Architectural Suggestions

I. What THX Needs From Architects

A. Updated Drawings

1. Floor Plan

An indication of seating area allows us to ensure even sound coverage of the audience through speaker placement and aiming.

2. Interior Elevations

Elevations are needed for room volume calculation and coordination of surround speaker placement with interior details.

3. Common Wall Construction Details

THX checks for appropriate isolation between theatres.

4. Roof Plans - HVAC

THX checks placement of roof top units and ducting.

B. Early Warning

1. Bid Set Date

We understand the importance of avoiding Change Orders and will work with you to meet Bid Set deadlines.

2. Opening Date

This helps us plan our design and field certification test schedules.

3. Changes

a) Floor Slope

b) Ceiling Height

c) Exits

d) Screen Sizes

e) Corridors Behind the Screen

f) Interior finishes

g) Mezzanine Overhang

h) Anything Else

II. Environmental Criteria

NOTE: The recommendations made in this section are general. An acoustical consultant should be retained to make site specific recommendations so that the THX criteria established in our Architect's and Engineer's Manual are met.

A. Isolation Walls

1. Suggested minimums

A minimum of Sound Transmission Class (STC) 75 construction is recommended. (Please refer to the wall construction details in the Isolation Section of our Architect's and Engineer's Manual.) A more specific recommendation of acoustic noise reduction between theatres is listed in the table below:

Octave band	Noise reduction
31.5 Hz	38 dB
63 Hz	48 dB
125 Hz	52 dB
250 Hz	54 dB
500 Hz	66 dB
1000 Hz	66 dB
2000 Hz	66 dB
4000 Hz	66 dB
8000 Hz	66 dB

2. Constructions

Avoid penetrations in theatre common walls. Perimeters of all isolation walls should be well caulked using acoustical sealant. Resilient mounting of the wall to the roof deck should be employed with constructions using gypsum. If it is not employed, deck deflection could deform the gypsum providing a flanking path for sound.

B. Reverberation

An acoustical consultant should be brought in to calculate the absorption needed to meet the reverberation specification supplied by THX.

1. Specific

a) Sidewall

If the sidewalls are too reflective, a "flutter" or side to side "slap" echo will be heard. The absorption needs to be brought down to below seated ear height, as close as possible to the level of the finished floor in the seating area. A minimum of 1" (2.5 cm) of fiberglass must be used, with

1" to 2" (2.5 to 5 cm) of air space behind the absorptive treatment preferred.

To avoid side to side reflections, the design of non parallel sidewalls is recommended although a “crawling” flutter echo may still occur.

b) Projection Wall

Much heavier absorption needs to be used on the projection wall to avoid delayed reflections of dialogue reaching the audience from the rear. A minimum of 2" (5 cm) of fiberglass should be used here also with an air space behind it. All of the available area of this wall should be treated, as it is otherwise the potential source for long delayed reflections for listeners in the front of the house.

2. General

a) Low Frequency (20 Hz - 250 Hz)

Excess reverberation in the low frequencies makes the theatre sound “boomy.” Generally, a thick material, 6" (15 cm) or greater thickness, spaced off a surface by 2" to 4" (5 to 10 cm) absorbs low frequencies. Because of the long wavelengths involved, large cavities or air spaces are also needed for low frequency absorption. Lay-in tile ceilings with a large air plenum above can be very useful for absorbing low frequencies. Six inches (15 cm) of batt insulation above the suspended ceiling absorbs low frequencies well. In climates where pipe freezing is a possibility, this technique may be limited to the front (screen end) two-thirds of the auditorium. The use of fiberglass tile instead of mineral fiber tile is also good for absorbing low frequency. However, fiberglass allows sound to pass through it more easily than mineral fiber. Thus sound from the area above the tile will tend to pass into the auditorium more easily. Therefore when using fiberglass tile, extra care must be taken to reduce breakout from the ducts or other sources of unwanted noise above the lay-in tile ceiling.

