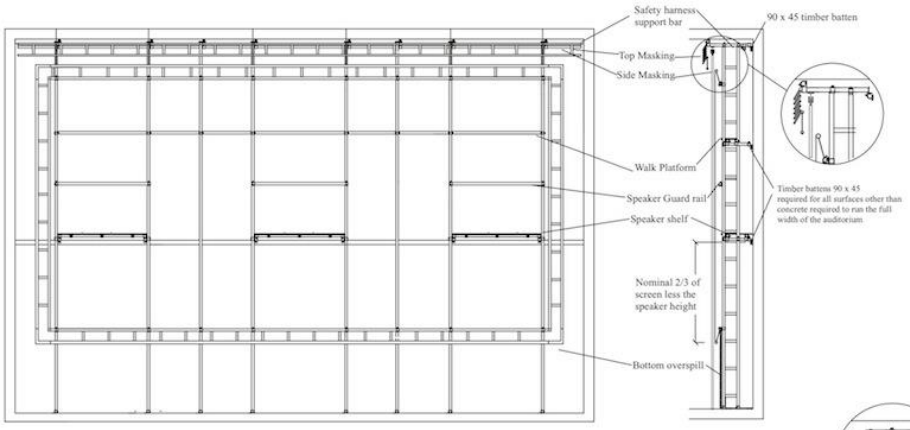

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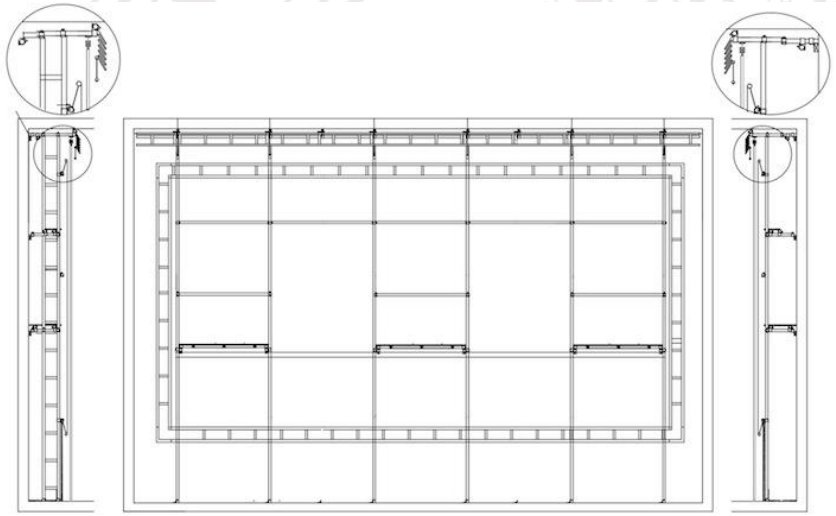

