

TARPTM v4.2

Thermal Analysis Results Processor

COVeRTM v4.2

Capture Output and Verify Results

October 2014

“Yeah, we’ve got that covered”

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What's new in Version 4

- Added StaticHeatMap as TARP/TARP Pro feature
- Added option at main GUI to toggle visibility of Nodes, Groups and Parameters in Working Node List
- Added support to truncate loading of very large node lists into WNL based on user specified criteria
- Added option to allow selected entities in WNL to be added to new objects
- Added option where multiple objects may be created and named at generation
- Added DescriptionFile where user may explicitly define Node Description instead of extracting from input or output files
- Added GroupLinkFile to continuously reference Groups from another Session
- Added support for COVeR, FLUINT Lump properties, and transposed generic text files for DataSets
- Allow support for up to 256 character submodel names
- Improved data storage structures to minimize memory usage for large models
- Improved time to read in data for DataSets with Referenced Nodes Only
- Fixed bugs associated with tarpParameter calculations in Excel®
- Allow data to be written beyond column 256 for Excel 2007® users
- Added feature to allow Groups to be Imported/Exported in simpler text format
- Time to reach or time outside limits added capabilities added to tables
- Alternate Node+Sheet Table output option added (allows Excel Filter to be used)
- Extended TARP calculation of Groups to Equivalent Sink temperatures
- Updated Group Modification within Excel to support TARP calculated workbooks and variable group levels
- Fixed bugs with Axes Max/Min auto determine algorithm for Plots/StripCharts
- Added better support for adding multiple groups including parent child relations
- Allow Groups and Groups Filters to be saved to and loaded from ASCII file
- Allow selection of timesteps for output to BinaryHeatMaps
- Group entry now allowed in Radk Manipulations
- Development of COVeR environment and capabilities
- Added ability of Working Node List to be populated by selection of Backloads, Binary HeatMaps or StaticHeatMaps
- Option to Optimize for Performance or Memory Usage
- Better support for running multiple TARP sessions in parallel
- 64 Bit version now available
- Installation no longer requires admin privileges
- Fixed various other bugs

What's new in Version 3

- Added StripCharts as TARP/TARP Pro feature
- Added RadkCompares as TARP Pro feature
- Checks included to ensure that Plot and StripChart Axes' Major Divisions do not exceed data range or create excessive gridlines
- Default Max and Default Min for Plots and StripCharts now determines appropriate integer multiples of Major Division for Axes values
- Allow user to include up to 6 User Points on Graphical Tables and to define Color, LineType, and Weight of Error bars
- Increased levels of child groups from 3 to 5
- User may now opt to be prompted to Remove or Promote deleted child groups
- Added options for user to control number of columns of groups for Excel output
- Added Weighting value for Group calculation. Use may select either node capacitances (SS or Transient average) or a user defined weighting file
- Added option for TARP to calculate Groups and Parameter values instead of Excel (much faster but loses automatic recalculation capability)
- Groups now allowed to be added to Backloads/Eq Sinks (previously only nodes were calculated)
- Group Eq Sinks weighted by Radk Sum
- Added support for lower temperature constraint and grey-body sink estimation
- Added support for T^4 averaging for Eq Sinks
- Added ability to add nodes and/or groups to binary HeatMaps. Groups are internally dereferenced to their constituent nodes. Any connections to specified nodes are included in the sub-network; all other connections are ignored. Useful for very large models or specific areas of interest.
- Added trace levels for Binary HeatMaps with nodes that traces out up to 5 levels of heat paths (or until terminated by specified boundary nodes) from base set
- Added option in HeatMaps to only calculate and store user specified combinations of Node-to-Node, Node-to-Group, Group-to-Node, and Group-to-Group heatflows
- Allow main process to run in background thread for better feedback at main GUI during run
- Support for Excel 2007 added
- Fixed various other bugs

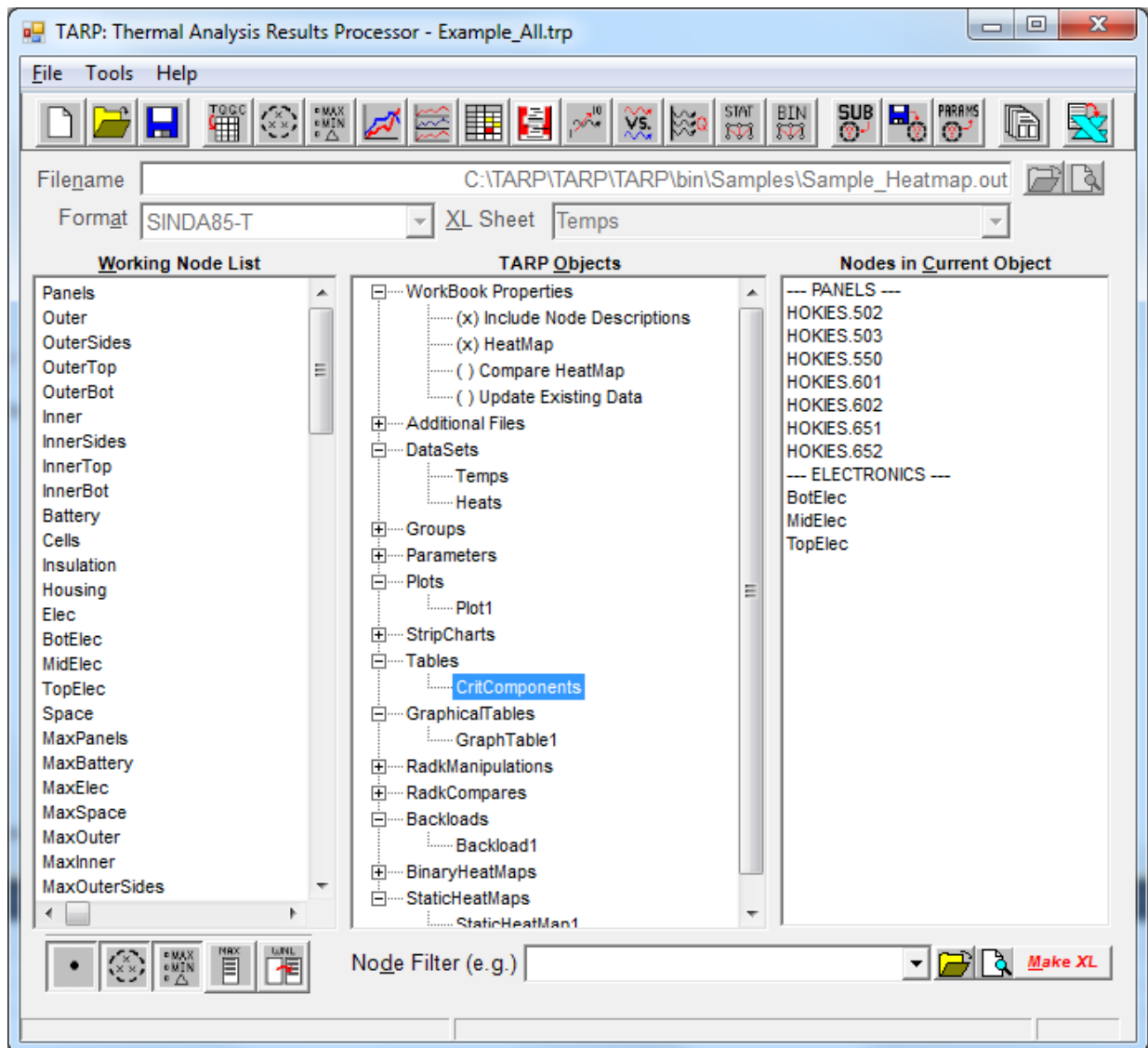
What's new in Version 2

- Added Binary HeatMaps as TARP Pro feature
- Added RadkManipulations as TARP Pro feature
- Added GraphicalTables as TARP Pro feature
- Added Backloads (and Equivalent Sinks) as TARP Pro feature
- Added “Make Max/Mins for Groups” to create MaxGroup and MinGroup Parameters for all defined Groups
- Table Max/Min Columns now reflects the MaxGroup/MinGroup parameter for a Group entry if it exists
- Added Expand.exe function to expand INCLUDED/INSERTed files in TMM
- Added Collapse.exe function to compress INCLUDED/INSERTed files in TMM
- Added ToCSV.exe to convert TMM output files to Comma Separated text file
- Added utility to identify Duplicate Conductor Numbers in SINDA file
- Improved selection capabilities in Working Node List
- Added option to Select All Groups in Working Node List
- Made significant improvements in calculation speed of Max/Min Parameters
- Allow reordering and grouping of nodes in objects
- Ability to modify existing group relations in GUI (e.g. make existing group a child of another)
- Nodes to be included in a Group may now be specified via a filter string
- Added capability to modify groups within Excel, update Workbook, and save group definitions to external file for later use in TARP
- Added Transient HeatMap capability
- Added TARP menu to output workbook to allow user to run macros to Update Groups, Make HeatFlow Matrix, Re-Calculate HeatMaps, and output Transient HeatFlows
- Table subheadings may now be shown as row grouping at left side of table
- Added Toolbar to main interface
- Improvement in speed for table creation
- Fixed various other bugs

1. Overview

Thermal Analysis Results Processor (TARP™) is a Windows® based, post-processing tool that interfaces with numerous commercial thermal solvers. The basic approach of TARP is to allow the user to define objects within the TARP environment, which are then used to create a Microsoft Excel® workbook containing the objects defined by the user. TARP is available in two versions: TARP and TARP Pro, with TARP Pro offering more objects for data processing.

