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## *Instructions and Checklist for Thermal Analysis Simulation Request*

**Version 20140804**

This document serves as a guide to be used in combination with the "Thermal Simulation Request and Definition Form" that has also been provided by Xicato. The template is provided in .ppt and pptx format to be opened and modified using Microsoft® PowerPoint®.

NOTE: At this time we are unable to process simulations related to forced cooling (ie Nuventix SynJet or fan) due to complexity in modeling and accuracy issues. If forced cooling is desired or required, contact the cooler manufacturer directly. In general, it is usually best to create a physical prototype and test to achieve accurate results. If you have any further questions regarding forced cooling, please contact your Xicato technical representative.

Prior to beginning the step by step definition process, it is important to check CAD compatibility and verify conditions have been met for geometry export.

Xicato uses a 3D CAD based CFD (computational fluid dynamics) numerical solver that requires a 3D CAD model in order to complete the analysis. Unfortunately we are unable to process requests that are only in 2D CAD. Depending on the 3D CAD system used, an export in to a generic or common CAD structure may or may not be needed. If Pro/E is being used, please save files in native .prt or .asm format. If SolidWorks, Catia, Rhino, Solid Edge, or other 3D CAD system is being used, please export as **solid geometry** in **.stp (.step) format.** Prior to saving or exporting, please read through the following notes:

*NOTES:*

1. Solid geometry as opposed to "shells" or "surfaced" geometry is essential for use within the thermal analysis tool because shells or surfaces do not contain mass, and since the CFD solver uses solid and fluid material properties to define complicated thermal interactions, mass (aluminum, air, etc.) must be defined. The following procedure can be used to check to see if your model and all of its components are solids.

   a) Perform a trial export by saving as a .prt, .asm or .stp (.step) file.

   b) Re-open (or import) the recently exported file into your 3D CAD system.

c) Perform a cross section view procedure to cut through the geometry. Please note that multiple cross sections may be needed to check all parts.