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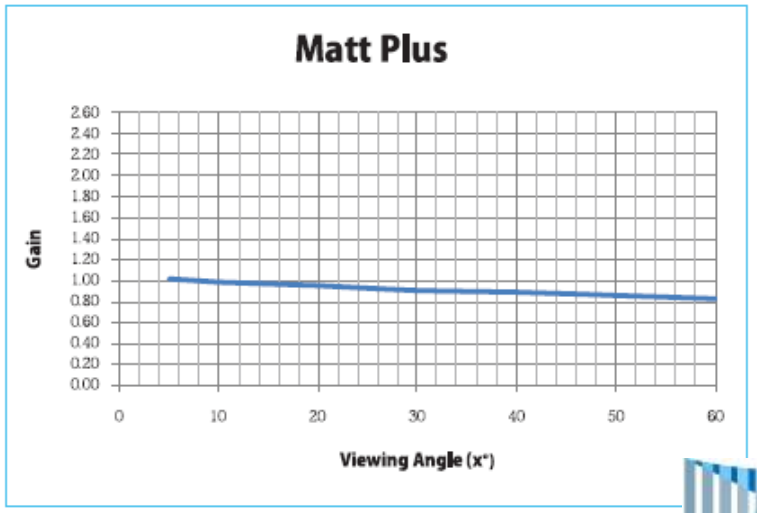
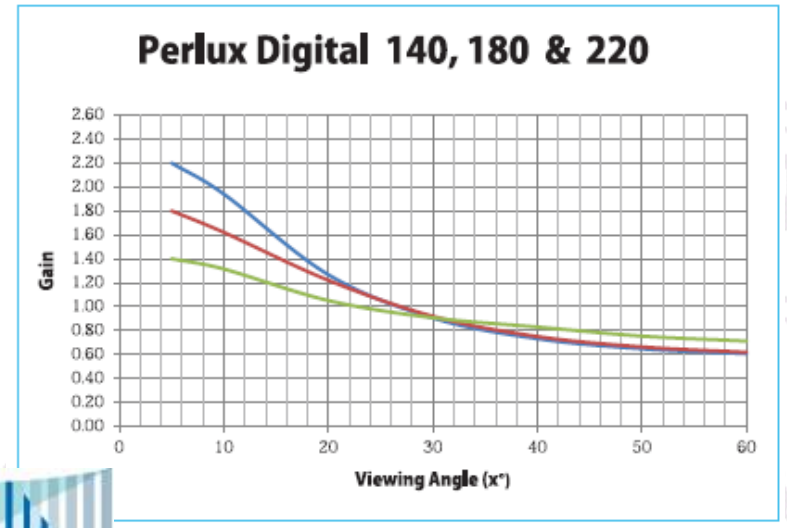
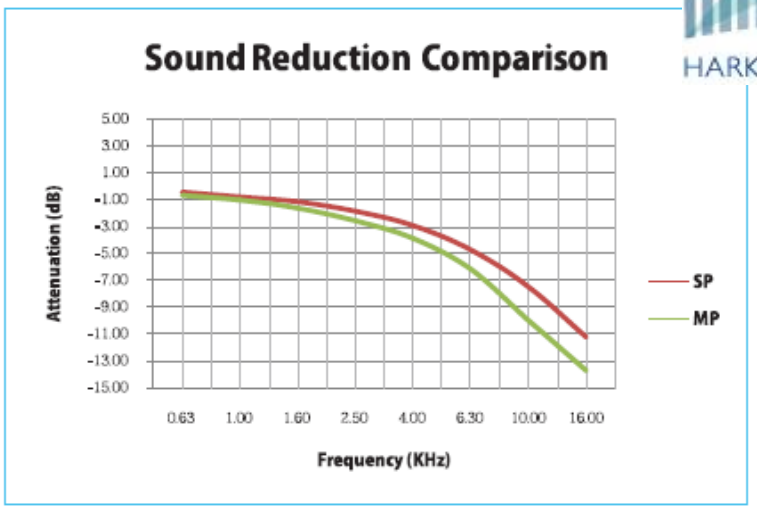
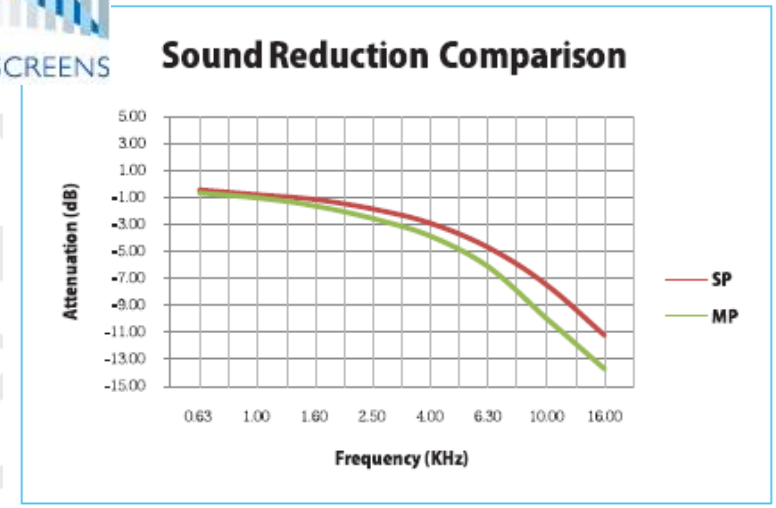
DESIGN AND DIMENSIONING OF A CINEMA THEATRE