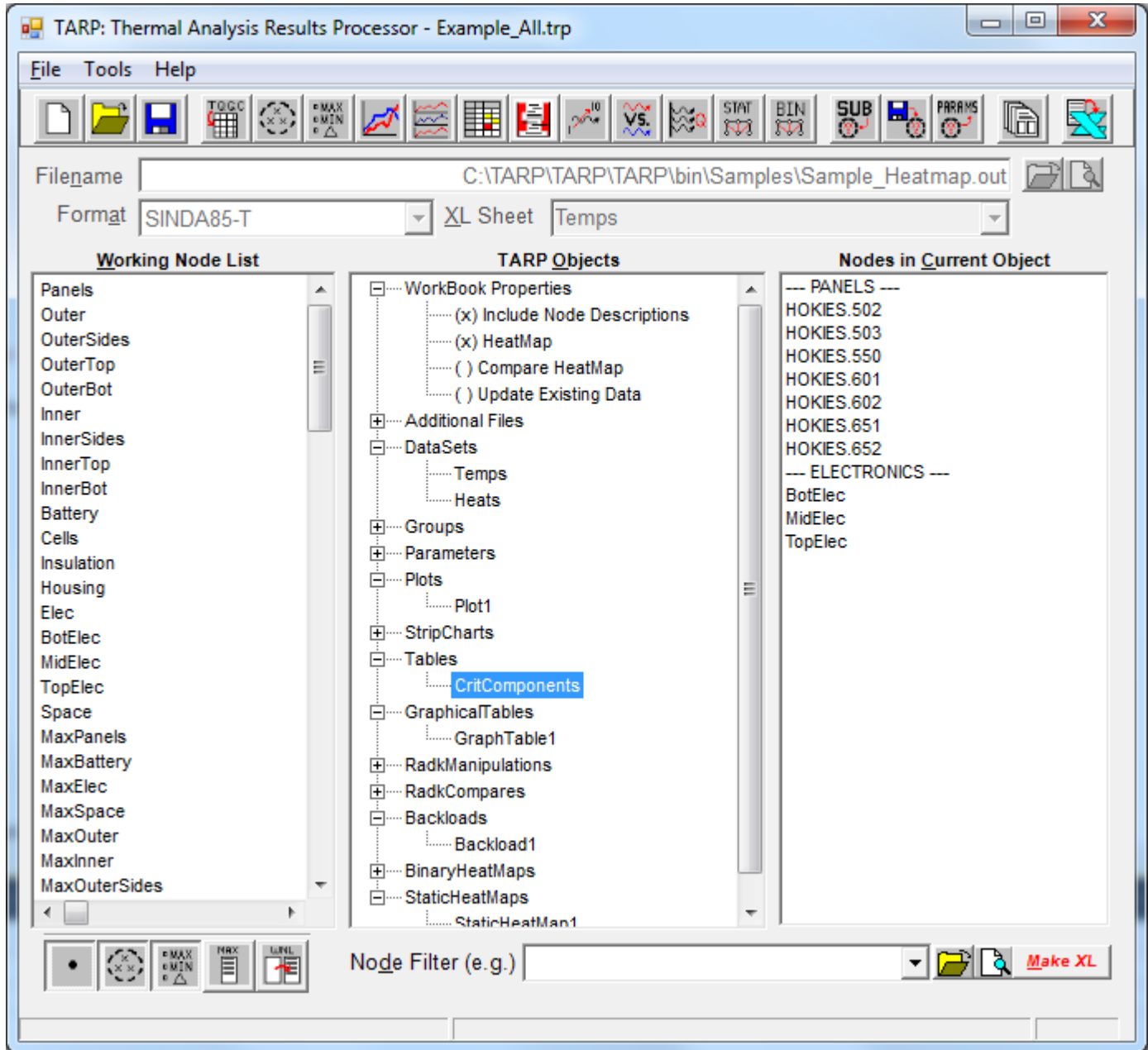
The TARP main interface (shown below) is where all objects are defined. From the main interface, the user defines the [properties of the output workbook](#), [specifies additional files](#) to be included, creates [DataSet](#), [Group](#), [Parameter](#), [Plot](#), [StripCharts](#), [Tables](#), and [StaticHeatMap](#) objects, adds/removes data from the objects, and creates the resulting workbook. TARP Pro users have the additional ability to create [RadkManipulation](#), [RadkCompare](#), [GraphicalTable](#), [Backload/Equivalent Sink](#), and [Binary HeatMap File](#) objects. Once the session is defined, it may be saved to a [session file](#) for later modification or retrieval. The *Make XL* button is used to generate the output workbook.



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2. Main Interface

The main interface for TARP™ is where the user defines the properties of, and objects to be included in, the output Excel® workbook. The user first selects any [Workbook Properties](#) as desired. Objects are then added to the session through the *TARP Objects* tree. Nodes for the current DataSet, as well as any defined Groups or Parameters, are displayed in the *Working Node List*. Filtering is used to display only nodes meeting the specified criteria. From here, a subset of nodes is easily selected from the *Working Node List* and added to objects in the *TARP Objects* tree. As objects are selected in the *TARP Objects* tree, the nodes associated with the selected object are shown in the *Nodes in Current Object* listbox.

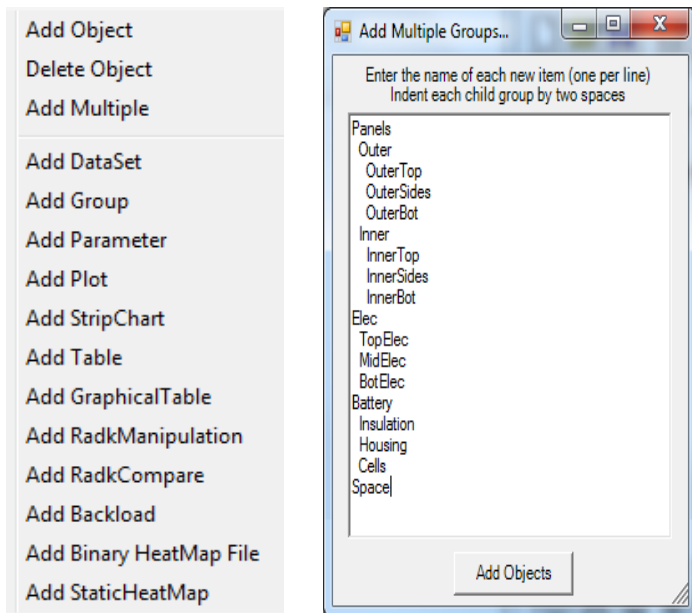


2.1 Working with TARP Objects

The *TARP Object* tree is where the user adds TARP objects to the current session. Available TARP objects include:

<i>ObjectType</i>	<i>HasProperties</i>	<i>HasNodes</i>	<i>Availability</i>
DataSet	Yes	No	TARP
Group	Yes*	Yes	TARP
Parameter	No	Yes	TARP
Plot	Yes	Yes	TARP
StripChart	Yes	Yes	TARP
Tables	Yes	Yes	TARP
StaticHeatMap	Yes	Yes	TARP
GraphicalTable	Yes	Yes	TARP Pro
RadkManipulation	Yes	No	TARP Pro
RadkCompare	Yes	No	TARP Pro
Backload	Yes	Yes	TARP Pro
Binary HeatMap File	Yes	Yes	TARP Pro

* Since groups only contain one property (*GroupFilter*), the property form displays the *GroupFilter* property for all groups rather than the single group that is selected



To add an object, the user right clicks in the *TARP Objects* tree to bring up a Context menu, shown to the left. If the user selects a specific object type (e.g. *Add DataSet*), then that object type is added. If the user selects *Add Object*, then the new object type is based on the currently selected object in the *TARP Objects* tree (e.g. if a Plot is selected, then a new Plot is created). If multiple objects are to be created at once (e.g. 5 Tables), the user first toggles the *Add Multiple* option on and then adds the object. When this option is checked, TARP prompts the user for the name of each object to be created, separated by a Carriage Return to define the hierarchy. Objects may also be deleted from the tree if they are no longer needed by selecting

Delete Object or pressing the Delete key. When adding a Parameter the parameter type must be further specified as described in the [Parameters](#) section. As objects are added to the tree, they are placed into the correct grouping (e.g. DataSet into DataSets, Plot into Plots, etc). One exception to this is the creation of Groups, since Groups may be nested up to five levels deep. If an existing Group is selected in the *TARP Objects* tree when a new group is created, the new Group is added as a child to the currently selected group. If an existing Group is not selected in the *TARP Objects* tree when a new group is created, then the new Group is added at the root level under Groups. Groups may be promoted/demoted by appending them to other existing groups using the *Make Child Group of* or *Make Sibling Group with* options.



The names of each DataSet, Plot, StripChart, Table, Graphical Table, RadkCompare and StaticHeatMap (and possibly Backloads if results are output to Excel) translate to sheet names in the resulting output workbook, and therefore must be unique. The Group/Parameter names translate to additional data points and must also be unique (but may duplicate sheet names). To rename an object from its default name, the user selects the object to rename, pauses for a moment, and clicks the object again. At this point, the name is selected in a local textbox and is able to be changed by the user. For DataSets, the name may also be modified by changing the *XL Sheet* field. All objects except Parameters have additional properties to fully define the object. These are accessed by double-clicking the object in the *TARP Objects* tree. The sheet name may also be changed on the properties form for each object. Properties for Groups are a special case; accessing the properties forms for Groups allows the user to update the [Group Filter](#) strings for all of the groups and not just the currently selected group. RadkManipulation, Backload, and Binary HeatMap objects generally create external files to Excel and therefore are not typically represented as sheets in the output workbook. Exceptions to this include the *List to Excel Sheet* option for RadkManipulations and the *Output Backloads to Excel Sheet* and *Output Equivalent Sinks to Excel Sheet* options in Backloads. With these options selected, backloads are output to a sheet name based on the Backload object name with “_BL” appended; similarly equivalent sinks are output with “_Snk” appended.