d) Inspect cross sections for solids vs. surfaces. If surfaces exist, change part(s) structure (or export technique) and restart at step "b" until only solid parts are present in the export. An example is provided below:
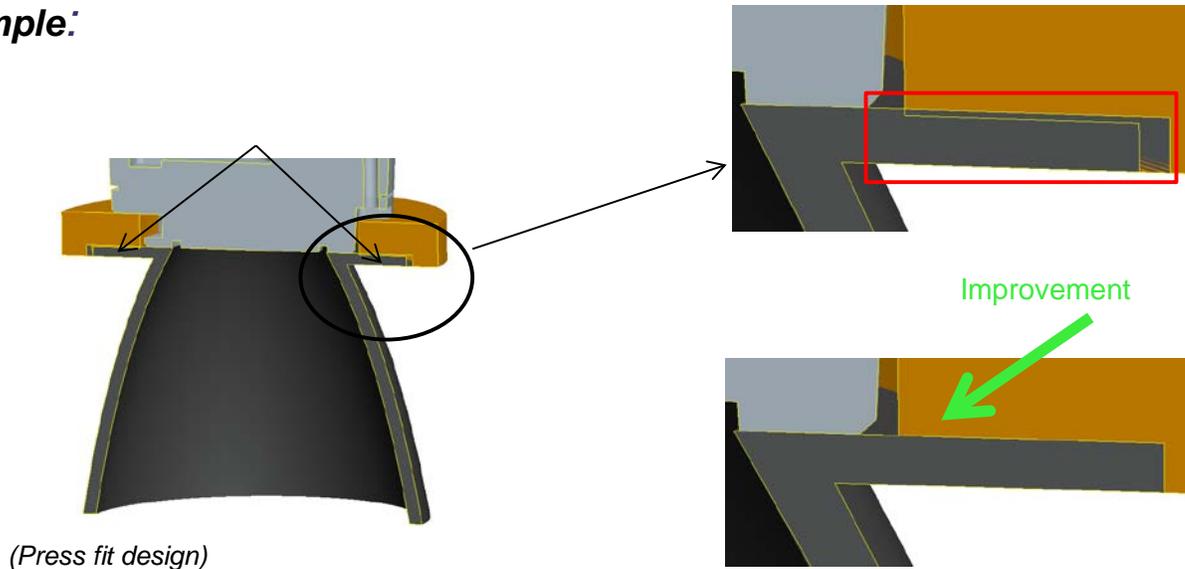
### *Example:*
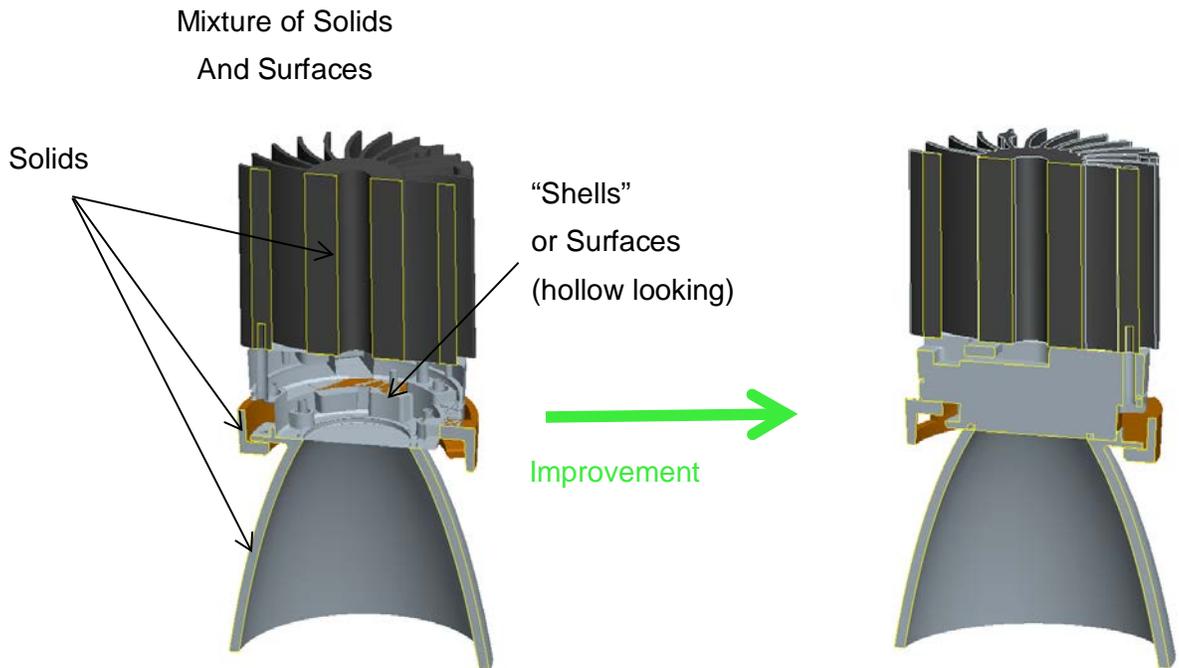


2. Unless absolutely necessary, all screws, washers, nuts, and other hardware should be excluded from the exported assembly. Exceptions include fasteners that are part of the thermal path (ie a large aluminum bolt used to carry heat to fixture or structure). If you are unsure whether a component is part of the thermal path, leave the component in the assembly and Xicato can determine relevance.

3. The thermal analysis software cannot handle overlapping geometry (ie two separate parts with surfaces that overlap each other). The software often makes poor assumptions or won't solve at all with such conditions. For this reason,

please make modifications to overlapping geometry such that new geometry is "surface to surface" or touching but not overlapping. An example is provided below.

## Example:



*(Press fit design)*

The previous example shows the orange and gray overlapping regions that have been fixed to have surface to surface contact.

The next section provides guidance and step by step instruction to accurately define the model for analysis. Please refer to the separate "Thermal Simulation Request and Definition Template" and provide necessary information as required.

## Material Definition

This section defines materials to each and <u>every</u> component in the assembly. The only exception is the Xicato Module. Xicato has a carefully defined thermal model and will substitute at the time of analysis. An example of the material definition procedure is provided at the end of this section.

Definition Procedure:

1. The easiest way to define materials (easier than a word description) is a picture with arrows and material information.  A semi blank page is left intentionally in order to place a screen capture(s) or pictures from your CAD system onto the page. Place a picture onto the screen in the blank area provided. It is crucial that <u>ALL</u> components have a material definition. Note: If one picture does not show all parts, a second picture or cross section is necessary and can be included on the

second blank materials page provided. Also, after pictures have been placed, please use your mouse to select each picture, right mouse click and select arrangement to "send to back".

2. Once the pictures have been placed, the materials can be defined using the table (if applicable), the arrows, and the balloon notes provided on the page. One by one, copy and paste enough arrows and balloons to define each component (for example if there are 7 parts not including the module, there should be 7 arrows and 7 balloons).

