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CONSULTANTS IN ARCHITECTURAL ACOUSTICS

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Re: Target Center Acoustical Treatment

*(**NOTE**: I have annotated this report with red italics to comment on the discussion of the treatment options and to show the process involved in coming to the final recommended treatment. This acoustical study was undertaken to improve the acoustical environment of the Target Center to make it more competitive with other venues, both local and around the country. There were two objectives; 1) To increase clarity by reducing the reverberation in the space by introducing additional acoustical material, and 2) To increase clarity by reducing echoes by means of placing absorptive material in specific locations that could produce echoes. Steve Kvernstoen, July 7th, 2008)*

We have reviewed the previous acoustics reports (KRA, WJHW, SFA), the available drawings, and test results and visited the space to more closely study the existing acoustical treatment. We also attended a Keith Urban concert in the Xcel Center to compare the acoustical environment to Target Center. Based on our analysis we have set goals and developed some preliminary recommendations and options for the Target Center acoustical treatment.

Current Acoustical Treatment

The current acoustical treatment in the Target Center consists of perforated metal covered glass fiber on the vertical wall surfaces and on the vomitory bulkheads. On the upper rear walls the glass fiber is very thick, 10” or more. This is a very effective treatment and explains why the reverberation is controlled as well as it is without an acoustical deck. Originally we had assumed that the space has an acoustical metal deck. However, this does not seem to be the case based on our visual examination of the deck (although could not see very well from the catwalk) and our calculations based on the tested reverberation times in the space.

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The acoustical treatment on the vertical wall surfaces also mitigates undesirable sound reflections. Still, there are several other hard surfaces that could cause problems, most notably the canted area of the roof deck. This issue will be further discussed below.

Acoustical Goals of the Project

As has already been discussed by us and in an earlier report by Jack Wrightson, excessive low frequency reverberation is the main acoustics issue in the space. We will want to significantly reduce low frequency reverberant energy in the space as well as to lower the overall Reverberation Times. We recommend that the mid-frequency RT's should be in the 2.5 second range or lower, and the 125 Hz RT's should be 3 seconds or lower. These RT's would be in the same range or somewhat lower than the RT's in the XCel Center, which is a well-regarded venue in this area.

There are also some surfaces that should be treated to mitigate harmful sound reflections. These include the canted areas of the ceiling deck, the face of the ring beam, and faces of the upper level columns, and wall surfaces behind the vomitory openings. We have recommended placing acoustical material on these surfaces.

Recommendations

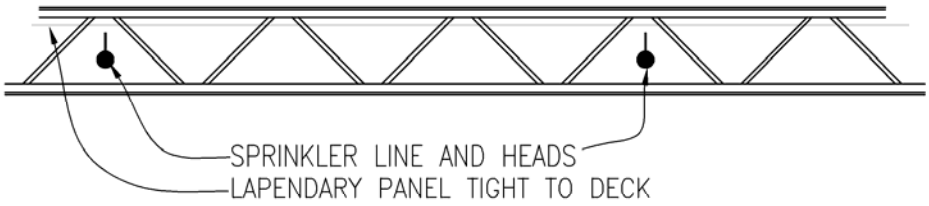
It will take a considerable square footage of acoustical material to make a significant difference in the low-frequency Reverberation Times. To provide the adequate area of treatment we will need to place acoustical material on the roof deck. We recommend treating both the canted part and the horizontal part of the roof deck. We recommend using lapendary panels because they provide effective low frequency control and are relatively cost-effective. We have estimated that we would be able to treat as much as 80% of the deck (canted and horizontal part of the deck) which would bring the RT's down to the desired range. We believe that we should treat as much of the deck as possible to provide the maximum impact on the low-frequencies and to make a noticeable improvement in the overall acoustical environment. We have estimated that the total square footage of acoustical material we could realistically expect to place on the deck for reverberation control is 115,000 square feet.

Both the horizontal and canted deck areas present challenges for panel installation. We have developed some possible scenarios that would be acoustically functional. The feasibility of these will need to be discussed with the fire marshal, city inspector and possible panel contractors.