2.2 TARP Toolbar



A toolbar (shown above) is available to perform the most frequently used functions. The left three buttons are used to create a new, open an existing, and save the current session. The next block of buttons is used to add the various TARP objects to the session. The buttons represent, from left to right, a new DataSet, Group, Parameter, Plot, StripChart, Table, GraphicalTable, RadkManipulation, RadkCompare, Backload, StaticHeatMap, and BinaryHeatMap file. Selecting the Parameter button displays a popup menu for the user to select the type of parameter to create. The next button group allows for the creation of groups from submodels, the loading of groups from a file, and creating MaxGroup and MinGroup parameters from Groups. The next button is used to access the properties for the currently selected object. The last button is the equivalent of the Make XL button and is used to create the workbook once all objects have been defined.

2.3 Entering Filenames

When a DataSet or Additional File is selected in the *TARP Objects* tree, the *Filename* field is enabled for input, and the currently associated filename (if any) is displayed. Furthermore, for a DataSet, the *Format* and *XL Sheet* fields are enabled and display their respective data. Selecting the browse button  prompts the user for the filename to associate with the selected DataSet or Additional File. The selected file may also be viewed in a Text Editor (or Excel® for the output file) by selecting the preview button. 

When a new file is selected for a DataSet, TARP attempts to determine the format (e.g. SINDA85, ESATAN, etc.) based on a header found in the first lines of the file. If the determined file format (e.g. SINDA/G) matches the displayed format (e.g. SINDA/G-Q), then the *Format* field is not changed. However, if the determined format (e.g. SINDA/G) does not match the displayed format (SINDA85-Q), then the displayed format is updated with the assumption that the user will process



temperatures (SINDA/G-T). The format may always be changed after the file is selected. The *XL Sheet* field shows the name of the DataSet, which defaults to Data1, Data2, Data3, etc. unless the *Sheet Names Same as Filenames* preference is enabled (through the [Preferences](#) form). If this option is enabled, then the DataSet name is based on the base filename, as long as no duplications occur (e.g. two DataSets with the same filename).

2.4 Using the Working Node List

Once the filename for a DataSet has been selected, the nodes or conductors contained in the file are displayed in the *Working Node List*. This list may be filtered by entering the desired range in the *Node Filter*; only entries meeting the user-specified criteria are then displayed in the *Working Node List*, allowing the user to display only a subset of interest. Values may be entered as either single values (SUB.100, 200) or ranges (SUB.1-100, 1-200), with multiple entries separated by commas (1-10, SUB.20). If no submodel is specified in a filter entry, then any values meeting the criteria are displayed, regardless of submodel (e.g. 1-10 would display INST.1 or SC.1). The * wildcard is allowed in the submodel name (e.g. HOK*.1-99). If a SINDA85 model is loaded, then a list of submodels from the file is stored in the *Node Filter* combo box for quick filtering. If Groups are defined, then a *Not In Group* option exists to show all nodes not included in a group. All defined Groups and Parameters are displayed at the beginning of the *Working Node List*, regardless of the filter criteria. Options exist in the [Preferences](#) to display only nodes, Groups, Parameters, or any combination thereof in the *Working Node List*. This may be helpful if a user wishes to only work with groups or nodes. The *Working Node List* is intended to be a frequently changing list as the user decides which nodes and conductors are needed for which objects and changes the list accordingly.



There is also a toolbar below the *Working Node List* which allows the user to toggle the display of Nodes, Groups, and/or Parameters without having to go through the *Preferences* form. Additionally, this toolbar allows the user to specify the maximum number of entries to be loaded into the *Working Node List* to minimize the wait time if conductors are selected, which may well number into the millions of entries. Lastly, a button exists to refresh the *Working Node List* based on the selected object.

A user may also load a node selection file if desired. Clicking the Browse button to the right of the *Node Filter*  prompts the user for a .sel file. This file is processed and each line is one entry in a filter criteria string. The file name is then displayed in the Node Filter combo-box and the nodes in the *Working Node List* are filtered accordingly. To preview or modify this file, the user may select the preview button to the right of the *Node Filter* .

2.5 Adding Nodes to TARP Objects

Add to Current
Add to Group ▶
Add to Parameter ▶
Add to Plot ▶
Add to StripChart ▶
Add to Table ▶
Add to Graphical Table ▶
Add to Backload ▶
Add to Binary HeatMap ▶
Add to StaticHeatMap ▶
Delete Selected
Delete Unselected
Select All Groups
Save Selection to File
Submodels to Groups
Load Groups from File
Make Max/Mins for Groups

Once the user has selected a collection of desired Nodes, Groups and Parameters in the *Working Node List*, they may then be added to a TARP object via two methods. The first is to select the desired nodes and right click to display the Context Menu shown to the left. From here, the user may add the selected nodes to the current object or specify the object through the menus. The second method is to drag them from the *Working Node List* and drop them onto the desired object in the *TARP Objects* tree. Not all object types accept inputs from the *Working Node List*; DataSets, RadkCompares, and RadkManipulations do not include nodes as part of their definition. Furthermore, Groups cannot accept another group or parameter for inclusion, only nodes. If nodes have been added to an object, but are no longer desired, they may be deleted from the *Working Node List* by pressing the Delete key or selecting the *Delete Selected/Delete Unselected* options. Capabilities also exist for the fast creation of Groups and Parameters. Groups may be created based on the submodels (for submodel supported output) or loaded from an existing file. This is discussed further in the [Groups](#) section. MaxGroup and MinGroup parameters may also be automatically

created for all defined groups by selecting the *Make Max/Mins for Groups* option.

2.6 Working with Nodes in a TARP Object

Move Up
Move Down
Group Selected
Select All
Deselect All
Delete Selected
Delete Unselected
Save Selection
Decompose Group to Nodes
Demote to ChildGroup ▶
Promote to ParentGroup
Reverse Difference
Change Source ▶
Change Axis
Change Source ▶
Move to StripChart ▶
Insert Table SubHeading

When an object is selected in the *TARP Objects* tree, or when nodes have been added to the current object, the associated nodes are displayed in the *Nodes in Current Object* listbox. For Plots, additional information is also shown in the *Nodes in Current Object* listbox for each entry, including the source DataSet for the series and the plot axis (Primary or Secondary). StripCharts similarly show the Source and Sub-chart. For a Difference Parameter, an additional “+” or “-” prefix is shown to indicate that one node is subtracted from the other. A Context Menu (accessed by a right click) allows the user to further manipulate the nodes in an object. Nodes may be reordered, selected, deselected, or removed from an object. Node selection may also be saved to an external file for later use by the *Node Filter* in retrieving the same node sets in another session. Furthermore, the order of the nodes may be changed by selecting the desired node(s) and clicking *Move Up* or *Move Down*. Alternately, this may be accomplished using the up/down cursor keys while holding the Alt key down. The selected nodes may

also be grouped together to combine related nodes. For example, if nodes 1-6 were included in the list and all the odd nodes were selected, selecting *Group Selected* would then combine all the odd nodes sequentially. As a result, the even nodes would be moved to the end of the selected nodes,

resulting in a 1,3,5,2,4,6 ordering. This is useful for grouping together related nodes (e.g. for a particular subsystem or component) without having to add them to the list in the desired order. The Decompose Groups to Nodes option allows the selected group to be replaced or supplemented by the nodes it defines. This is helpful to quickly include the associated nodes in a Table or Plot or other object.

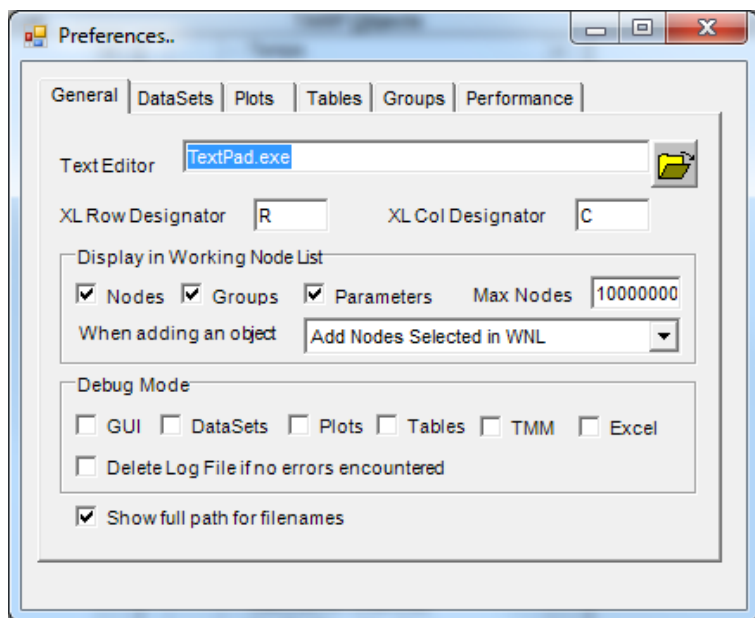
Object specific modification capabilities are also provided. If the current object is a Plot, then the user is able to change the source DataSet or the plotting axis for any series. If a StripChart, then the SubChart may be specified. If it is a Table, then the user may *Insert Table SubHeadings* (see [Table Output](#) for an example). If the current object is a Group, the nodes defined in the group may be promoted into its parent group or demoted into existing or a new child group. Lastly, if the current object is a Difference type parameter, then the order of the two nodes may be reversed. Each of the options beneath a blue line in the image is only available for appropriate object types.