3. Place an arrow and a balloon that clearly indicates each component.

4. If common materials are used in the design, use the table to select applicable materials and change the number designator in the balloon to match the desired material. If there is a special material required that is not on the list, please type the new material in the editable table on the right side of the page, and enter the thermal conductivity in W/m-K units. Continue by using the balloon designator to indicate which parts are made of this material. Once all materials have been defined, please proceed to "Interface Definition".

## *Example:*



Material Definition
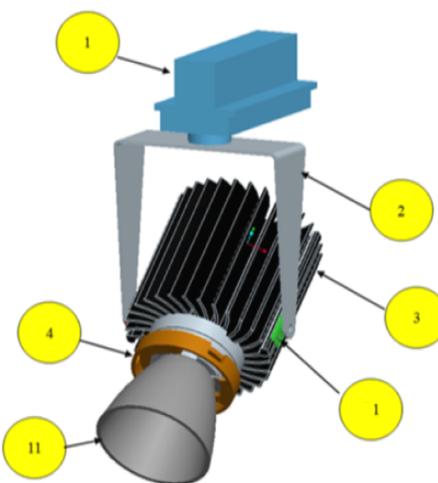
| # | Material | Conductivity (W/m·K) |
|---|----------|---------------------|
| 1 | ABS Plastic / Acrylic | 0.17 |
| 2 | Aluminum 6061 | 180 |
| 3 | Aluminum 6063 | 218 |
| 4 | Aluminum ADC6 | 130 |
| 5 | Aluminum Cast A360 | 113 |
| 6 | Aluminum Cast A380 | 116 |
| 7 | Brass | 120 |
| 8 | Copper (99% pure) | 390 |
| 9 | Fiberglass (FR4) | 0.25 |
| 10 | Glass | 1.0 |
| 11 | Nylon / Polycarb / PVC / Teflon | 0.20 |
| 12 | Steel, Low Alloy | 50 |
| 13 | Steel, Stainless | 16 |
| 14 | Zinc | 116 |
|  | Other (Specify) |  |
| 15 | - - - - | - - - - |
| 16 | - - - - | - - - - |
| 17 | - - - - | - - - - |
| 18 | - - - - | - - - - |

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## Interface Definition

This section defines the interfaces between <u>ALL</u> touching components in the assembly. If an interface is not defined, the software will assume prefect contact (ie welded) which is not usually the case. Please note that as described above, any overlapping surfaces should be resolved prior to submitting for analysis (see note 3 on page 2 for more information).

Definition Procedure:

1. Similar to the materials definition section, a picture with arrows and associated information is the easiest method to define interfaces. With interfaces, however, it is sometimes easier to use cross sectional views in order to show contacting regions. Again, a semi blank page is left intentionally in order to place a screen capture(s) or pictures from your CAD system onto the page. Place a picture onto the screen in the blank area provided. It is crucial that <u>ALL</u> interfaces have been defined. Note: If one picture does not show all interfaces, a second picture or cross section is necessary and can be included on the second blank interfaces page provided. Also, after pictures have been placed, please use your mouse to select each picture, right mouse click and select arrangement to "send to back".

2. Once the pictures have been placed, the interfaces can be defined using the table (if applicable), the arrows, and the balloon notes provided on the page. One by one, copy and paste enough arrows and balloons to define each interface.

3. Place an arrow and a balloon that clearly indicates each interface.

4. If common interfaces and/or interface materials are used in the design, use the table to select applicable interfaces and change the <u>letter</u> designator in the balloon to match the desired interface. If there are two surfaces touching with no specific thermal interface material in between, select "Air Gap (1mil)", as this is a common interface between objects that have been screwed, clamped or sandwiched together. If there is a special interface that is not provided in the table, please type the new material in the editable table on the right side of the page, and enter the new value for thermal resistance in ⁰C-m²/W OR in terms of thermal conductivity (preferably in W/m-K units) <u>AND</u> thickness. Continue by using the balloon designator to indicate which interfaces are represented by this special case. All Xicato modules ship with eGRAF HT-1205 thermal pad pre-attached. An example is provided below. Once all interfaces have been defined, please proceed to "Product Selection and Boundary Conditions".