b) Mid Frequency (250 Hz - 2000 Hz)

Excess reverberation in the mid frequencies lessens dialogue intelligibility. Absorption is easily dealt with by 1" to 2" (2.5 to 5 cm) of fiberglass mounted on wall surfaces. For the lower part of this frequency range, spacing the absorptive treatment off the wall is recommended.

c) High Frequency (2000 Hz - 16000 Hz)

Excess reverberation in the high frequencies makes the dialogue too sibilant. In most theatres, absorption in this range is usually not a problem due to the absorption from air in large volumes and the high absorption coefficients (at high frequencies) of typical acoustical panels.

C. Background Noise

1. HVAC as a Noise Generator

a) Roof Top Units (RTUs)

(1) Structure

Low frequency noise can be transmitted structurally in the form of vibration through walls or the roof deck. Avoid this by providing isolation (spring isolators), short-circuiting vibrations to ground (mounting RTUs over a load bearing wall), or distance (mounting RTUs as far away from the theatre as possible or, in the worst case, over the projection booth). If possible, avoid locating any mechanical equipment directly above the theatre. When using spring isolators, attention must be paid to spring deflection. Deflection is determined by frequency of the vibrations, stiffness of the roof deck, and weight to be mounted on the spring isolator. It is best to request an acoustical consultant or mechanical noise specialist to specify the exact isolation springs for a given mechanical unit.

(2) Roof

Avoid mounting RTUs mid-span over an auditorium. This causes the roof deck to act as a diaphragm creating low frequency noise problems that are difficult to reduce. The more the deck deflects, the more severe the problem.

(3) RTU Duct Exit

A side exit from the RTU allows a large amount of the airborne sound to dissipate in the first turn (more if the duct is lined).

b) Ducts

(1) Turns

In general, the more turns between the RTU and the diffusers, the more noise attenuation. Turns also produce turbulence so the last run up to the diffuser needs to be straight. The longer this straight portion is the less turbulence will contribute to the noise.

(2) Lining

Fiberglass duct lining absorbs airborne noise (especially at turns). Ten to sixteen feet (3 to 5 meters) lined ductwork is a good minimum for each auditorium's feed.

(3) Breakout

Sound leaving the duct through its walls can be avoided by boxing in the duct with a frame and gypsum board that does not touch the ductwork. This enclosure may also be lined with fiberglass to provide even more duct breakout absorption.

c) Diffusers

(1) Air Flow Recommendations:

(a) In general and depending upon the size of the register, the supply should be 350–425 CFM (10–12 cubic meters per minute) maximum per register.

(b) In general and depending upon the size of the grille, the return should be 420–510 CFM (12–14 cubic meters per minute) maximum per grille.

(2) Rattles (There should not be any.)

Generating a slowly varying sine wave signal through the sound system can easily test this. As the frequency is increased, different parts of the theatre construction will rattle. Identify the sources and eliminate the rattles by tightening, damping, or fastening them down. Common rattles occur from lay-in ceiling tiles, HVAC grilles, and loose lighting fixtures.

2. Reciprocating Equipment (e.g. Compressors, Pumps, and Related Ducts)

Spring isolation mounting should be used. Box enclosures should be used in extreme cases. All ductwork connected to vibrating equipment will also transmit vibrations along its path. The use of flex duct is recommended at the beginning of the duct run and isolation hangers should be used wherever the ducts need to be suspended or supported to a nearby wall/ceiling construction. Avoid mounting any mechanical equipment and ducts directly on demising theatre constructions. Avoid locating concession stand equipment directly adjacent to the theatre.

