Sorry, not that kind of reflections!
### Outside...

<table>
<thead>
<tr>
<th>IGU Type</th>
<th>VLT (%)</th>
<th>Rext (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEAR GLASS IGU</td>
<td>79%</td>
<td>14%</td>
</tr>
<tr>
<td>VNE1-63 IGU</td>
<td>62%</td>
<td>11%</td>
</tr>
<tr>
<td>LE54-GREEN IGU</td>
<td>42%</td>
<td>8%</td>
</tr>
<tr>
<td>PPG-SB80 IGU</td>
<td>47%</td>
<td>33%</td>
</tr>
</tbody>
</table>
Inside…
Case Study #1:
350 Mission Street, San Francisco
Photo credit: Refik Anadol
Layers of Light
Layers

Ambient Daylight Only
Media Screen with Ambient Daylight
Three View Points

Corner

Millenium

Transbay
Three types of content

Ove Arup (Greyscale)

Degas (Low contrast color)

Kandinsky (High contrast color)

Three levels of screen brightness

1500 cd/m² 2500 cd/m² 5000 cd/m²
Veiling Luminance - Annual Simulation

Typical worst case:
January 20 11:30AM

Typical average case:
June 4 12:30PM

Days in the year
Typical Worst Case

January 20, 11:30AM

Corner  Millenium  Transbay
Typical Average Case
June 4, 12:30PM

Corner

Millenium

Transbay
Visualizations – Worst Case

January 20, 11:30AM
January 20, 11:30AM [1500 cd/m²]

Date/Time

Media Screen Brightness
January 20, 11:30AM [1500 cd/m²]
Visualizations – Average Case

June 4, 12:30PM
June 4, 12:30PM [5000 cd/m²]
Conclusions

• Veiling reflection analysis indicates that views of the media screen through the façade may be challenged on the order of 2 hours per day.

• Under average conditions, the lowest screen brightness was judged to be sufficient by the Client and design team.

• Under worst case conditions, visibility for all but the highest brightest (5000 cd/m²) screen were challenged by veiling reflections.

• The Client selected the lowest brightness screen given their priority to achieve the best visual performance inside the building, with exterior visibility being secondary.
Radiance

Photograph
Case Study #2: SeaTac International Arrivals Facility
June Sunpath

Note: All times listed assume local solar time. Daylight savings time has not been accounted for, so 1 hour should be added to march/september and summer times.
Figure below: Illustrative diagram of glare sources studied in this report

1. Disability (Direct) Glare from sun
2. Contrast Reduction from Veiling Reflections
Monitor Contrast

Monitor Contrast = \( \frac{L_{\text{white pixel}}}{L_{\text{black pixel}}} \)

Apparent Monitor Contrast = \( \frac{L_{\text{white pixel}} + L_{\text{veiling reflection}}}{L_{\text{black pixel}} + L_{\text{veiling reflection}}} \)

Monitor specification

Calculated with simulation
# Recommended Contrast Ratios

<table>
<thead>
<tr>
<th>Category A</th>
<th>Category B</th>
<th>Category C</th>
</tr>
</thead>
<tbody>
<tr>
<td>100:1</td>
<td>25:1</td>
<td>5:1</td>
</tr>
<tr>
<td>Images show a full range of colors (or grays in black and white photographs) and have good shadow detail.</td>
<td>The range of colors is like that of Category A except the images are limited in shadows and details and have a flat two-dimensional appearance.</td>
<td>The images are composed of contrasting colors or black and white (no grays). They have little or no detail in the dark areas.</td>
</tr>
<tr>
<td>Examples: Portraits and landscapes</td>
<td>Examples: Cartoons and flatly lighted photographs of subjects with limited brightness range.</td>
<td>Examples: Printed test, charts, and other linework for use with slide and overhead projectors.</td>
</tr>
</tbody>
</table>

*Source: Kodak Audiovisual Projection
Kodak Publication S-3
Revision 036-03-82
Page 10*
Sensitivity Study

This page shows the sensitivity of allowing varying percentages of veiling reflections on the display screens. The higher the percentage of screen area that is allowed to show reflected glare, fewer locations exceed the threshold.

Typical TSA screen

Allowable size of reflections (approx)

15%

10%

5%

Max

Current Assumption

Comment:
TSA screens, with their vertical orientation and close proximity to curtainwall, are highly sensitive to veiling reflections. Reflections tend to occupy more than 15% of the screen area.

Comment:
77%

15%

5%

% hours reflected glare exceeds threshold

APC 1

APC 2

TRIAGE 1

TRIAGE 2

TSA 1

TSA 2

Comment:
When screen reflections are allowed to occupy up to 10% of the screen, all of the locations except TSA deep below threshold.

Comment:
Triage screens (which are angled up toward ceiling) mainly reflect the skylights, but this occupies a relatively small % of all screen < 10%.

Comment:
APC blocks (as currently configured) are relatively insensitive to veiling reflections on the screens.

% hours reflected glare exceeds threshold

APC 1

APC 2

TRIAGE 1

TRIAGE 2

TSA 1

TSA 2

% hours reflected glare exceeds threshold

APC 1

APC 2

TRIAGE 1

TRIAGE 2

TSA 1

TSA 2

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Viewpoint Plan

View 1: Looking Southeast

View 2: Looking Northeast

Assumption: glossy screen angled up at 45 degrees.
View 1: Looking Southeast
May 9 6:00 AM (sunny sky)

Annual Glare Analysis

- Disability (Direct) Glare
- Veiling (Reflected) Glare

Disability Glare 10%
Reflected Glare 0%
Combined Glare 10%

% of all daylight hours during the year
View 2: Looking Northeast
May 9 6:00 AM (sunny sky)

Annual Glare Analysis

- Disability (Direct) Glare
- Veiling (Reflected) Glare

Disability Glare: 5%
Reflected Glare: 0%
Combined Glare: 5%

% of all daylight hours during the year
View 1: Looking Northeast
May 9 6:00AM (sunny sky)

View 2: Looking Southwest
May 9 6:00AM (sunny sky)

Reflections of skylight and glazing visible on screen

Annual Glare Analysis

Disability Glare  | Reflected Glare  | Combined Glare
1% | 79% | 79%

% of all daylight hours during the year

Disability Glare  | Reflected Glare  | Combined Glare
0.1% | 21% | 21%

% of all daylight hours during the year
View 1: Looking Northeast
May 9 6:00AM (sunny sky)

View 2: Looking Southwest
May 9 6:00AM (sunny sky)

Annual Glare Analysis
- Disability (Direct) Glare
- Veiling (Reflected) Glare

- Disability Glare: 1%
- Reflected Glare: 0%
- Combined Glare: 1%

- Disability Glare: 0%
- Reflected Glare: 0%
- Combined Glare: 0%

% of all daylight hours during the year
View 1: Looking Northeast
May 9 6:00AM (sunny sky)

View 2: Looking Southwest
May 9 6:00AM (sunny sky)

Annual Glare Analysis:
- Disability (Direct) Glare
- Veiling (Reflected) Glare

Disability Glare
- 0%

Reflected Glare
- 0%

Combined Glare
- 0%

% of all daylight hours during the year
View 1: Looking Northeast
May 9 6:00AM (sunny sky)

View 2: Looking Southwest
May 9 6:00AM (sunny sky)

Screen reflections are close to zero

Annual Glare Analysis

Disability Glare
Reflected Glare
Combined Glare

0% 0% 0%
% of all daylight hours during the year

Disability Glare
Reflected Glare
Combined Glare

0% 0.1% 0.1%
% of all daylight hours during the year
Thank you!