Knight Cancer Research Building

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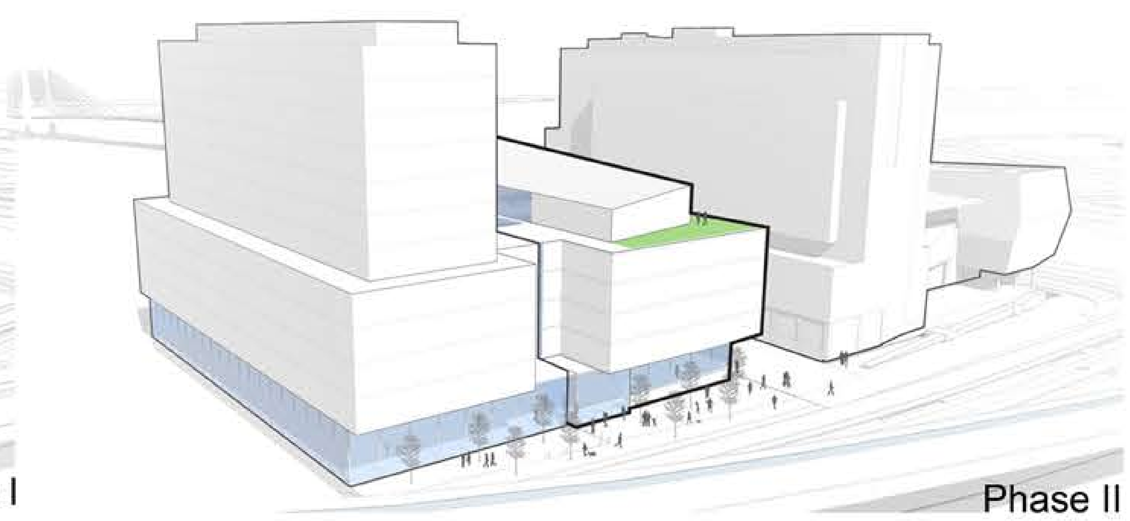


RESEARCH OVERVIEW:

The Knight Cancer Research Building (KCRB) will be a 7-story research facility with a proposed site in the South Waterfront district. It will be the first building of a two-phase construction project; the second building, expected for completion in about 10 years, will connect to the KCRB's north facade. Until then, the KCRB north facade will be visually and environmentally exposed. The north façade will include an atrium flanked by more enclosed spaces such as egress stairs, storage, and meeting rooms. The south façade of the Phase II building will define the remaining walls of the atrium as its lower levels will nearly mirror KCRB's north façade.

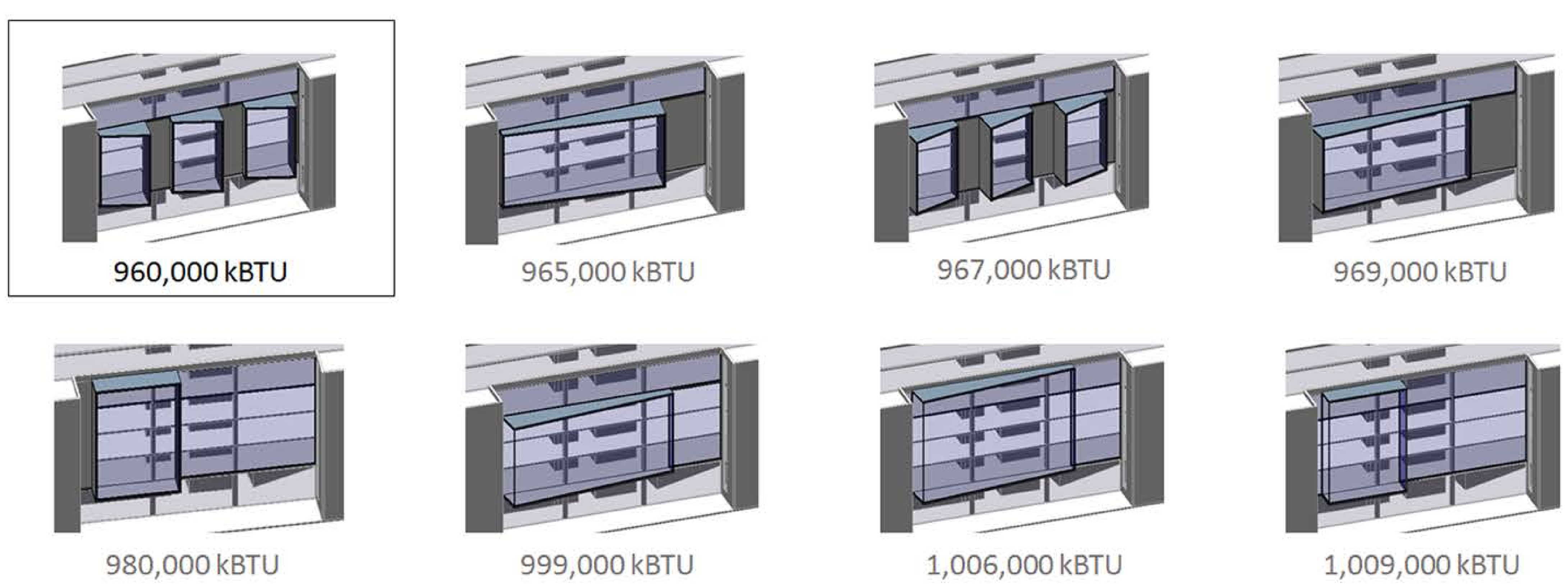
The north facade atrium design began as all-glass and spanned several levels in order to create a desirable communal space for the occupants. The engineering consultants for the project had expressed concern about the thermal performance of an all-glass design and recommended that the north facade have some mass to decrease solar gain in the summer and heat loss in the winter. The first half of this research project focused on exploring design alternatives and their impact on thermal performance and daylighting. Before the completion of this study, a final façade design was chosen by SRG, so there was a change in direction for the second half of the research project. SRG wanted to better understand how a cut-out feature on the Phase II building might influence atrium daylighting and asked that a study be conducted.