HARKNESS SCREENS





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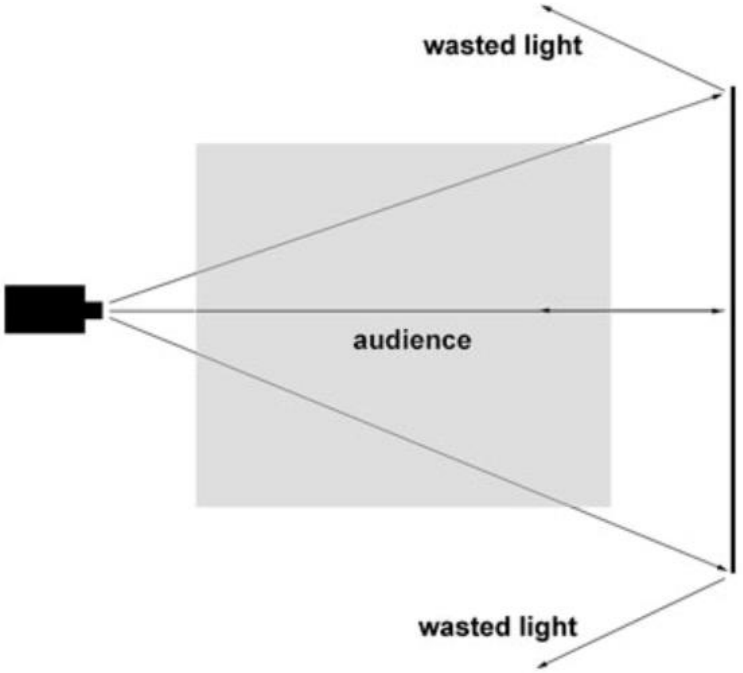
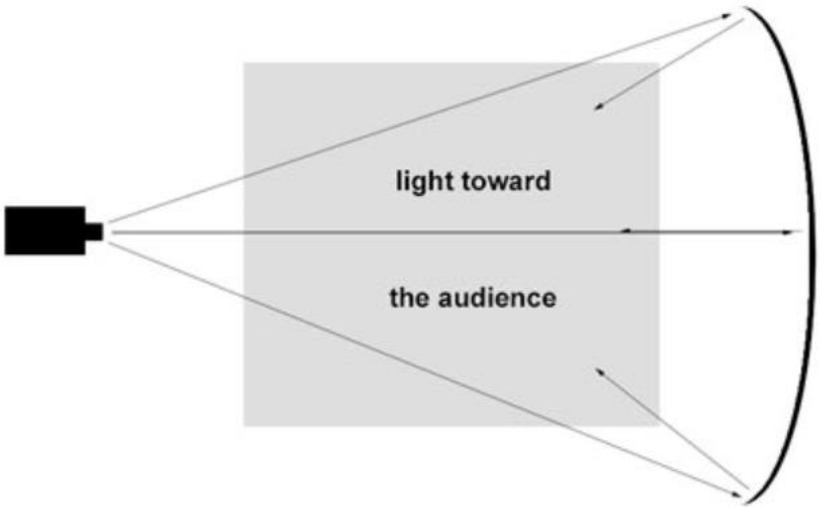




DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- The projector must be aligned in the center of the screen with an accuracy of 5%, preferably of 3% of the width and height of the screen.