Horizontal part of the roof deck

Treating the horizontal part of the roof deck presents the largest challenge because of the existing sprinkler system and the more difficult location for installation. We have identified six different options to install the panels on the roof deck. We will need to discuss these options with the fire marshal and city inspectors to find out which ones they would find acceptable.

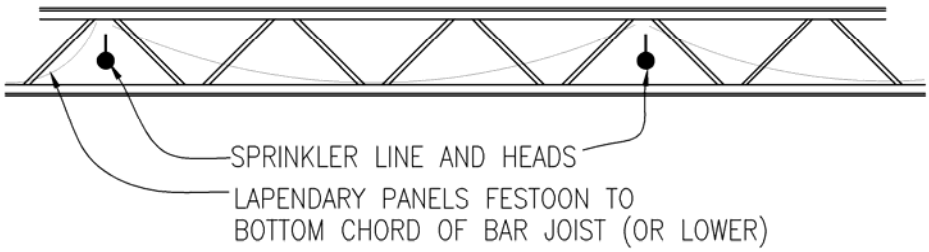
1. Horizontal lapendary panels installed tight against the deck. Panels festoon only a few inches below the deck, between sprinkler heads.



We do not recommend this option. When the panels are installed tight against the deck they will not provide effective low frequency control.

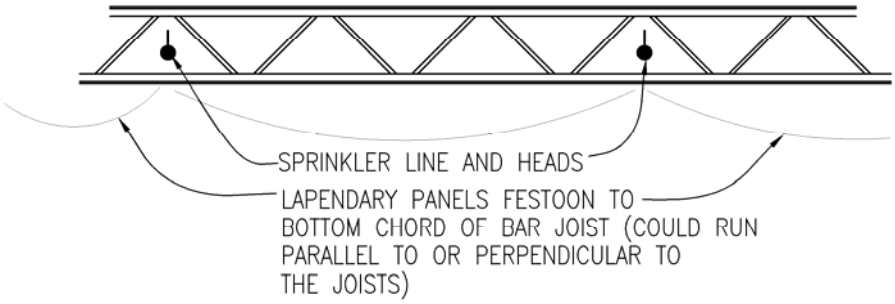
(This option was rejected because it would not work very well, and also because it would have been very difficult to meet the fire code requirements using this option. The fire code requires that there be no air space whatsoever behind the acoustical material SK 7/7/08)

2. Horizontal lapendary panels installed so that they festoon parallel to the joists. The panels are tight against the deck at the sprinkler heads but festoon down several feet in the areas between the sprinkler heads. With both this option we would only be able to treat 2/3 or less of the deck area. The joists are approximately 6' o.c. The lapendary panels are 4' wide. If the panels are placed between the joists there will be a 1' wide area of untreated deck on each side of the panel between the joists. The total area of lapendary panels in the high deck area would be approximately 77,400 ft².



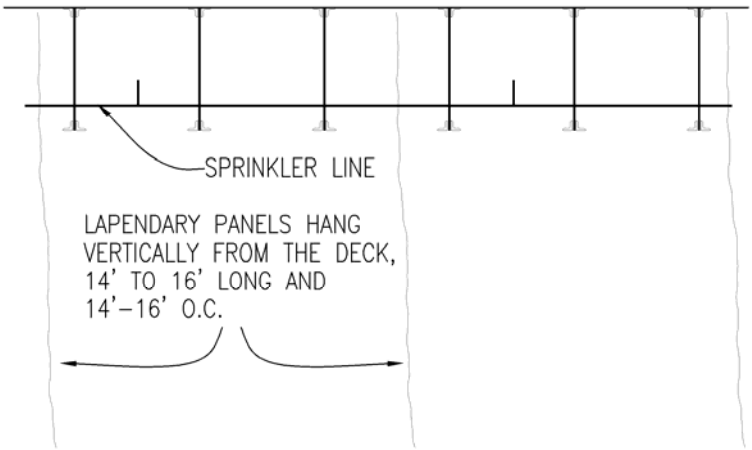
(This option was rejected because it because it would not meet the fire code requirements, due to air space behind the lapendary panels. SK 7/7/08)

3. Festooning horizontal lapendary panels installed well below the sprinklers running either parallel or perpendicular to the joists. Total area of panels would be approximately 93,000 ft².