3. Environmental Sources

Special steps may need to be taken if the outside noise threatens to interfere with the quiet of the theatre. Resiliently mounted suspended ceiling isolation, exterior wall isolation, and sound rated doors with neoprene head and jamb gasketing are recommended.

a) Trains

b) Subways

c) Airports

d) Traffic

e) Discos

f) City Streets

g) Lobbies

D. Projection

1. Projection Port

Projection booth noise (e.g. projector, speech) should not be audible anywhere in the auditorium.

a) Double Glass

Two panes of glass help isolate the noise of the projection room from the auditorium. The frame construction should have neoprene perimeter gasketing to create a tight seal and eliminate sound leakage around the edges.

b) Angled Glass

Angled glass on the projector side avoids a reflected image from being sent back into the projector lens. Our general recommendation is a 7 degree outward tilt from the plane of the projection angle.

Glass angled up slightly on the auditorium side avoids sound from the screen being reflected to the audience.

c) Access Hole

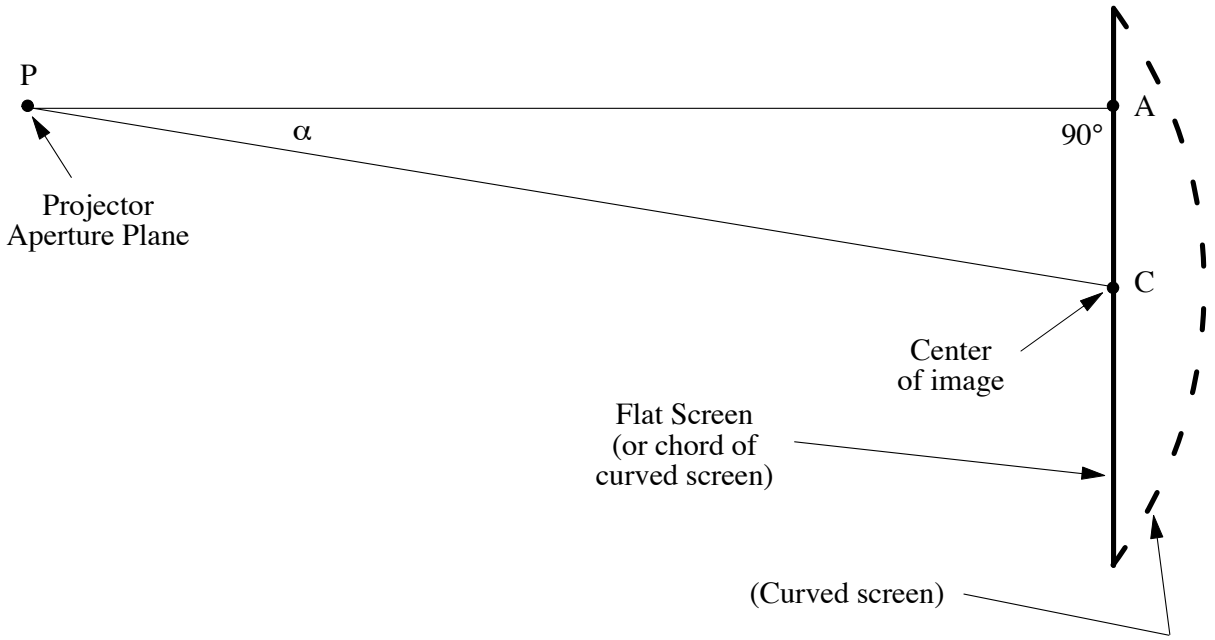
A pass-through, sealable hole of 1.5" (4 cm) in diameter is necessary to provide access for microphone test cables and communication between the booth and the auditorium. Another option for test cable access is to use removable and sealable glass. (Please note that removable glass or access holes must be sealed before presentations.)