2.7 Saving and Loading Sessions

Once all the objects are fully defined in the TARP environment, the session may be saved for later use. Under the File menu, the user has options to Save, Open, Edit, or create a New session file. The session files are simple ASCII files that store all properties for every object defined. Further information is found in the section on [Sessions](#). The four most recently opened or saved sessions are also displayed under the File menu.

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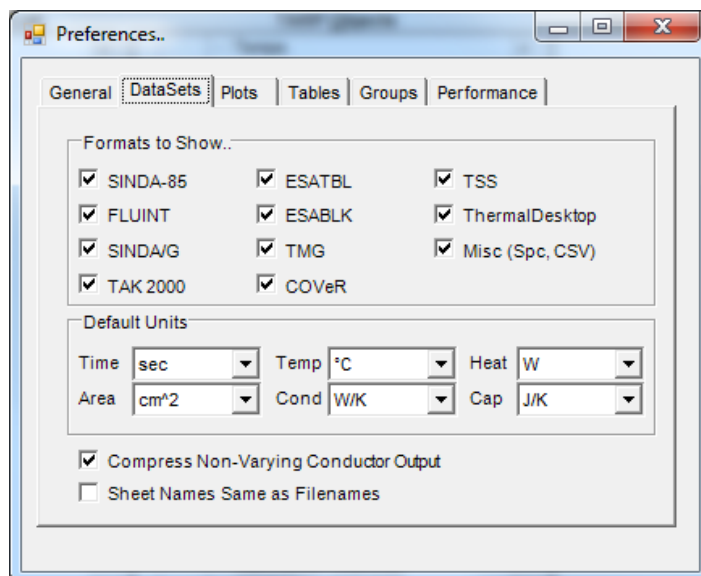
3. Preferences

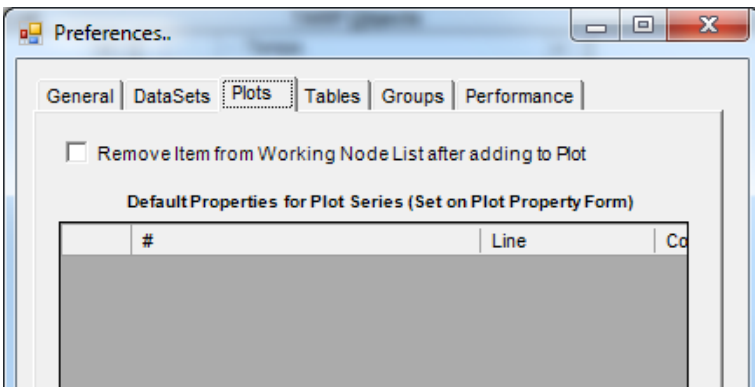


A number of preferences to control the behavior of the TARP™ interface and output workbook are accessible under the Tools menu. The *General Tab* allows the user to set the *Text Editor* to be used for previewing files. An option is also available for displaying full paths to filenames or simply the basename and extension. This is useful when a file is nested many directories deep and the filename cannot be seen in the text box without scrolling. If the user is only interested in working with Nodes, Groups, Parameters or combinations thereof, options are available to display only the selected entity type(s). The maximum number of entries to load into the Working

Node List can also be specified to minimize the wait time to load huge data sets (e.g. for conductors, which may number well into the millions). An option also exists to determine how TARP should behave when a new object is created. The three options are: just add the object, add the object with no nodes, add the object and add the nodes selected in the Working Node List to the new object, or prompt the user for what to do. Debug modes also exist, which report numerous breakpoints in the code to indicate progress. This is intended to be used to help troubleshoot locations in the code where an unhandled exception may have occurred, without the need for a user to provide files to the software vendor for debugging purposes (e.g. proprietary models).

For DataSets, the *Formats to Show* frame has a listing of all supported output file formats. Only those that are checked are displayed in the *Format* field at the main interface and the DataSet properties form. For example, if a user only needs SINDA/G outputs, then all other formats could be removed from the display by unchecking all options except SINDA/G. Default units for DataSets may also be set and applied to all new DataSets. An option also exists to *Compress Non-Varying Conductor Output*. This saves significant space in the output workbook, as a constant conductor is only output once, instead of at each timestep. Lastly, the Excel® SheetName may be automatically set to the base name of the file. This capability may not function if the same filename is used for multiple datasets (e.g. Temp and Heat from same file).

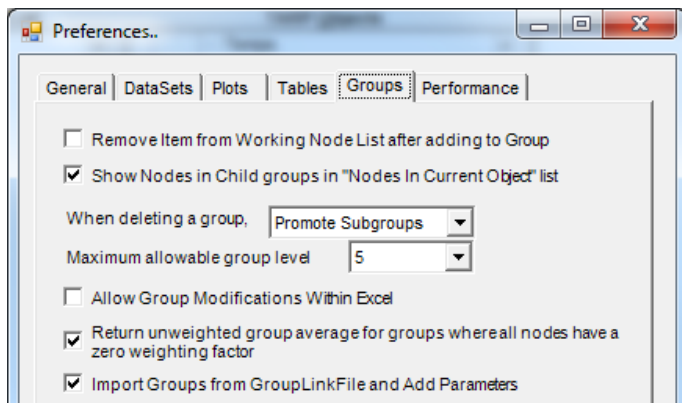
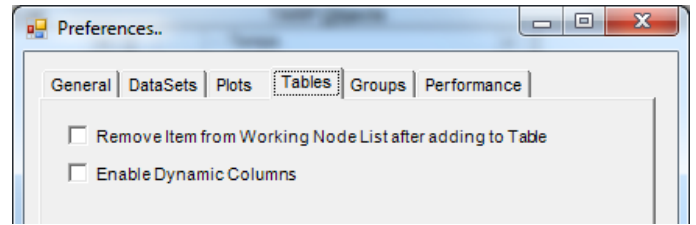




As nodes are added to an object from the *Working Node List*, they may be automatically removed from the *Working Node List* as they are added to a Plot, Table, or Group. This is helpful to see what nodes remain that have not yet been included on a Plot, Table, or Group. The default series characteristics for plots are also displayed, including: line type, color, weight, marker symbol, fore color, back color,

size, shadow, and frequency. While these values cannot be changed here, it does provided a simple view of what values will be assigned to series as they are added to a plot. The values themselves are defined at the [Plot Properties](#) form for any plot.

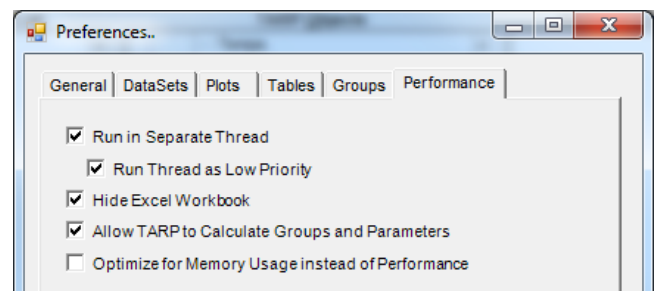
Tables include an option for the creation of *Dynamic Columns*. This allows the user to define the source sheet and source parameter for each column of simple values by selecting the appropriate values from dropdown listboxes in the Excel® Workbook.



For groups, an option exists to either delete subgroups when a group is deleted, promote the subgroups up to the next level, or to prompt the user when a group is deleted. The *Maximum allowable group level* controls how many columns to allocate for groups on the DataSet worksheets. If Auto is selected, then the maximum level of subgroups determines the number of columns (e.g. 2 columns if groups only go to Minor level). An option also exists to prevent a Divide by Zero error

for weighted group calculations when the sum of weighting factors for a group is zero. Furthermore, nodes displayed in a group may be controlled to either display only the nodes defined in the group, or to include all nodes contained in child groups of the selected group. The option to *Allow Group Modifications Within Excel* is used to signal to TARP to create the workbook from the template which includes the macros to allow the user to access the group modification from within Excel as described in [Creating and Using the Workbook](#).

Lastly, some options exist to improve the performance of TARP. Running the main calculations in a separate thread allows the main interface to update even when the screen is moved, resized, or minimized or when other windows are dragged over top of it. The user may also opt to expose the Excel workbook during TARP



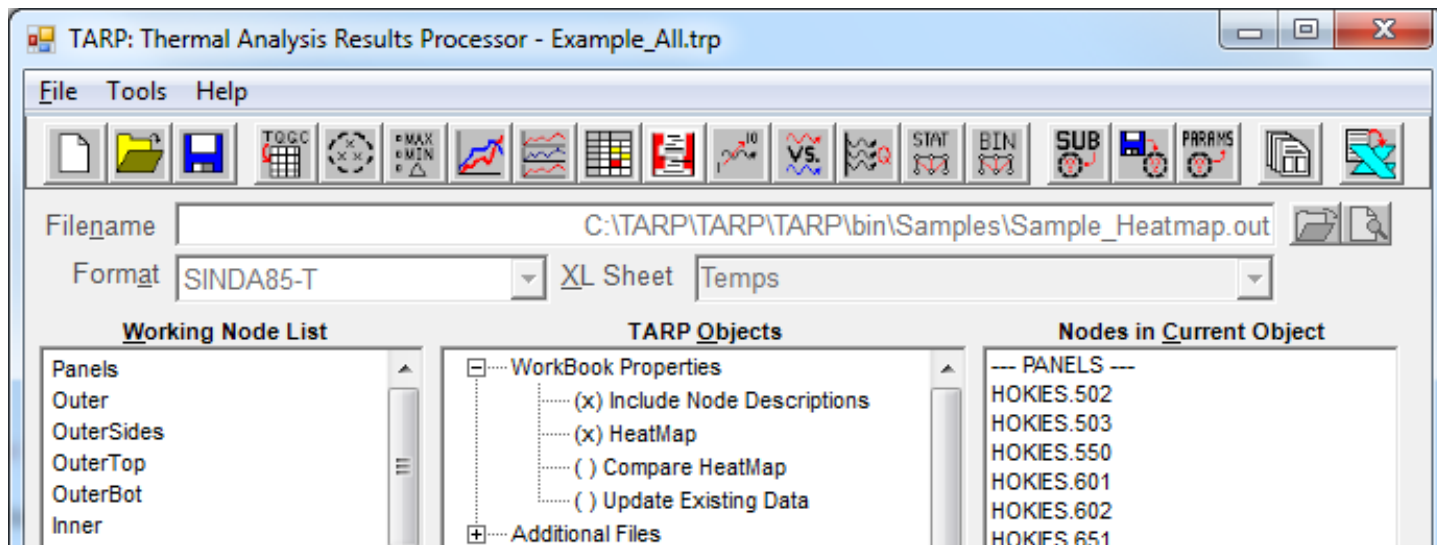
execution. This may be useful if TARP encounters an error to see how far it has gotten in the creation of the workbook. Allowing TARP to Calculate Groups and Parameters is much faster than relying on Excel. The formulas for Group lookup and calculation, as well as Parameter