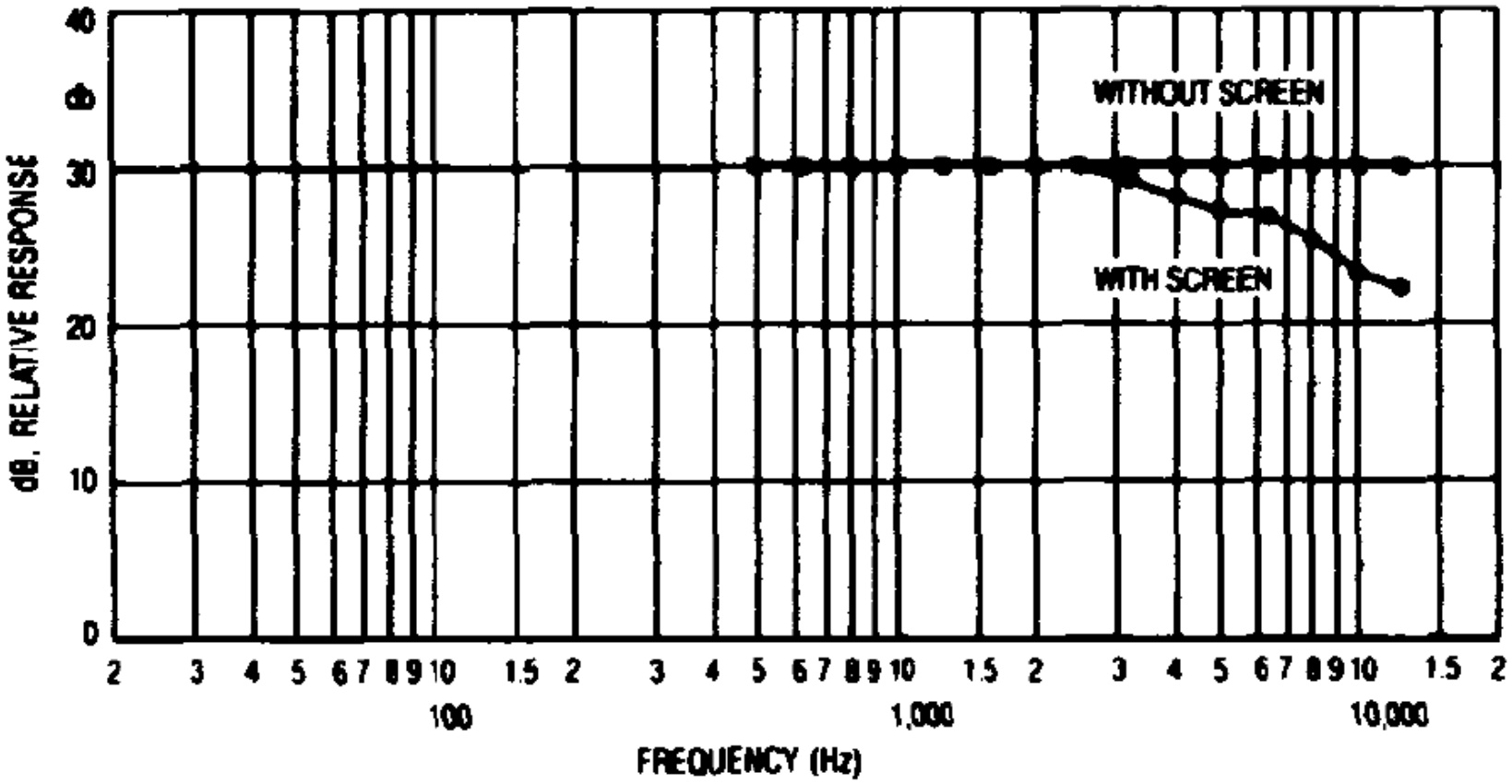
DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- The screen introduces losses for normal incidence ("on-axis") with a slope of 6 dB/oct from 5 kHz.
- Off-axis, the response of the screen is very complicated, but for certain angles of incidence in high-frequency losses are relatively small.
- This produces very laterally seated spectators to perceive more treble than the sitting on the axis of screen systems. This effect outweighs the losses of the speakers off-axis and keeps a good response of MF and HF across the room.

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

- Si se desea mantener una respuesta plana por encima de 3 kHz, normalmente se requiere alimentar los sistemas de agudos con una pendiente de + 6dB/oct por encima de 3 kHz.
- Esto supone que a la frecuencia de 12 kHz el nivel de potencia del altavoz de HF será entre 10 y 12 dB mayor que a frecuencias medias.
- En salas pequeñas, al haber menores pérdidas debidas a la absorción en el aire, no se debería superar el nivel en alta frecuencia en mas de 10 dB con respecto a frecuencias medias.

DESIGN AND DIMENSIONING OF A CINEMA THEATRE



DESIGN AND DIMENSIONING OF A CINEMA THEATRE

HARKNESS SCREENS

Harkness Hall UK
Tel +44 (0) 1438 725200
Fax +44 (0) 1438 344400

Harkness Hall USA
Tel (540) 370 1590
Fax (540) 370 1592

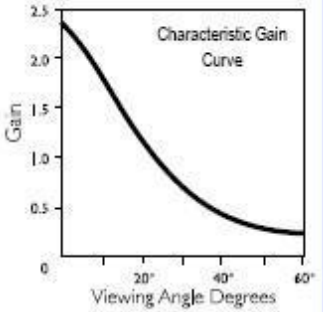
E Mail sales@harknesshall.com www.harknesshall.com

PROJECTION SCREEN SPECTRAL™ 240 3D MP

PRODUCT DATA SHEET

Document Ref DS-048 Issue 3 August 2005

Spectral™ 240 3D MP front projection screens build on the leading technology of Harkness Hall. The surface has smaller diameter perforations (less than half of standard perforation) to provide an excellent surface for close viewing while providing strong acoustic performance. MP can be used in electronic cinema where larger perforations can interfere with pixel generated images.
Noted for invisible seams under normal projection conditions.