2. Projection Angle

a) THX Standard

Image distortion due to the horizontal or vertical projection angle should be less than 3%, the maximum preferred, with 5% distortion the maximum accepted for THX Certified Theatres. (Please refer to SMPTE EG 18–1994 for further details about the formulas.)

b) Formulas for Determining Projection Angle Distortion



H = Image Height
W = Image Width
PA = Horizontal Distance from Projector Aperture Plane to Screen (or chord if curved screen)
CA = Vertical or Horizontal Offset

$PC = \sqrt{PA^2 + CA^2}$ = Distance from Projector Aperture Plane to Center of Image

$\alpha = \arctan \frac{CA}{PA}$ = Projection Angle (Vertical or Horizontal)

$$\% \text{ Vertical Distortion} = \frac{H (\sin \alpha)}{PC} \times 100 \qquad \% \text{ Horizontal Distortion} = \frac{W (\sin \alpha)}{PC} \times 100$$

Examples of Projection Distortion Calculations:

H = 20 feet (Image Height)
PA = 80 feet
CA = 4 feet (Vertical Offset)

PC = 80.10 feet
α = 2.86 degrees

Percent Vertical Distortion = 1.25%

W = 47 feet 10 inches (Image Width)
PA = 80 feet
CA = 1 foot (Horizontal Offset)