METHODOLOGY:

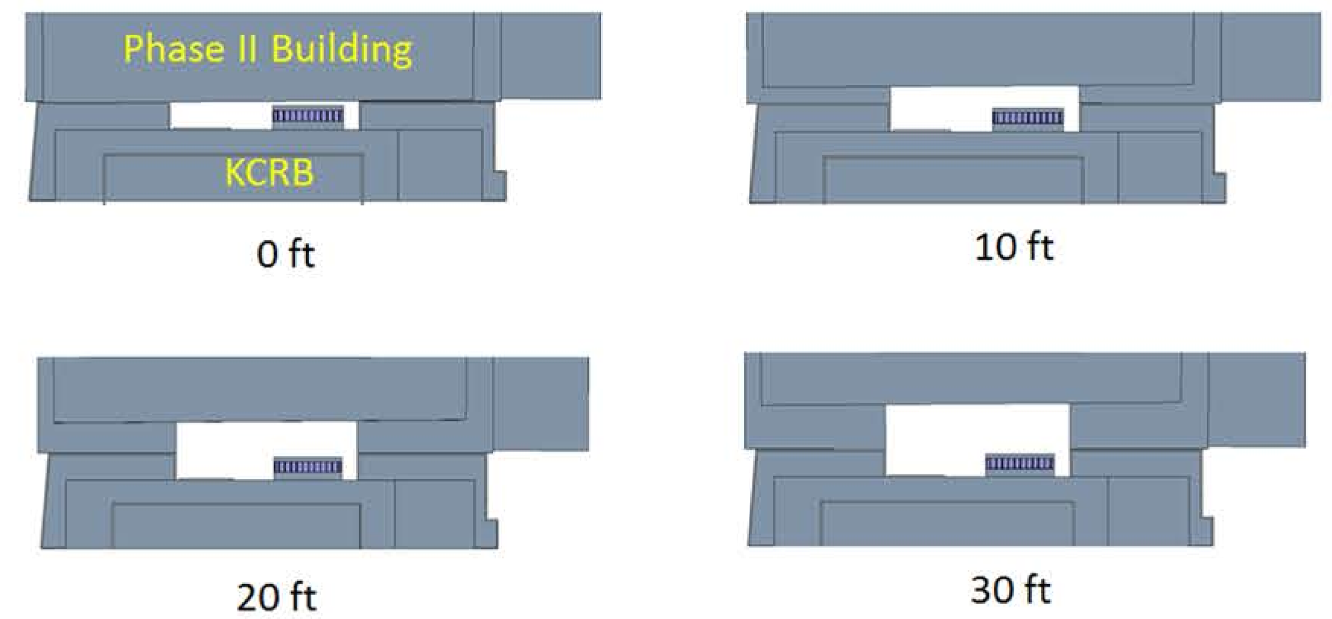
Revit's plugin Sefaira was used to perform both thermal and daylighting analyses for alternate atrium designs. Glazing orientation was shifted and rotated based on direct solar heat gains. Other iterations explored the ratios of massing to glazing. The thermal load results were compared to each other and to an all-glass and all-mass design for a baseline comparison. In the process of this study, SRG had in fact come to a design conclusion as their deadlines were approaching. They requested that their design decision be further analyzed to determine how the Phase II building might affect daylighting.