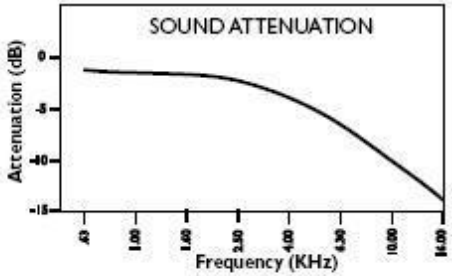


Application

Spectral™ 240 3D MP screens are recommended for a wide range of applications where close viewing conditions apply, including:

• Preview Theatre • Cinema • Electronic Cinema • Screening Room • Roller Screen • 4D Themed Rides

Surfaces suitable for use in flat or curved frames and roller screens.



Surface Edging

- Web and eye (grommet). Triple fold web integral with surface
- Preformed pipe pocket any size on any side
- Cloth web and fixings (snaps) for press stud frames
- Straight sides or shaped to special order
- Cut square

Fire Retardancy: Certification to the following standards:-

UK BS5867 Part 2;
France M1;
Japan BT-08-050 *(Regulation requires certification by importing company)*
Korea *(Regulation requires certification by importing company)*

General Detail

View Distance	Minimum of 1.5mtr (5')
Maximum Size	USA manufacture: 24.4m x 12.2m (80' x 40') French manufacture: 27m x 11m (88' x 36')
Perforation Size	Ø0.5mm (0.020")
Perforation Density	1.7%
Weight	0.50kg/m² (0.10lb/ft²)
Eyelet Spacing	150mm (6") nominal (US) / 200mm (8") France

Typical Packing

Tube rolled. In a long wooden box when height over 7m (23').

DESIGN AND DIMENSIONING OF A CINEMA THEATRE

Harkness Hall UK
Tel +44 (0) 1438 725200
Fax +44 (0) 1438 344400

Harkness Hall USA
Tel (540) 370 1590
Fax (540) 370 1592

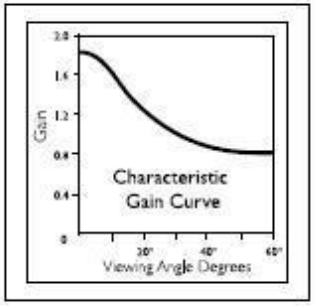
E Mail sales@harknesshall.com www.harknesshall.com

PROJECTION SCREEN PERLUX™ 180

PRODUCT DATA SHEET

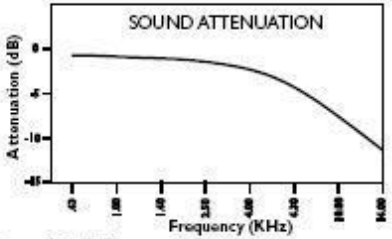
Document Ref DS-005 Issue 10 August 2005

Harkness Hall Perlux™ screens are considered by leading cinema exhibitors and special venue operators world-wide to be the 'premier' gain projection surface. Perlux is a pearlised white surface providing established high gain characteristics, high contrast, bright pictures, generous viewing angles and excellent colour temperature. Noted for invisible seams under normal projection conditions.



Application

Perlux™ 180 is specially developed by Harkness hall to meet the world-wide demand for a gain surface which folds for ease of transportation, cinema access and installation.
Perlux™ 180 screens are recommended for lace-in stretching into flat or curved frames.
Perlux™180+ should be used for roller and wrap-round screens in preference to Perlux™ 180.
Available in full screen perforated form where behind screen speakers are required (see attenuation curve).
Mini-perforated and non-perforated options also available.



Surface Edging

- Web and eye (grommet). Triple fold web integral with surface
- Preformed pipe pocket any size on any side
- Cloth web and fixings (snaps) for press stud frames
- Straight sides or shaped to special order
- Cut square

Fire Retardancy: Certification to the following standards:-
UK BS 5867 Part 2;
Australia AS1530.2;
Canada CAN ULC S102-2;
Japan BT-08-050 *(Regulation requires certification by importing company)*
Korea *(Regulation requires certification by importing company)*

General Detail

View Distance	Minimum of 5mtr (15') recommended on perforated surfaces
Maximum Size	24.4m x 12.2m (80' x 40')
Perforation Size	Ø1.2mm (0.047")
Perforation Density	5.3%
Weight	0.43kg/m² (0.09lb/ft²)
Eyelet Spacing	150mm (6") nominal

Typical Packing

Folded in parcel or parcel box up to 90m² (1000ft²). Wooden crate for larger sizes. Can also be tube packed (long box over 7m (23')).