calculation are preserved as the first row (for Group Lookups), the row containing the first Group (for Group Calculation) and the row containing the first Parameter (for Parameter Calculation) should the user need to re-evaluate the formulas due to a group definition change. The last option allows TARP to Optimize for minimum memory usage during processing instead of using more memory to optimize speed in processing the files. If OutOfMemory exceptions are thrown while trying to process a file, checking this option *may* resolve that issue. OutOfMemory are very unlikely if using the 64 bit version of TARP and it is recommended to upgrade to this version if memory issues persist with an end user's models.

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4. Workbook Properties

Properties for the workbook are selected under the *WorkBook Properties* branch in the *TARP Objects* tree. Selected options are indicated by an (x). Clicking the option toggles the value between selected and not selected. Available workbook properties include: *Include Node Descriptions*, *HeatMap*, *Compare HeatMap*, and *Update Existing Data*.



4.1 Including Node Descriptions

The *Include Node Descriptions* option requires either the thermal model input file (for SINDA85, SINDA/G, and TAK2000), a PRNDTB call for ESATAN output, or a user specified [DescriptionFile](#). For thermal model input, two types of comments are processed: in line comments, and block comments. For the following NODE DATA section, the in-line comments are what appear after the comment character (\$), and the block comments are what appear before the block of nodes. Therefore, “Panel Nodes” is the Block description for Node 10, and the in-line comment is “Upper Panel”. For ESATAN, a PRNDTB is expected prior to any other calls with the ‘L’ zent included. For TMG, no option currently exists to associate nodes with descriptions from an input model file, but the [DescriptionFile](#) may be used.

```
C      Panel Nodes
C
      10, 10.0, -1.0    $ Upper Panel
      20, 10.0, -1.0    $ Lower Panel
```

The outputs from this data are stored on the NodeInfo sheet created in the output workbook. The first two columns (A and B) are reserved for the Block Description and the Node Description respectively, while the third column displays the node number. This range of data in Excel® is subsequently used by Plots, StripCharts, Tables, Graphical Tables, and HeatMaps to display the Node Description along with the node number. Should the user wish to change this data, it need only be changed on the NodeInfo worksheet to propagate to all other references throughout the workbook.

4.2 Updating Existing Data

The *Update Existing Data* option allows the user to update only the data contained in DataSets. It does not generate any of the other objects specified in the session. Upon specifying an Excel Output File with this option enabled, the specified workbook is scanned to determine the names of all existing sheets. If the specified worksheet name already exists, then only the data is updated; the Group, Minimum, Average, and Maximum formulas are not updated. However, if a *new* worksheet name is specified, then this sheet will be *added* to the workbook and *will* include the Minimum, Average, and Maximum formulas as well as the Group definitions. If plots or tables exist in the output workbook, then the data needs to be in exactly the same order and have the same number of timesteps to ensure that all Plots/Table formulas still reference the correct rows and columns.

4.3 Creating HeatMaps

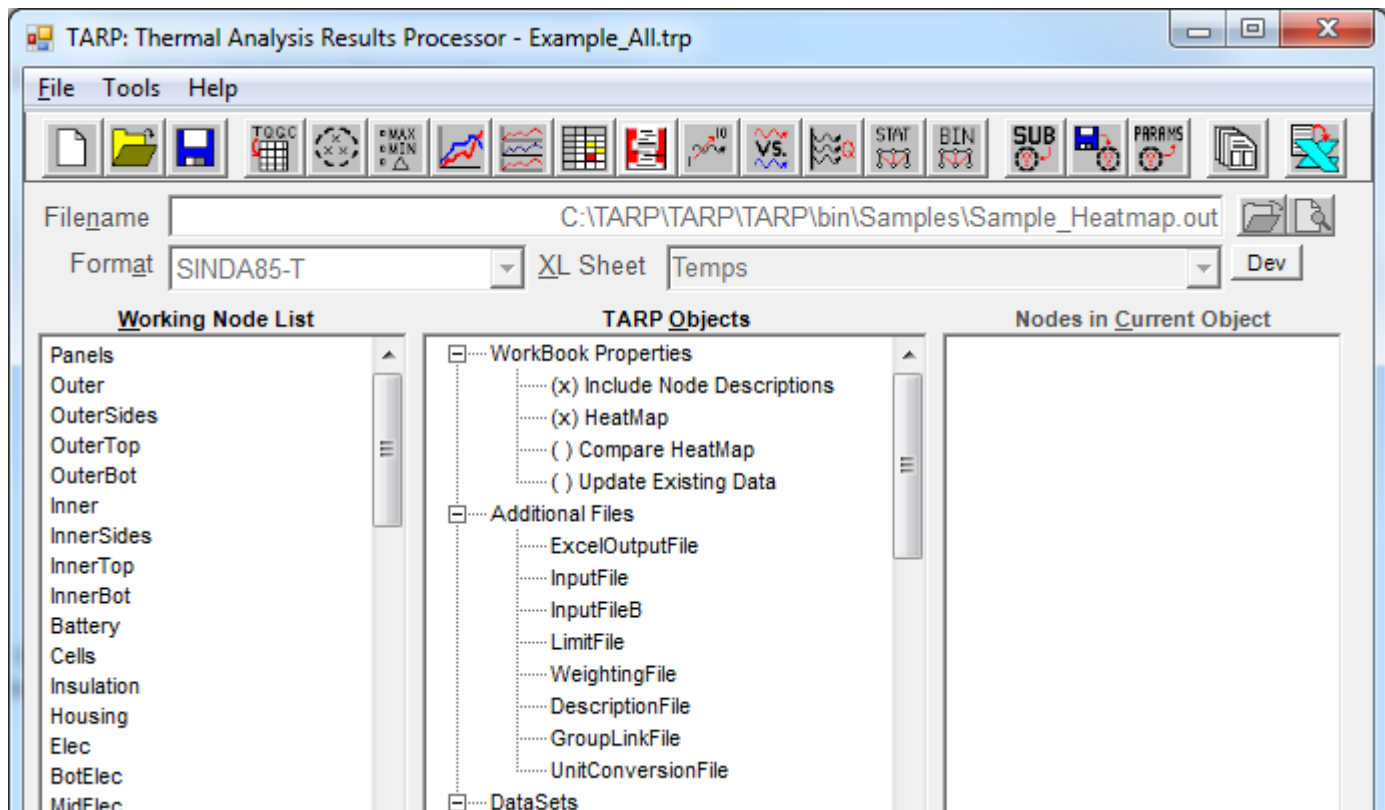
The *HeatMap* and *Compare HeatMap* options create a specialized, *interactive* workbook to investigate heat flow between nodes and/or groups of nodes. This workbook type requires Temperature, Heat, and Conductor data for *each output timestep*. Upon selecting the HeatMap option, TARP Pro users are prompted to create DataSets or Binary HeatMap Files. TARP users automatically default to DataSets. If DataSets is selected for the HeatMaps, all existing DataSets are deleted and three pre-defined DataSets are created: Temp, Heat, and Cond. Similarly, selecting the Compare HeatMap option with DataSets removes all existing DataSets and creates 6 pre-defined DataSets: TempA, HeatA, CondA, TempB, HeatB, and CondB. Additional DataSets may not be created or existing DataSets deleted when HeatMap options are enabled. For further information, see the [HeatMaps](#) section.

Certain combinations of Workbook properties are not allowed. For example, selecting the HeatMap does not allow the user to also select Compare HeatMap. Furthermore, selecting either HeatMap option automatically enables the [Include Node Descriptions](#) option, as the input file must be processed for Node Descriptions used in the HeatMap output as well as the node pairs for each conductor (for SINDA85, SINDA/G, and TAK2000). For ESATAN output, the node pairs and node descriptions are available in the output file, therefore, the input file is not needed.

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5. Additional Files

Additional files may also be needed to create the workbook. The Excel Output filename, Thermal Model input file(s), user Limit Files, Weighting Files, or Description Files, and Unit Conversion files may all be specified and used in the creation of the final workbook.



5.1 Excel Output File

The *ExcelOutputFile* specifies the path to the output workbook generated by TARP, which is blank by default. If the value is blank and a file for a DataSet is selected, then the *ExcelOutputFile* is updated to have the same base name and path as the filename specified for the DataSet. If the user then selects another file for the first DataSet, the *ExcelOutputFile* is not changed unless it was made blank prior to the second file selection. Therefore, some care should be taken when continuously working in the same session. Creating a new session resets the *ExcelOutputFile* to a blank value. It is recommended that the user explicitly specify the *ExcelOutputFile* file, but the default behavior allows for a meaningful name to be assigned to the output workbook if the user does not specify it explicitly.