The Phase II building was modeled with cut-out depths of 0ft, 10ft, 20ft, and 30ft and analyzed in Sefaira for daylighting. The aim of the analysis was to determine which cut-out depths allow the minimum required illuminance based on each floor's space usage. The cut-out depth cannot exceed 30ft without violating the minimum width requirement for the upper-level tower. ASHRAE standard 90-75 recommends a minimum illuminance of 25 footcandles for general area lighting and 8 footcandles for corridor lighting. The daylighting results show the illuminance at a specified floorplate height as a percentage of occupied hours that meet or exceed the minimum illuminance specified by the user; we chose a floorplate height of 2.79ft (default) and minimum illuminances of 9 fc and 23 fc (the daylighting interface has preset values for illuminance). The results were overlaid on each floor's CAD drawing to get a more detailed look at where electric lighting would be needed based on the space usage.

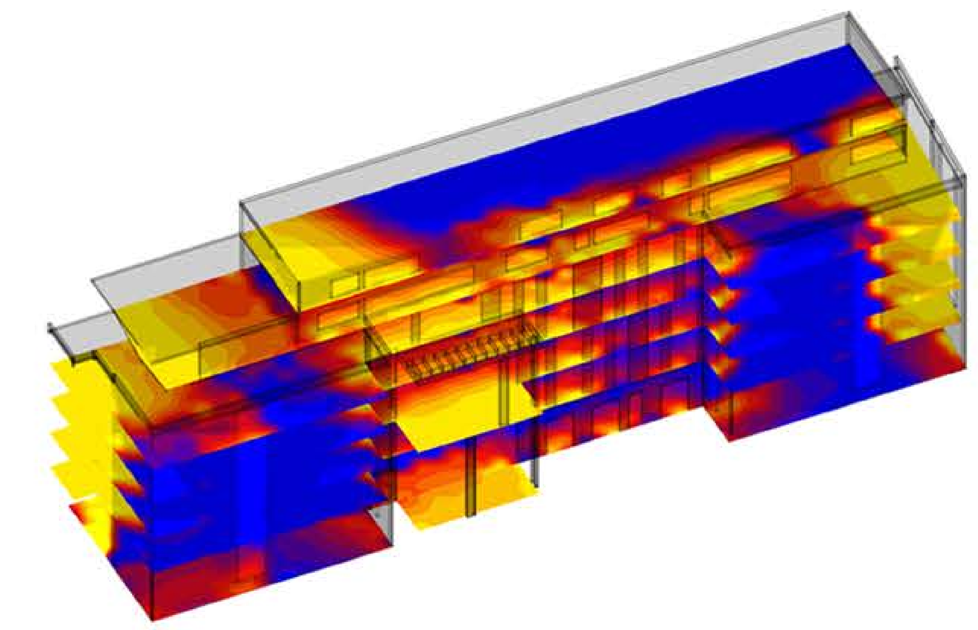
Alternate Atrium Design Energy Analysis Results | Annual Thermal Loads



