1.1 Mechanical Systems Comfort Criteria

The intention is to operate the building through a broader range of internal environmental conditions than is typical within current industry norms. The building design shall be based on this intention with the full acknowledgement and agreement of the Owner, the Design and Construction Team, and all project stakeholders.

The building shall be designed to meet the comfort requirements in ASHRAE 55-2013 based on the Analytical Comfort Zone Method, which evaluates comfort based on a calculation of the *predicted mean vote (PMV)* per the *Standard Effective Temperature* comfort model. The Berkeley Center for the Built Environment Comfort Tool (http://smap.cbe.berkeley.edu/comforttool) will be used to evaluate the comfort conditions. To account for passive and active heating/cooling strategies, this project will analyze the expected occupied hours (between 8 am and 6pm) that the building will be outside of the comfort criteria using 8760 temperature data and building energy modeling, rather than static design load calculations using ASHRAE design conditions. Given the expanded setpoints, it is expected that occupied hours will fall within the comfort range for all but 1.5% of occupied hours. The Owner recognizes that temperature uniformity throughout the building would require significant mechanical conditioning infrastructure and may not provide occupants the natural variation to select where they are the most comfortable. Therefore, the owner is willing to accept temperature variations within the building itself, such that one area is at a different temperature than another, as long as all areas are within the acceptable range described below. Specific criteria for spaces in the building have been expressed separately below.

In events of extreme weather, as defined by days outside the standard ASHRAE 0.4% and 99.6% ranges, or cooling-days in which the diurnal temperature swing is less than 35°F, RMI is willing to accept the building being outside of the stated comfort ranges and will request that all employees work from home if comfort cannot be maintained during these periods.

1.1.1 Space Performance Conditions

During the design process, the comfort criteria was expanded and refined. For further details regarding the definition and development of these comfort criteria, please refer to Appendix B: Thermal Comfort Design Criteria.

Open office areas, enclosed offices, phone booths, media room and conference rooms

The open office areas, enclosed offices, media room and conference rooms are designed assuming the use of CBE Hyperchairs (aka Personal Comfort Systems). Hyperchairs will not be provided in the telephone rooms but occupants can bring in their own chairs as needed. The lower thermal comfort range of the phone booths is allowed to deviate from a PMV -0.5 per ASHRAE 55- 2013 to 64 °F and the upper limit will be maintained at 0.5 PMV for 3 calls of 15 minute duration at 100% capacity per hour, with 5 min breaks between each call. The modified thermal requirements in this space during all occupied periods shall be:

Measured		
Heating conditions	Operational temperature – calculated from MRT and air temperature	≥ 64 °F for spaces with hyperchairs ≥ -0.5 PMV for spaces without hyperchairs
	Airspeed	<20 fpm
Cooling conditions	Operational temperature – calculated from MRT and air temperature	PMV <= 0.5
	Airspeed	Up to 200 fpm via ceiling fans, personal USB fans, or floor standing portable fans. Minimum design rate to meet comfort requirements is specified for each room in the room data sheets in the design drawings.
Design assumptions – Not measured but required for comfort		
Heating conditions	Clo	1.01
	Met	1.0
Cooling Conditions	Clo	0.57
	Met	1.2

PMV shall be evaluated based on Room Datasheets indicating comfort criteria for each space and provided in the Mechanical Plans. The room datasheets are developed through the use of CBE's thermal comfort tool available at: http://smap.cbe.berkeley.edu/comforttool. The CBE tool uses the ASHRAE Standard 55-2013 SET method with elevated air speed to calculate predicted mean vote. The contractor will be responsible for maintaining the measured criteria above. These will be measured using permanent air temperature and MRT sensors that are integrated and trended in the BMS. Quantity and locations of these sensors is will be determined by the Project Team prior to installation informed by worst case location in the model. The airspeed will be measured and documented during commissioning to confirm that the design rate is provided in all locations, through a combination of ceiling fans and personal fans. This will happen after furniture install. However, if data or other indications suggest that an Air Speed-related issue may be the cause of the Event, then the fans may be re-investigated as feasible with handheld or other portable instrumentation.

It is assumed the occupants are maintaining the correct clo and met values, and that RH will not be a significant variable effecting comfort in this climate.