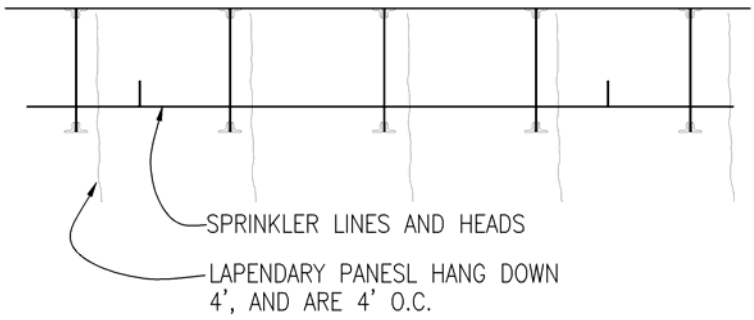
(This option was rejected because it because it would not meet the fire code requirements, due to air space behind the lapendary panels. SK 7/7/08)

4. Long vertical baffles (14' to 16') hanging from the joists 14' to 16' oc. The sprinkler main are approximately 14' o.c. The baffles could be hung between the sprinkler mains. The baffles can't come lower than approximately 12' a.f.f. from the catwalk so that they stay clear of the air ducts and light pipes.



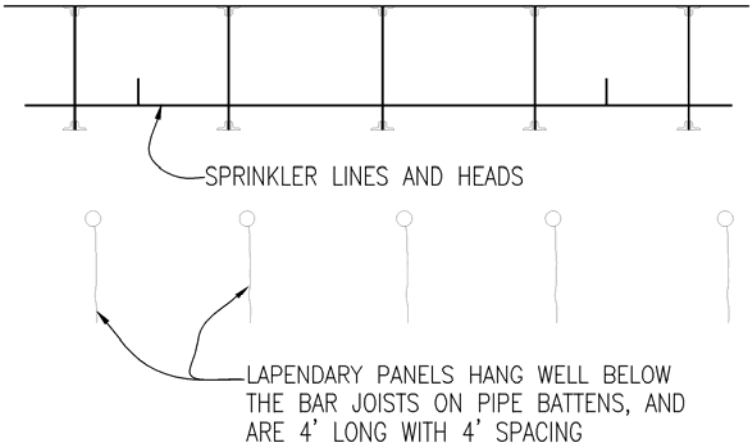
(This option was rejected because it could have caused smoke or return air to collect at the roof deck. SK 7/7/08)

5. 4' high vertical baffles 4' oc parallel to the joists and hung from the deck.



(This option was rejected because it because it could have allowed return sir or smoke to collect at the roof deck. SK 7/7/08)

6. 4' high vertical baffles hanging well below the joists.



(A variation of this option was chosen, with the lapendary panels hung from the bottom of the joists. The variation of this option satisfied the fire code requirements and allowed for cost savings by hanging the absorptive material directly from the joists. SK 7/7/08)

<u>Canted part of the roof deck</u>

The canted part of the roof deck currently causes detrimental sound reflections back down to the main floor. How harmful these reflections are depends on the concert sound set up, but this could significantly affect the quality of sound.

We recommend draping lapendary panels over the canted part of the deck. This will mitigate harmful reflections and provide overall acoustical control in addition to the panels in the high deck area. In the best case scenario we would like to drape the panels over the canted roof section extending down over the ring beam to prevent any harmful reflections from the face of the beam. However, there are smoke detectors above the ring beam that can't be obstructed. It seems that the best we can do is to attach the bottom of the lapendary panels just above the ring beam (or above the smoke detector where necessary) and place acoustical panels on the face of the beam.

(This option was modified somewhat to meet the fire code requirement. Instead of draping the lapendary panels down from the horizontal deck, we used 6" thick semi-rigid panels fastened tight to the canted deck. SK 7/7/08)

Bottom of the platforms and catwalks

Based on the available drawings we calculated that it would be possible to place approximately 22,000 ft² of acoustical panels below the catwalks and platforms. This is a significant area that would be available for additional absorptive material. The panels will also mitigate any unwanted reflections from these surfaces.