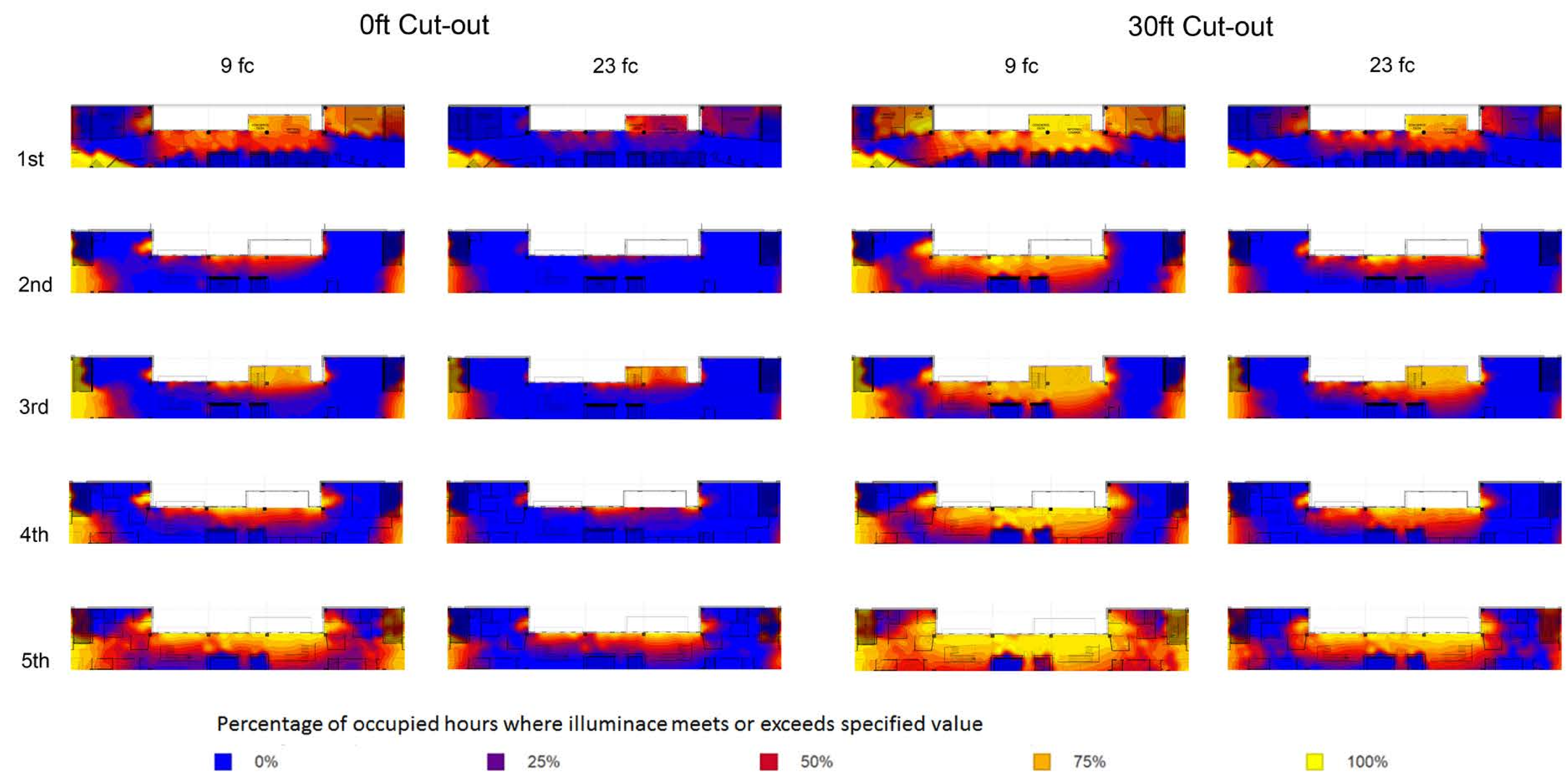
Phase II Building Cut-out Options | Plan View



Sefaira Daylighting Results | 3-D View



Atrium Daylighting Results | Effect of Phase II Building Cut-out Depth on Atrium Daylighting



RESULTS AND DISCUSSION:

In general, the alternate atrium designs with more massing had lower heating and cooling loads. The best performer in terms of thermal load was the design with multiple bump-outs rotated north. Having multiple rotated bump-outs allows more of the glazing to be re-oriented away from the west, where solar gain is high, and enables the lateral faces of the bump-outs to serve as effective shading devices. Using a normalized scale with the all-mass design as the lower limit and all-glass design as the upper limit, the multiple bump-out design had a 26% reduction in total thermal load compared to the all-glass design. As expected, though, this design was the least successful in terms of daylighting. A more detailed analysis was planned to determine whether this design's daylighting performance was adequate. However, at this point the atrium design was no longer in flux and a previous design had already been chosen by SRG, so no further analysis was done.

As the Phase II building's cut-out depth increases, daylighting levels improve. However, even at the maximum cut-out depth, 30 ft, some level of electric lighting will be needed on all floors because no floor achieved the minimum illuminance for 100% of its corridor or general usage space. The 30 ft cut-out results are shown above, as well as the 0 ft results for reference. Level 2, which is all corridor space around the atrium, had the lowest daylight levels and will require the most electric lighting to meet the 8 fc minimum. Level 5, which has both corridor and general use space, had the highest daylight levels and will require the least electric lighting for its corridor space. The general use space in the bump-outs on levels 1 and 3 meet the 25 fc minimum for about 70-75% of the occupied hours; they will need about equal levels of electric lighting for those areas. A calibration study can be done to correlate daylighting data with actual electric light levels needed to meet the minimum illuminance for each space type. Once correlated, the atrium Sefaira results would show in high resolution where and how much electric lighting should be added.