Convening area, breakout rooms, perch, and lobby

The convening area and breakout rooms will maintain the standard ASHRAE 55–2013 requirement of PMV +/- 0.5 during all occupied hours using the elevated airspeed thermal comfort model. These areas will not have Hyperchairs. The thermal requirements in the convening and break out rooms shall be:

Measured

Heating conditions	Operational temperature – calculated from MRT and air temperature	≥ -0.5 PMV
	Airspeed	<20 fpm
Cooling conditions	Operational temperature – calculated from MRT and air temperature	PMV <= 0.5
	Airspeed	Up to 200 fpm via ceiling fans, or floor standing portable fans. Design rate will be specified on the mechanical documents.
Design assumptions – Not measured but required for comfort		
Heating conditions	Clo	1.01
	Met	1.0
Cooling Conditions	Clo	0.57
	Met	1.7 for speaker 1.2 for seated occupants

PMV shall be evaluated based on Room Datasheets indicating comfort criteria for each space and provided in the Mechanical Plans. The room datasheets are developed through the use of CBE's thermal comfort tool available at: http://smap.cbe.berkeley.edu/comforttool. The CBE tool uses the ASHRAE Standard 55-2013 SET method with elevated air speed to calculate predicted mean vote. The contractor will be responsible for maintaining the measured criteria above. These will be measured using permanent air temperature and MRT sensors that are integrated and trended in the BMS. Quantity and locations of these sensors is will be determined by the Project Team prior to installation. The airspeed will be measured and documented during commissioning to confirm that the design rate is provided in all locations, through a combination of ceiling fans and personal fans. This will happen after furniture install.

The convening space and the breakout rooms require aggressive precooling in order to maintain comfort during cooling conditions, and it shall be the responsibility of the building operator to ensure that pre-cooling and other operational protocols as described in the Operations and prompted by the BMS are conducted. The clothing requirement (CLO value) may change between am and pm occupied hours.

1.1.2 Criteria for Determining The Cause of Out of Range Conditions and Responsibility for Mitigations

As a highly passive building, thermal comfort depends on the correct interaction of the buildings' passive and active systems, occupant use, and climactic conditions. In the event of space conditions occurring outside the ranges described in Section 3.2.1 (Out-of-Range Event), a sequential protocol will be followed to isolate and identify causes. Mitigation efforts will then be undertaken as described in this section.

Potential causes of an Out-of-Range Event have been grouped into three categories: Construction-related, Operations-related, and Systems/Equipment-related. Verification of

potential Construction-related issues will be performed prior to occupancy, and their validity shall be assumed to continue for a period of four years after substantial completion. However, if data or other indications suggest that a Construction-related issue may be the cause of the Event, then they may be re-investigated as feasible with handheld or other portable instrumentation. Potential Operations-related issues shall be verified at the time of and Out-of-Range event through a series of validations performed by the Owner.

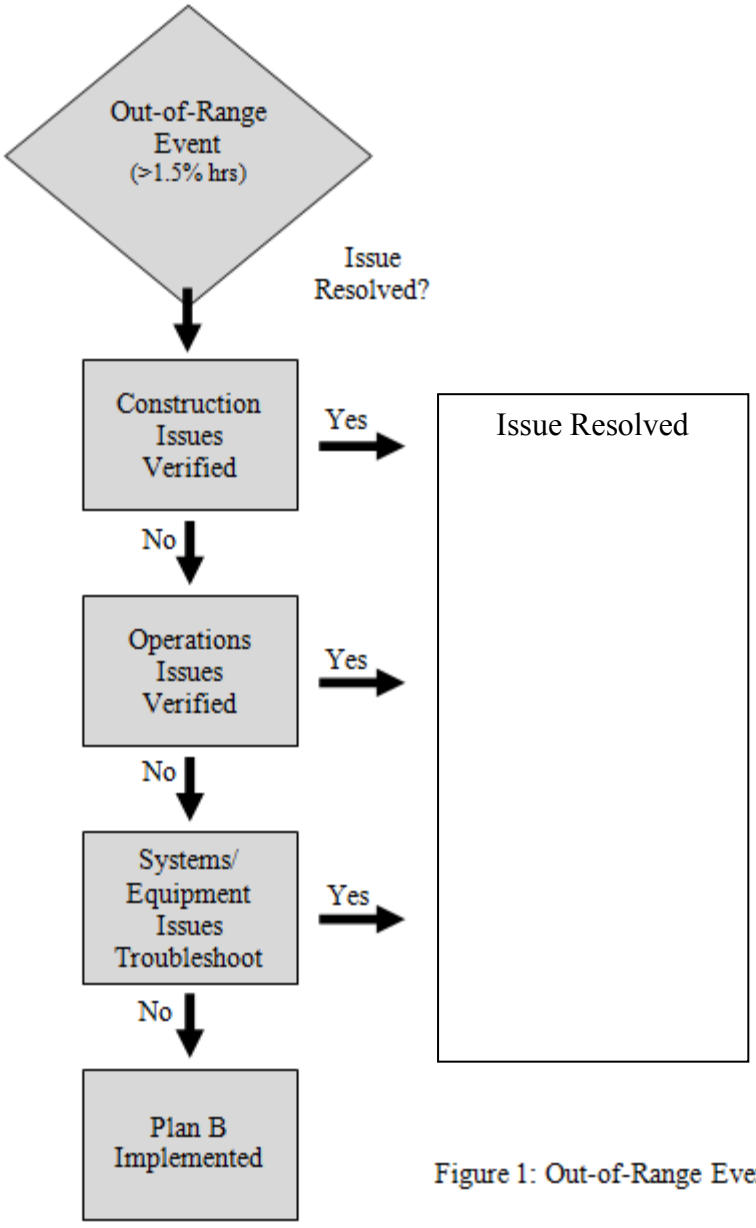

Figure 1: Out-of-Range Event Resolution Protocol

I. Construction-related Issues

Issue	Performance Metric	Performance Target	Verification Conducted	Verification Method	Verification Party