Other hard surfaces

The faces of the upper level columns are hard surfaces that would benefit from acoustical treatment although any detrimental sound reflections from these surfaces are quite localized and small scale.

The vomitory openings are closed by a curtain that will not prevent sound from going through. We discussed with Tom the possibility of treating the Concourse wall area that is opposite of the vomitory opening so that the hard surfaces would not reflect sound back to the main space. This is a good idea. The panels will improve acoustical environment in the Concourse in addition to preventing harmful reflections back to the main space. Of course in this location any treatment will need to be abuse resistant material. This additional treatment would be approximately 7,800 ft².

Expected Outcome with Different Levels of Acoustical Treatment

Above we have discussed the choice of acoustical materials and different mounting options. The table below includes the expected Reverberation Times with different areas of absorptive treatment based on our preliminary calculations.
This table should not be used as the single deciding factor when comparing different treatment options. Although the RT's are directly dependent on the area of absorptive material there are other factors that need to be taken into consideration. Much of the recommended treatment serves two purposes: to

provide reverberation control and to mitigate harmful sound reflections. Examples of surfaces that provide relatively little reverberation control, but are important to mitigate harmful reflections are the ring beam, the column faces and vomitory faces.

The final square footage of acoustical material in the space will depend on the amount of treatment we can place in the horizontal deck area. Once the Fire Marshall and City Inspector have narrowed down the acceptable options for treating the horizontal deck area we can determine how much acoustical material we can place in the horizontal deck area and how much material will need to be placed in other locations. At that time we will calculate the expected RT's for the specific treatment option chosen.

Priority for treatments discussed above is as follows:

1. Canted deck
2. Horizontal deck
3. Under platforms and catwalk
4. Ring beam, concourse walls, columns etc.

Table 1: Expected RT's with lapendary panels in the deck with or without glass fiber faced with perforated metal under the catwalks and platforms.

Treatment	Ft²	RT's					
		125	250	500	1K	2K	4K Hz
Tested RT's		4.1	3.2	3.0	2.4	2.3	1.7 sec
Goal RT's		Approx. 3 seconds		Above 500 Hz RT: 2.5 seconds or less			
Only canted areas of the deck treated							
CD 22,000 ft²	22,000 ft²	3.9	2.9	2.7	2.2	2.2	1.7 sec
CD 22,000 ft² + UC 29,800 ft²	51,800 ft²	3.7	2.5	2.4	2	1.9	1.5 sec
Canted areas + 80% of the horizontal deck treated							
CD 22,000 + HD 93.000 ft²	115,000 ft²	3.3	2.2	2.0	1.8	1.8	1.6 sec
CD 22,000 ft² + HD 93,000 ft² + UC 29,800 ft²	144,800 ft²	3.1	2.0	1.8	1.6	1.6	1.4 sec
Canted areas + 67% of the horizontal deck treated							
CD 22,000 ft²+ HD 77,400 ft²	99,400 ft²	3.4	2.3	2.1	1.8	1.8	1.6 sec
CD 22,000 ft² + 77,400 ft²+ UC 29,800 ft²	129,200 ft²	3.2	2.1	2.0	1.7	1.7	1.5 sec
Canted areas + 50% of the horizontal deck treated							
CD 22,000 ft²+ HD 58,000 ft²	80,000 ft²	3.5	2.4	2.2	1.9	1.9	1.6 sec
CD 22,000 ft² + HD 58,000 ft² + UC 29,800 ft²	109,800 ft²	3.3	2.2	2.0	1.8	1.8	1.6 sec

Red= does not meet goal RT
CD= canted area of the deck
HD= horizontal part of the deck
UC= under catwalks and platforms

The above RT's are based on preliminary calculations. As can be seen, the more absorptive material that is added the lower the RT's will be, and consequently, the better the acoustical environment will be.

It has been difficult to attach realistic budget numbers to the different options at this time. However, we have discussed the possible costs with a local contractor who agreed that $6 - $7/ ft² would be a realistic estimate for now. Some treatment scenarios could be less expensive than others, but it is likely that we will need to zero in on more specific treatment options before getting serious price quotes.

Sari Rönnholm

cc. Tom Reller
Frank Anderson