5.2 Input Files

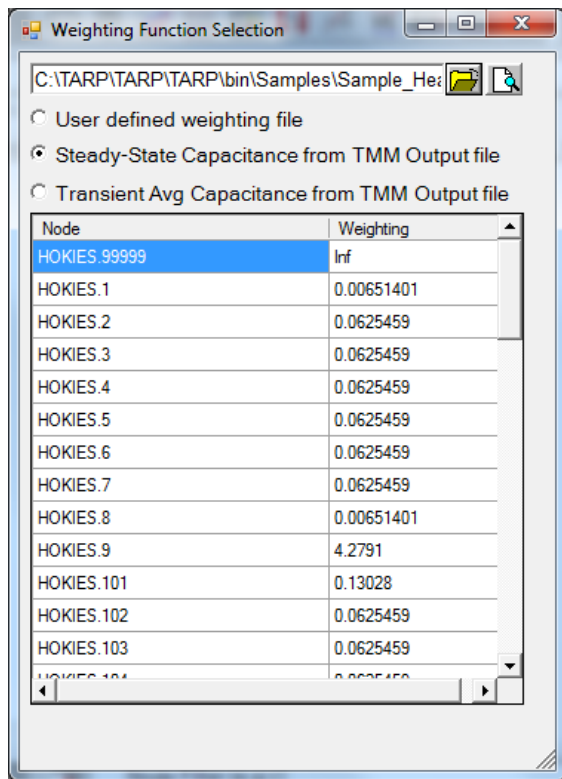
The *InputFile*(s) are used for two separate sub-tasks. If the user has enabled the [Include Node Descriptions](#) workbook property, then the input file is used to extract the node descriptions. Furthermore, if the user has specified the [HeatMap](#) or [CompareHeatMap](#) workbook property, then the thermal model input file is necessary to extract the node pairings for each conductor for SINDA85, SINDA/G, and TAK2000.

5.3 Limit File

The *LimitFile* is a user-created file that defines limits to be applied to Nodes or Groups in a comma-separated format. The first line of this file should include the word Node followed by the limit names desired by the user. Once a *LimitFile* is specified, the limit names, as defined on the first row, are available for inclusion in any table or graphical table. A sample format is shown below.

```
Node, Red High, Yellow High, Yellow Low, Red Low
INST.1, 45, 40, -30, -35
INST.12, 40, 30, -30, -40
...
```

5.4 Weighting File



The *WeightingFile* is another user-defined file that specifies the weighting factors to apply to each node for the purposes of calculating an average temperature that is representative of the group. The Group temperature is calculated from $T_{group} = (\sum(w_i * T_i) / \sum w_i)$. Weighting factors can be used to more heavily favor some temperatures and neglect others. For example, the temperature of a massive diffusion node might be more relevant than an MLI node for groups with both nodes.

A common and quick method to select relevant nodes is by nodal capacitance. Two options are available to evaluate and apply the nodal capacitance as the weighting factor: capacitance based on steady state temperatures and orbit average capacitances. Once these values have been read from the selected file, they are displayed in the form. Upon closing the form, the user is prompted for a file to save the data for later use. Arithmetic nodes are assigned a zero

weighting factor; boundary nodes, being of infinite mass are excluded by also assigning a zero weighting factor.

5.5 Description File

The *DescriptionFile* is a user-created file that defines descriptions to be applied to nodes in a comma-separated format. The first line of this file should be a header such as "Node,Description". All subsequent lines should be a node number followed by a comma followed by the descriptions, as shown below. Commas are allowed in the description.

```
Node, Description
INST.1, Avionics Panel, Top
INST.12, Avionics Card
...
```

5.6 GroupLink File

The *GroupLinkFile* allows the current session to always reference Groups from another specified session. This is helpful when numerous cases are developed for various configurations of models. Making a change to the Groups in the base session file would impact all others rather than having to import into all other destination sessions when a change is made in one. This option also automatically creates MaxGroup and MinGroup parameters for all the Groups. The Groups from the base file are imported at load time. Once the session is loaded, changes made to the base session are not updated until the next session load.

5.7 Unit Conversion File

The *UnitConversionFile* is another user-defined file that specifies the necessary coefficients to convert from one set of units to another for DataSets. The following Unit conversion coefficients are included; should the user need units not supplied, this file may be modified to include new unit sets. However, it is advised to include unit conversions for all other units available for the Unit Type. (i.e. if the user adds a new heat unit, include conversion to all other existing heat units)

Unit Type	From Unit	To Unit
Time	S	min
Time	S	hr
Time	S	day
Time	min	s
Time	min	hr
Time	min	day
Temperature	°C	K
Temperature	°C	°F
Temperature	°C	R
Temperature	K	°C
Temperature	K	°F
Temperature	K	R
Heat	W	J/min
Heat	W	BTU/hr
Heat	W	BTU/min
Heat	J/min	W
Heat	J/min	BTU/hr
Heat	J/min	BTU/min
Lin Cond	W/K	J/min/K
Lin Cond	W/K	BTU/hr/R
Lin Cond	W/K	BTU/min/R
Lin Cond	J/min/K	W/K
Lin Cond	J/min/K	BTU/hr/R
Lin Cond	J/min/K	BTU/min/R
Rad Cond	cm ²	m ²
Rad Cond	cm ²	ft ²
Rad Cond	cm ²	in ²
Rad Cond	m ²	cm ²
Rad Cond	m ²	ft ²
Rad Cond	m ²	in ²
Capacitance	J/K	W min/K
Capacitance	J/K	BTU sec/min/R
Capacitance	J/K	BTU/R
Capacitance	W min/K	J/K
Capacitance	W min/K	BTU sec/min/R
Capacitance	W min/K	BTU/R

Unit Type	From Unit	To Unit
Time	hr	s
Time	hr	min
Time	hr	day
Time	day	s
Time	day	min
Time	day	Hr
Temperature	°F	°C
Temperature	°F	K
Temperature	°F	R
Temperature	R	°C
Temperature	R	°F
Temperature	R	K
Heat	BTU/hr	W
Heat	BTU/hr	J/min
Heat	BTU/hr	BTU/min
Heat	BTU/min	W
Heat	BTU/min	J/min
Heat	BTU/min	BTU/hr
Lin Cond	BTU/hr/R	W/K
Lin Cond	BTU/hr/R	J/min/K
Lin Cond	BTU/hr/R	BTU/min/R
Lin Cond	BTU/min/R	W/K
Lin Cond	BTU/min/R	J/min/K
Lin Cond	BTU/min/R	BTU/hr/R
Rad Cond	in ²	cm ²
Rad Cond	in ²	m ²
Rad Cond	in ²	ft ²
Rad Cond	ft ²	cm ²
Rad Cond	ft ²	m ²
Rad Cond	ft ²	in ²
Capacitance	BTU sec/min/R	J/K
Capacitance	BTU sec/min/R	W min/K
Capacitance	BTU sec/min/R	BTU/R
Capacitance	BTU/R	J/K
Capacitance	BTU/R	W min/K
Capacitance	BTU/R	BTU sec/min/R

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6. DataSets

DataSets create Excel® worksheets that contain the raw data from the thermal model output file. The user has options to specify the Source File, Format, Parameter, and worksheet name. Further options are also available under the DataSet properties form, including: unit conversion, transposing of the output, selecting nodes for output, selecting timesteps for output, inclusion of additional output points (e.g. Minimum, Maximum, etc.), and the definition of the last cycle for cyclical output.

DataSet Properties for Temps

Filename: C:\TARP\TARP\TARP\bin\Samples\Sample_Heatmap.out

Format: SINDA85-T | XL Sheet: Temps

Unit Conversion

	From	To
Time	hr	sec
Temperature	°F	°C

Output Options

Additional Parameters

- Minimum
- Average
- Maximum
- Time Min
- Time Max
- Delta

Output Only..

- ..Referenced Nodes
- ..meeting Filter Criteria
- Transpose Output

Output Timestep Patterns

Include: 1 Timesteps | Skip: 0 Timesteps

Total Number of Timesteps: 222
Total Number of Output Timesteps: 24
Total Number of Timesteps in Last Cycle: 22

Output Timesteps

- 5995.08
- 5995.116
- 0
- 299.754
- 599.508
- 899.262
- 1199.016
- 1498.77
- 1798.524
- 2098.278
- 2398.032
- 2697.786
- 2997.54
- 3297.294
- 3597.048
- 3896.784
- 4196.556
- 4496.328
- 4796.064
- 5095.836
- 5395.572
- 5695.344
- 5995.08
- 5995.116

Last Cycle Definition

- 5995.08
- 5995.116
- 0
- 299.754
- 599.508
- 899.262
- 1199.016
- 1498.77
- 1798.524
- 2098.278
- 2398.032
- 2697.786
- 2997.54
- 3297.294
- 3597.048
- 3896.784
- 4196.556
- 4496.328
- 4796.064
- 5095.836
- 5395.572
- 5695.344
- 5995.08
- 5995.116

6.1 Supported Formats

TARP can process a number of commercial thermal solver outputs. For each of these, the common ASCII output from the various output subroutines (e.g. TPRINT for SINDA/G) can be processed, as well as output from some Radiation solvers. The following formats and parameters are supported:

Format	Parameters
SINDA85 & SINDA/FLUINT	T, Q, G, C
FLUINT	LT,LP,LX,LV,LD,LH,LQ,LM
SINDA/G	T, Q, G, C, F
COVeR	T,Q,G,C, Sink, BL, Env
ESATAN (PRNDBL)	T, Q, QS, QA, QE, QI, QR, G, GL, GR, C
ESATAN (PRNDTB)	T, Q, QS, QA, QE, QI, QR
ESATAN (GFF)	T, Q, QS, QA, QE, QI, G, GL, GR, C
TMG	T, Q
TAK2000	T, Q, G, C
TSS	Q, Q''
ThermalDesktop	Q, Q''
Comma, Space, or Tab Delimited	T, Q, G
Comma, Space, or Tab Transposed	T, Q, G

6.2 Converting Units

Unit conversion is based on the conversion coefficients provided in the [UnitConversionFile.csv](#) specified under Additional Files. Only units applicable to the current parameter are displayed. The units available are based on those contained in the UnitConversionFile, as well as the conversion coefficients used in the resulting formulas. Both Linear and Radiative conductors may be converted independently. For heat flux from a Thermal Radiation output file (e.g. ThermalDesktop), the area component may also be converted independent of the energy term.