*Example:*



Interface Definition
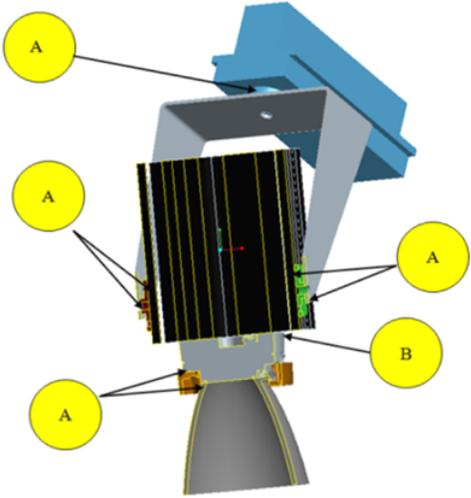
| # | Interface*** | Contact Resistance ($^{\circ}C \cdot m^2/W$) |
|---|---|---|
| A | Air Gap (1 mil)* | $9.37 \times 10^{-4}$ |
| B | eGRAF HT-1205** | $1.27 \times 10^{-5}$ |
| C | Bergquist Q-pad3 | $2.26 \times 10^{-4}$ |
| D | Wakefield Grease | $3.46 \times 10^{-5}$ |
| | Other (Specify) | |
| E | - - - - | - - - - |
| F | - - - - | - - - - |
| G | - - - - | - - - - |
| H | - - - - | - - - - |

*Air gap (1 mil) is equivalent to standard part to part contact, with no thermal interface material in between.

**No Need to specify thermal interface between the module and the heat sink. All Xicato Products ship with eGRAF HT-1205 thermal pad attached.

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## Luminaire Style

This section allows for the definition of the luminaire boundary conditions. Defining how your luminaire interfaces with the world will allow for more accurate simulation results, as the installed luminaire condition can greatly affect thermal performance. Walls, ceilings, and cavities influence airflow characteristics, and can therefore influence the results of an analysis.

Definition Procedure:

1. Select the style of luminaire by grabbing the yellow circle in the top right corner of the page and dragging it over the style of luminaire that closest represents your

design. Alternatively, you can paste a picture or drawing of the installed condition.

2. If the luminaire is in a cavity such as in ground or in a ceiling, please define the cavity dimensions and materials. Providing a CAD model of the cavity or IC box with your luminaire is very helpful. The difference in thermal performance between free air, a sealed cavity, and an insulated sealed cavity can be as much as 40°C.

## *Simulation Orientation(s)*

Orientation of the luminaire relative to gravity is very important and can have a dramatic effect on results. Most luminaires are cooled passively (natural convection – no forced air or fans), so buoyancy forces of air dominate air flow speed and direction. Depending on the purpose or type of the luminaire, an analysis may be required for as little as 1 or as many as 3 different orientations. A fixed vertical downlight for example, rests in the ceiling vertically, and cannot move, so only 1 orientation is required. This section defines the luminaire orientation relative to gravity.

1. Similar to the material definitions section, the easiest way to show orientation is with a picture. Using your CAD software, rotate the luminaire model into the desired orientation, do a screen capture, and paste into the corresponding blank orientation division. NOTE: It is not required to have exact rotation angles for the picture (meaning if 45° is required for analysis, the picture only has be angled at roughly 45°)

2. After pasting the image into the divided section, modify the yellow box indicating orientation angle relative to the gravity arrow in the "Legend" box. For reference, if a downlight is pointing down from the ceiling, the orientation is 0°.

If multiple orientations are required, repeat steps 1 and 2 above in the divided space provided. An example is provided below.