Ia. Air Tightness	Air Changes per Hour at 50 Pa (ACH50)	0.60 ACH50	Pre-occupancy	Blower Door	GC
Ib. Insulation	Overall Thermal Resistance (R)	Wall-R40 Roof-R60 Floor-R20	Pre-occupancy	IR Camera	RMI
Ic. Thermal Mass	Per Design Doc's	Per Design Doc.s	Construction Phase	Construction QA	GC
Id. Construction Quality	Per Design Doc's	Site Visit /Construction Observation Reports	Construction Phase	Construction QA	GC
Ie. Product Quality	Per Design Doc's	Submittals	Construction Phase	Construction QA	GC

II. Operations-related Issues*

Issue	Performance Metric	Performance Target	Verification Conducted	Verification Method	Verification Party
IIa. Climate Conditions	Weather events as described in Section 3.2	As defined in Section 3.2	At time of event	Owner Reporting	Owner
IIb. Schedule/ Intended Use	Hours of Operation	As defined in Mechanical Room data sheets.	At time of event	Owner Reporting	Owner
IIc. Occupant Density	Number of occupants in building-zone	As defined in Mechanical Room data sheets.	At time of event and with history 8 hours prior.	Owner Reporting	Owner
IId. Equipment Density	Total wattage connected	As defined in Mechanical Room data sheets.	At time of event	DDC Trended	Owner
IIe. Manual Adjustments/ ("Sailing")	Manual windows, blinds, fan operations	Manual windows, blinds, fan operations	At time of event	Owner Reporting	Owner
IIf. External Shade Operation	Per controls sequence	Manual overrides less than 3% of occupied hours*	At time of event	Owner Reporting	Owner
IIg. Automated Window Operation	Per controls sequence	Manual overrides less than 3% of occupied hours*	At time of event	Owner Reporting	Owner

***It is an important distinction that manual override for more than 3% of hours does not necessarily indicate incorrect operation by the owner. Before this assumption is made, it must be determined the override is not in response to and compensating for a design or construction issue. These root cause of persistence overrides must be determined through owner input and troubleshooting.**

III. Systems/equipment-related Issues

Issue		
IIIa.	Issues unresolved after completion of protocols in Groups I and II "Plan B" for Heating or Cooling may be implemented.	

Timescale:

1. Temperatures are verified to be out of range during more than 1.5% of occupied hours.

If all of the above conditions are determined to be within the design parameters and heating or cooling is not being maintained, "Plan B" for heating or Cooling shall be implemented. The cost share for the fallback option is valid for the longer of the two durations: 2 years from substantial completion or 1 year from the date the issue first appears in the Issue Log, a document that shall be accessible to all project team members. This is dependent on a documented response and active troubleshooting for this issue during that time.

3.2.3 Cooling Plan B:

A fallback option for adding cooling to the design will be the addition of a DX-based cooling system to either the office or convening system.

Office: Space will be reserved in the MEPIT room for 4-tons of cooling capacity to be added via duct-mounted cooling coil. Space will also be reserved for a remote condensing unit. Reconfiguration of controls and commissioning will also be included. Upon determining Plan B is desired, RMI will obtain an estimate for the cost of plan B. The cost of the materials will be covered by RMI, the cost of the installation will be split 50/50 between RMI and PAE, with PAE's cost liability limited to $6,000. This will provide approximately a 2-degree cooling benefit to the space.

Convening Wing: Space will be reserved in the eastern most mechanical room for 3-tons of cooling to be added via packaged fan coil unit with a DX cooling coil. Space will also be reserved for a remote condensing unit within the Convening space mechanical room. Reconfiguration of controls and commissioning will also be included. Upon determining Plan B is desired, RMI will obtain an estimate for the cost of plan B. The cost of the materials will be covered by RMI, the cost of the installation will be split between 50/50 RMI and PAE, with PAE's cost liability limited to $6,000. PAE will complete the design

for the system at cost (billing rates current at time of design) without profit. This will provide a space with a 75-degree cooling setpoint.

The fallback option and cost share of a cooling addition will only be applicable after the *Criteria for Determining Out of Range Conditions* has been documented by RMI.

3.2.4 Heating Plan B:

Most of the building is provided with heating capacity sized to meet ASHRAE 0.4% design points based on standard load calculations. The open offices are provided with active and inactive heating elements. In the case that heat is not maintained, the additional heating elements will be connected.

RMI will pay the cost of the electrical work to engage the backup heating system.