6.3 Filtering Nodes and Timesteps

Selected nodes may be output using one of two methods. Selecting *...Referenced Nodes* outputs only nodes that are used in a Plot, StripChart, Table, Graphical Table, Group, or Parameter; all unused nodes are not output. The second method is to explicitly specify the nodes to output using the *...Meeting Filter Criteria* option. In this case, all nodes are processed, but only those meeting the specified filter criteria are output. The filter criteria is based on the same rules for the [Node Filter](#) used at the main interface. Filter entries may be entered as either single nodes (SUB.100, 200), ranges of nodes (SUB.1-100, 1-200), or a combination thereof, with multiple entries separated by commas (1-10, SUB.20). If no submodel is specified in a filter entry, then any nodes meeting the criteria are displayed, regardless of the submodel (e.g. 1-10 would display INST.1 or SC.1). The * wildcard is allowed in the submodel name (e.g. HOK*.1-99). Use of node filtering *may* result in improved performance to process the file for certain source formats that utilize submodels. The submodels from user specified criteria or referenced nodes are used to bypass submodel data in the output that is not needed, reducing the time to process the output file.

Specific timesteps may also be selected for output by highlighting the desired timesteps in the *Output Timesteps* listbox. A user may output repeating patterns of timesteps using the *Include/Skip* values. An *Include* of 1 and a *Skip* of 1 would output every other timestep; an *Include* of 1 and a *Skip* of 4 would output every fifth timestep. This is useful to output the trends for numerous data points without having to output each point.

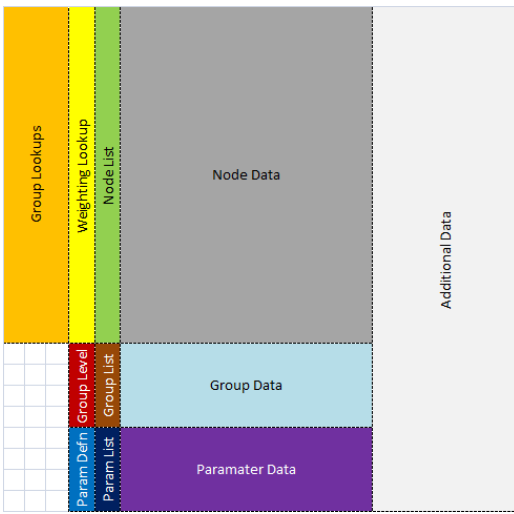
6.4 Defining the Last Cycle

The *Last Cycle* is used for cyclical output (e.g. 0-6000, 0-6000, 0-6000...) to define the time range for plotting and the range over which to compute the *Additional Parameters*. By default, TARP starts at the last timestep and checks if the preceding timestep is smaller. If so, it continues tracing back until a timestep value greater than the current location is found or a steady state result or initial condition is found. The user may over-ride the default selection by specifying their own range as the last cycle. Once this is set, the user may opt to include additional output such as the Maximum, Average, or Minimum over this range, the timesteps where these occur, or the Delta (Maximum-Minimum) over this range.

6.5 DataSet Output

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
2	MajorGroup	MinorGroup	SubGroup	Sub2Group	Sub3Group	Weighting	Node#	File: Sample_Heatmap.out					1199.016	1498.77	1798.
3	Panels	Outer	OuterTop	OuterTop	OuterTop		1 HOKIES.1	Path: C:\TARP\TARP\TARP\bin\Samples					36.353891	33.47277966	31.37944
4	Panels	Outer	OuterSides	OuterSides	OuterSides		1 HOKIES.2	Date: 6/18/2008 5:35:48 PM					97777922	25.73222348	24.07000
5	Panels	Outer	OuterSides	OuterSides	OuterSides		1 HOKIES.3	Size: 5073349					50166815	26.1361124	24.44833
6	Panels	Outer	OuterSides	OuterSides	OuterSides		1 HOKIES.4	Format: SINDA85					01722406	30.68389054	28.98555
7	Panels	Outer	OuterSides	OuterSides	OuterSides		1 HOKIES.5	Parameter: T					33889116	36.18611321	34.35166
8	Panels	Outer	OuterSides	OuterSides	OuterSides		1 HOKIES.6	Time Units: hr converted to sec					26889099	34.25611305	32.33166
9	Panels	Outer	OuterSides	OuterSides	OuterSides		1 HOKIES.7	Temperature Units: °F converted to °C					14000161	28.02166811	26.26944
10	Panels	Outer	OuterBot	OuterBot	OuterBot		1 HOKIES.8	Timestep Filtering: Selected Timesteps Included					33.25722408	31.25555726	29.7822
11							1 HOKIES.9						-15.000002	-72.3011177	-72.30278436
12	Panels	Inner	InnerTop	InnerTop	InnerTop		1 HOKIES.101						-15.000002	33.97611303	37.59277999
13	Panels	Inner	InnerSides	InnerSides	InnerSides		1 HOKIES.102						-15.000002	26.04389017	28.45111259
14	Panels	Inner	InnerSides	InnerSides	InnerSides		1 HOKIES.103						-15.000002	26.9794458	29.449446
15	Panels	Inner	InnerSides	InnerSides	InnerSides		1 HOKIES.104						-15.000002	32.59000181	34.93555755
16	Panels	Inner	InnerSides	InnerSides	InnerSides		1 HOKIES.105						-15.000002	36.59055768	38.92778009
17	Panels	Inner	InnerSides	InnerSides	InnerSides		1 HOKIES.106						-15.000002	32.8027796	35.050002
18	Panels	Inner	InnerSides	InnerSides	InnerSides		1 HOKIES.107						-15.000002	27.57277918	29.93555715
19	Panels	Inner	InnerBot	InnerBot	InnerBot		1 HOKIES.108						-15.000002	31.69222396	32.92555739
20							1 HOKIES.109						-15.000002	-6.13777969	-6.155556848
21	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1001						-15.000002	31.91222396	32.8327796
22	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1002						-15.000002	31.93777953	32.85000183
23	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1003						-15.000002	31.94889064	32.8616685
24	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1004						-15.000002	31.95500176	32.8616685
25	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1005						-15.000002	31.9594462	32.85611294
26	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1006						-15.000002	31.94222398	32.88555739
27	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1007						-15.000002	31.96611287	32.89555739
28	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1008						-15.000002	31.96555731	32.89833517
29	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1009						-15.000002	31.97166842	32.89333516
30	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1010						-15.000002	31.98111287	32.87000183
31	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1011						-15.000002	31.87944619	32.88777961
32	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1012						-15.000002	31.90500175	32.90944628
33	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1013						-15.000002	31.91611286	32.91611294
34	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1014						-15.000002	31.92222398	32.91611294
35	Battery	Cells	Cells	Cells	Cells		1 HOKIES.1015						-15.000002	31.92666842	32.91055739
36	Battery	Housing	Housing	Housing	Housing		1 HOKIES.1501						-15.000002	31.80944619	32.75333515
37	Battery	Housing	Housing	Housing	Housing		1 HOKIES.1502						-15.000002	31.80166841	32.69000182
38	Battery	Housing	Housing	Housing	Housing		1 HOKIES.1503						-15.000002	31.71055729	32.91611294

Sample DataSet output is shown above. The cell containing the “Node#” heading includes a comment, indicated by a small red triangle in the upper right hand corner of the cell that provides traceability for the output. This comment includes: the source file name, format, parameter, path, and size, as well as original and converted units, node filter criteria, and an indication if timesteps were filtered. Any converted data is displayed as the result of a formula. Therefore, the original raw data value is preserved in the formula (e.g. “=93.075 * 0.5555556 + -17.77778”); the conversion can be removed by performing a search and replace on the entire sheet for the conversion formula. Hint: to avoid the * being interpreted as a wildcard, replace “0.5555556 + -17.77778” with “1”.



In addition to the raw data, groups and parameters are also added to the data after the last node entry. The image to the left shows the relative location of information on a DataSet worksheet. The Group Lookups for each node are shown in Column A (MajorGroup), Column B (MinorGroup), Column C (SubGroup), Column D (Sub2Group), and Column E (Sub3Group). If the Auto option is selected under Maximum Allowable Group Level on the Preferences form, then the minimum number of columns needed to describe the groupings is output. The group lookups are determined using the MATCH and INDEX Excel® functions referencing the NodeInfo sheet. Therefore, changes in Group definitions

made on the NodeInfo sheet are automatically updated on all DataSet sheets as long as the formulas are used. The next column after the Group lookups is the Weighting value. If the option is checked under Preferences to *Allow TARP to Calculate Groups and Parameters*, then only the first row of the Groups block and the first row of the Parameters block contains the formula. This is also true for the Group and Weighting lookup formulas to the left of the node column. The formulas are included such that if any changes to the Group definitions are made on the on the NodeInfo sheet, the user has the capability to fill the formulas down, and once again allow Excel to calculate the values.

