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Date: 07 July 2017

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Topic: SolaTheatre Theatrical Light – Acoustic Testing

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To determine whether the High End System's *SolaTheatre* fixture operates at a quiet enough level once installed in a lecture hall with a very low background noise level of approximately RC-15, testing was conducted at S&V Solutions in Sycamore, IL to understand the radiated sound levels during different operational sequences which may be performed once installed. Testing confirmed that the *SolaTheatre* fixture, when not in motion, is certainly quiet and will not raise the background noise levels in this particular scenario.

## Testing Procedure

### *Setup*

The *SolaTheatre* light was mounted to a fixed pipe at the ceiling of the testing chamber. Four Brüel & Kjær microphones were used to capture the radiated noise, one of which was higher in sensitivity, allowing it to pick up lower sound levels when compared to the other three microphones. Three of these microphones were positioned at distances of 39 inches (~1 meter) from the light, with the fourth at 70 inches (~1.75 meters). Testing setup is shown in Figure 1. Measurements were captured and processed using the Brüel & Kjær PULSE software.



Figure 1: SolaTheatre Testing Setup

## *Tests Completed*

A series of tests were performed to understand the full range of motion and capabilities for which the fixture may experience when installed. Unless otherwise specified, all cues (time taken to complete a motion) were set at two (2) seconds, and repeated continuously over the specified time.

- Background Noise of test chamber - HVAC & Light Off, Solatheater Unplugged
- Solatheater calibration sequence – approx. 1 min 10 seconds
- Tilting – 0 degrees (downfiring) to 90 (parallel to floor) degrees, continuous over 1 min, lamp off
- Panning - 0 degrees to 90 degrees, continuous over 1 min, lamp off\*
- Zooming - 0 to 100%, continuous over 1 minute, lamp off
- Zooming - 0 to 100%, continuous over 1 minute, lamp off (5 second cues)
- Gobo wheel spin – fixture held parallel to floor (90 degrees) continuous cycling over 1 minute, lamp on
- Gobo wheel spin & rotation - fixture held parallel to floor (90 degrees) continuous cycling over 1 minute, lamp on
- Color mixing (cycle) – fixture downfiring (90 degrees) continuous cycling over 1 minute, lamp on (CMY Color Mix FX)\*
- Framing - continuous over 1 minute, lamp on (2 second cycle)
- Framing - continuous over 1 minute, lamp on (1 second cycle)
- Focusing – continuous over 1 minute, lamp off
- Diffusion (frosting) – continuous over 1 minute, lamp off
- Lamp On, Downfiring 100% Brightness - continuous over 15 seconds\*
- Lamp On, Downfiring 50% Brightness - continuous over 15 seconds\*
- Lamp On, Downfiring 10% Brightness - continuous over 15 seconds\*
- Lamp On, Angled 100% Brightness - continuous over 15 seconds, angled approx. 45 degrees from vertical\*
- Lamp On, Angled 50% Brightness - continuous over 15 seconds, angled approx. 45 degrees from vertical\*
- Lite Stress Test – continuous over 15 seconds, lamp on
  - Pan and Tilt FX
  - CMY FX
  - Gobo wheel spin & rotation
- Moderate Stress Test – continuous over 15 seconds, lamp on
  - All of the above, plus:
  - Extended Pan size and rate
  - Animation & Prism
- High Stress Test – continuous over 15 seconds, lamp on
  - All of the above, plus:
  - Zooming
  - Focusing
  - Iris FX

Despite such extensive testing being performed, a smaller sample of the testing is deemed most suitable for how the light will be applied in its final setting. These are indicated by an asterisk (\*) in the above list.

## Results

The data has been averaged to a single number A-weighted sound pressure level (dBA) over the time of the measurement. The applied A-weighting is a weighting mimicking how the ear perceives sound, as the ear processes each frequency of sound slightly differently. Due to how quiet the light fixture performed in certain scenarios, only the low-level microphone was able to provide an accurate representation of the operating level of the *SolaTheatre* fixture.

**Table 1: *SolaTheatre* Test Scenarios, Overall A-Weighted Sound Pressure Levels (dBA)**

Test Scenario	Overall Sound Pressure Level (dBA)
Background Noise of test chamber	1
Solatheater calibration sequence	18
Tilting	20
Panning	18
Zooming - 0 to 100% (2 second cue)	27
Zooming - 0 to 100% (5 second cue)	25
Gobo wheel spin	12
Gobo wheel spin & rotation	8
Color mixing (cycle)	4
Framing (2 second cycle)	7
Framing (1 second cycle)	15
Focusing	21
Diffusion (frosting)	3
Lamp On, Downfiring 100% Brightness	2
Lamp On, Downfiring 50% Brightness	2
Lamp On, Downfiring 10% Brightness	2
Lamp On, Angled 100% Brightness	3
Lamp On, Angled 50% Brightness	2
Lite Stress Test	25
Moderate Stress Test	27
High Stress Test	32

With the light holding both at 0 degrees (downfiring), angled at 45 degrees, and color changing whilst downfiring, all levels experienced are below the threshold of hearing. When multiple lights are introduced into the same room, the overall sound pressure level output by these fixtures collectively will increase, but overall will typically remain below the threshold of hearing at any audience seat and at the presenter location. Instances such as the calibration sequence would most likely be performed prior to room use and remains a one-time event. The levels are predominantly motor noise as the light defines its internal limits of motion, lasting just over 60 seconds, and ceases to make audible noise once completed. Although scenarios such as panning, focusing, etc., breach the threshold of hearing, we don't anticipate this motion being used while the space is its quietest. Meaning, we would anticipate these sorts of motions to occur during a louder event, which would mask the noise produced by the fixture.

During testing, the speed and range of motion experienced by the light was continuous and well-beyond what would be a normal use-case (including scenarios outside of the "Stress Tests"). As such, the resultant levels of a more realistic motion speeds would be closer to the threshold of hearing.

## Conclusion

Overall, the data can be split into two separate conditions: when the light is in motion, and when the light is held stationary. It is understood that the light is usually in motion (be it calibration, panning, zooming, framing, etc.) prior to the use of the room, and remains stationary or rarely moves during more sensitive events. Once stationary, the light intensity and color are the driving factors, yet remain inaudible.

The data confirms that when the *SolaTheatre* fixture is not in motion, sound pressure levels produced will be inaudible to the audience or presenter within most indoor venues.

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