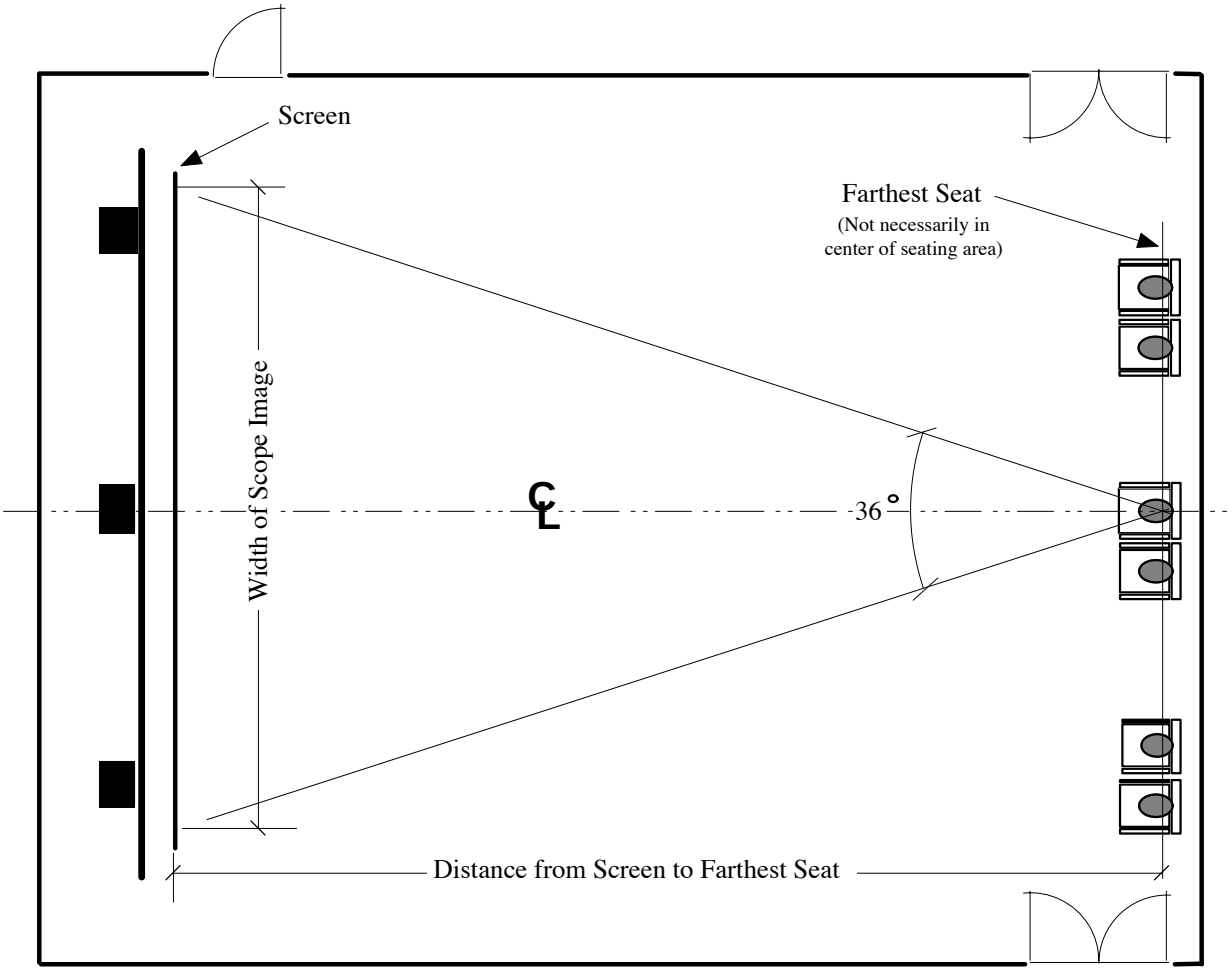
PC = 80.01 feet
α = 0.72 degrees

Percent Horizontal Distortion = 0.75%

3. Viewing Angle

a) Horizontal

The angle subtended by the left and right edges of the Cinemascope image and the farthest seat in the auditorium is recommended to be 36 degrees. The minimum acceptable angle is 26 degrees for THX certified cinemas.



Horizontal Viewing Angle =

2 x ARCTAN [(0.5 x Width of Scope Image) / (Distance from Screen to Farthest Seat)]

b) Vertical

The vertical viewing angle is measured at seated eye height from the front row center seat to the top of the tallest projected image. SMPTE notes that for most viewers physical discomfort begins when this angle exceeds 35

degrees. We strongly recommend that the layout of the auditorium adheres to this engineering guideline.

III. Sound System

A. Baffle Structure

1. Construction

With each site specific baffle drawing set supplied by the THX design office, the overall dimensions, materials specification, and installation directions must be closely followed. Also, please note a minimum amount of available room is necessary behind the screen to construct the baffle. The specific amount is dependent upon the screen channel system selected.

2. Speaker Holes

a) Placement

The placement of the speaker holes in a THX baffle structure is very specific and is determined by the image sizes. The THX design office must generate a new baffle drawing if the image sizes change.

b) Size

The equipment chosen from the THX approved equipment list determines the size of the speaker holes.

3. Isolation Pads

One Mason “Super W” pad (Durometer 40) is used under each corner of the screen woofers and the subwoofers to isolate the vibrations of the speakers from the baffle structure. A list of Mason Industries’ representatives is available from the THX design office.

4. Absorption on Face

The entire face of the baffle structure is covered with 1" (25 mm) of an absorptive material from the THX Acceptable Baffle Treatments list available from the THX design office. These are specific products and substitutes are not allowed without the prior approval of the THX design office. To add a material to the list, a sample of the material along with a manufacturer’s specification sheet must be submitted to THX for approval.

5. Exit Corridors Behind Screen

In general, corridors behind the screen are difficult to deal with but they can be accommodated in most cases. If your theatre has screen wall exit corridors, make sure to send elevations to the THX design office for coordination.

6. Absorption on Demising Wall

The area behind the baffle structure should be covered with 2" (5 cm) of fiberglass. This should include the rear wall, a minimum of one side wall, and the ceiling.

B. Surround Speakers

The surround speaker array is designed by THX to provide uniform coverage of the audience. THX supplies spacing, height above finished floor, and aiming angle for the loudspeakers.

If you have any sidewall treatments or interior design details with which you would like to coordinate the speaker layout, please let the THX design office know.

IV. What Architects Should Expect From THX

A. Drawings

1. Baffle

2. Surround Speaker Layout

3. Single Line Electrical

B. Reverberation Limits Curve

C. Equipment List

D. Resource Materials

1. EG-18

2. THX Architect's and Engineer's Manual

E. General Advice

1. Equipment

2. Construction

a) Common Wall

b) Baffle

c) Absorption Material

3. Installation

4. Projection

a) Images

b) Sight Lines