*Example:*
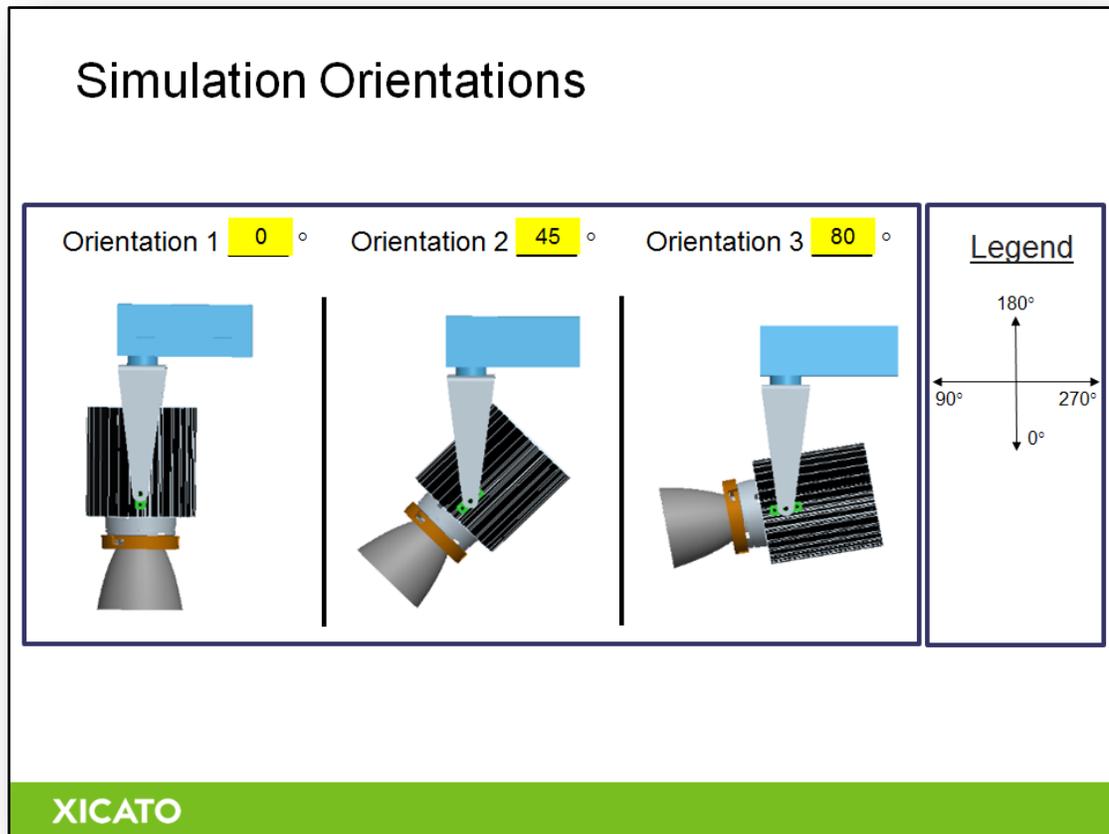


## System Definitions – Goals

This section allows for selection of the goal of the analysis.

Definition Procedure:

1. The "Goal of Analysis" field asks for information relating to the purpose of the analysis. There are three choices.
   A. Determine the Tc of a specific Xicato module installed in the luminaire
   B. Determine the maximum flux package of a Xicato product family the design is capable of accommodating.
   C. Perform a design optimization. Such as "What length of extrusion is required to maintain the Tc under 90°C in a 40°C ambient?"  Or "What is the performance impact of making the luminaire housing of cast aluminum vs.

machined 6063?" Please clearly define the unique goal. Paste pictures, sketches, or additional text in the blank space of this page to further explain the goal if required.

2. The "Maximum Ambient Air Temperature" field requires input for the maximum possible ambient air temperature immediately surrounding the outside of the luminaire. Because the purpose and type of luminaire vary greatly (outdoor fixture vs. indoor, track vs. recesses downlight), the maximum ambient can vary greatly as well. The default value is 40°C, but if another value is required, please change the text in the yellow box as instructed above. For most cases, a change in 1°C in ambient temperature will also change the luminaire temperature by 1°C. For example, if the analysis predicts a 70°C Tc value in a 25°C ambient air temperature, the analysis will predict 75°C in a 30°C ambient air temperature.

## System Definitions – Product Selection

This section allows for selection of the modules to be used in the analysis.

Definition Procedure:

1. The product selection table lists the various product ranges offered by Xicato, along with common drive currents that correspond to different power dissipations. Please select products and currents of interest by typing "X" into the designated areas.

## Final Notes:

- Once completed, please email your file back to thermal.sim@xicato.com in ppt format, along with your exported CAD files (please zip if more than 5 files).
- Simulation results should always be verified by making prototypes and comparing measured temperature values.
- Simulation does not qualify under the Xicato Luminaire Thermal Validation Program – see separate program requirements for details.
- Simulation results do not guarantee performance or lifetime: results should be used as design guidance only.
- Drivers and electronics can be simulated for system power dissipation, but due to complexities and accuracy issues with individual component temperatures (ie capacitors, ICs, etc.), temperatures of drivers and electronics will not be accurate and therefore not reported. Electronics temperature gradients shown in thermal plots should be disregarded.
- For additional help or information, please contact your Xicato technical representative, or email at support@xicato.com