The computed group values (Group Data) are appended to the end of the node data block, with Group values representing the total heatload or the average temperature. These values are computed using the SUMIF and COUNTIF functions in Excel® as well as a SUMPRODUCTIF VBA function provided in the TARP.xls template workbook if Weighting values are used. If the option is unchecked under preferences to *Return unweighted group average for groups where all nodes have a zero weighting factor* and this condition is met, then the returned value will be a #DIV/0! Excel error. The Group List contains the unique names/levels defined by the user. Groups at the Minor level are preceded by 2 spaces, and groups at the Sub level are preceded by 4 spaces and so on. If nodes exist in the same group name at multiple levels (e.g. nodes defined in Minor group are propagated to a Sub group of the same name), then the group name may appear more than once but with different spacing. This is needed to uniquely identify the group temperatures or heat loads at different levels if some nodes are included explicitly and some are included as members of a child group.

The Parameter List contains the listing of all parameter names, and the Parameter definition contains text needed to evaluate the parameter itself. The Parameter Data block contains formulas that call the tarpParameter function, which internally calls MAXIF and MINIF VBA functions, also provided in the TARP.xls template.

To the right of all Node/Group/Parameter data, additional data is appended as requested by the user. Most often, this includes Minimum, Average, Maximum, Time Min, and Time Max. These formulas use the MIN, AVERAGE, MAX, and the MATCH and INDEX functions for the TimeMin/TimeMax lookups. At this time, the average is not a time weighted average.

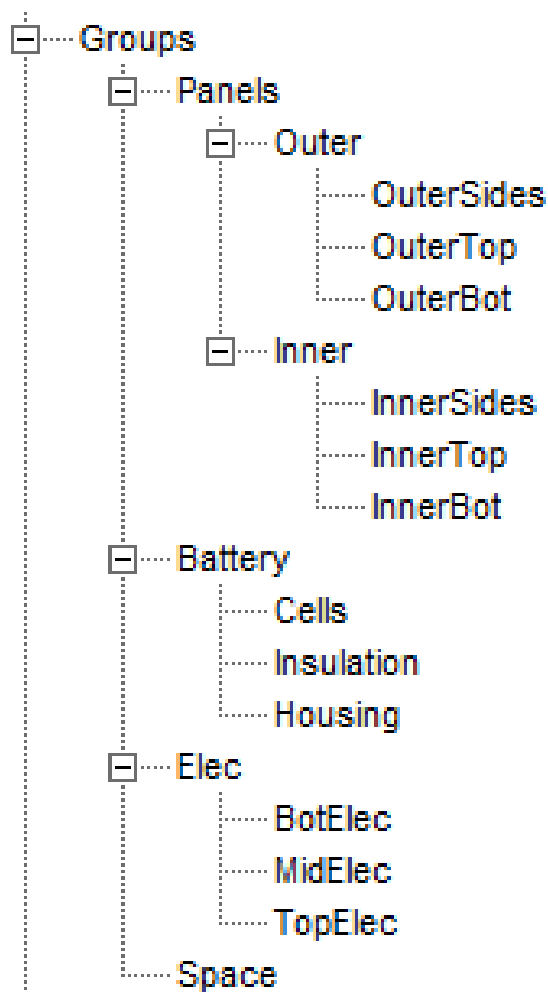
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7. Groups

Groups are used to simplify larger models. Groups compute the average Temperature or total Heat Load or Capacitance of all nodes contained in the group and all of its child groups. They are most powerful when combined with [HeatMaps](#) to determine heatflows into and out of the groups. As a group is added to the session, it is displayed in the *Working Node List* at the main interface and is treated as if it were any other node that may be added to a Plot, Table, or Graphical Table, etc. Nodes are added to a group in the manner described in [Adding Nodes to TARP Objects](#). However, other groups and parameters may not be added to a group, only nodes. Alternately for groups, [Group Filters](#) may be used to define the nodes to include by specifying a range which is then resolved to determine the nodes in a DataSet that meet the filter criteria.

When a group is created, it is automatically made a child group of the currently selected group in the *TARP Objects* tree. If no group is selected, the group is added as a MajorGroup at the root level under the Groups heading in the *TARP Objects* tree. This is how multi-level groups are created in TARP. Groups may be nested up to five levels deep (Major, Minor, Sub, Sub2 and Sub3). These first three levels are intended to represent an Instrument:Region:Component hierarchy. In the group hierarchy tree to the left, the *Panels* group is a MajorGroup, with *Outer* and *Inner* child groups at the MinorGroup level. Furthermore, the *Outer* MinorGroup has *OuterSides*, *OuterTop*, and *OuterBot* as child groups at the SubGroup level.

A node is only *defined* in one group, but based on parent-child relations it is *included* in up to three groups (one at each level). If a node is defined in a MinorGroup, it is also included in its parent group as well as a SubGroup with the same name. The table on the left shows nodes 1 through 6, the group name where the nodes are defined, and the group containing the nodes at the Major, Minor, and Sub Group levels for the Panels:Outer:OuterSides path. The table on the right shows the resulting groups that are created by TARP for each level.

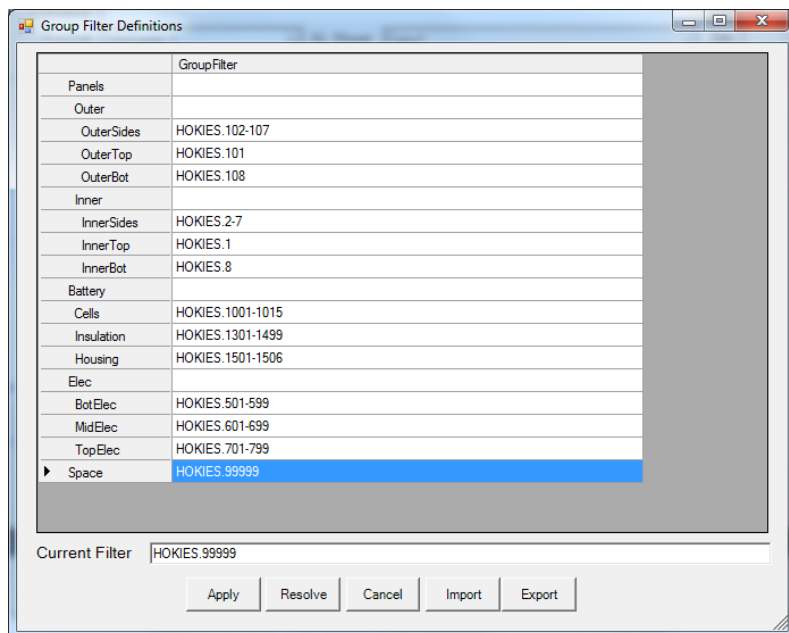


Node	Defined In	Major	Minor	Sub, Sub2, Sub3
1	OuterSides	Panels	Outer	OuterSides
2	OuterSides	Panels	Outer	OuterSides
3	Outer	Panels	Outer	Outer
4	Outer	Panels	Outer	Outer
5	Panels	Panels	Panels	Panels
6	Panels	Panels	Panels	Panels

Group	Level	Contains Nodes
Panels	Major	1,2,3,4,5,6
Panels	Minor	5,6
Outer	Minor	1,2,3,4
Panels	Sub	5,6
Outer	Sub	3,4
OuterSides	Sub	1,2

7.1 Group Filters

Group Filters provide a simpler method for defining groups if an organized nodal numbering scheme was used in the thermal model (e.g. 1-1000 is Inst1, 1001-2000 is Inst 2, etc.). Instead of explicitly adding each node to a group, a range (e.g. MAIN.1-100, MAIN.150, INST.1) may be entered at the Group Filter form, shown below. These ranges are then used to evaluate which nodes from output datasets are included in the group. For example, if (1) the range MAIN.1-100 is defined for *Panels*, (2) *DataSet1* contains nodes 1-10, and (3) *DataSet2* contains nodes 50-75, then *Panels* contains nodes 1-10 and 50-75, even if some of those nodes do not exist in all datasets. The inclusion of nodes that do not exist in all DataSets is allowed, since nodes not included do not have any contribution to the total heat load or average temperature formulas in Excel[®]. Resolving the Group Filters processes the current DataSets and assigns the appropriate nodes into the appropriate groups. This allows a user to see which nodes are included in a group and promote, demote, or remove them if necessary.



```
Panels|
  Outer|
    OuterSides|HOKIES.102-107
    OuterTop|HOKIES.101
    OuterBot|HOKIES.108
  Inner|
    InnerSides|HOKIES.2-7
    InnerTop|HOKIES.1
    InnerBot|HOKIES.8
  Battery|
    Cells|HOKIES.1001-1015
    Insulation|HOKIES.1301-1499
    Housing|HOKIES.1501-1506
  Elec|
    BotElec|HOKIES.501-599
    MidElec|HOKIES.601-699
    TopElec|HOKIES.701-799
  Space|HOKIES.99999
```

The group filters may also be exported or imported from a text file and follow the format of Group Name followed by a pipe (|) followed by the range. Indenting two spaces signals that group as a child group based on the previously defined parent. The above group definitions would appear as shown on the right. This does not allow for the creation or removal of groups, only the loading of the filters for the existing group structure defined from the main GUI.

7.2 Fast creation of Groups, Promoting, and Demoting

For output with submodels (i.e. SINDA85 or SINDA/FLUINT), an option exists to create Major groups based on the submodels found in the output. A user may also load existing groups from a file. Nodes that are *defined* in a group may be demoted into a new child group or any existing child groups. Similarly, nodes in an existing group may be promoted into their parent group. These options are only allowed for nodes defined in the group. Nodes displayed from a child group in the *Nodes in Current Object* list may not be acted upon. Furthermore, groups themselves (not the nodes defined in them) may be promoted or demoted using the popup menu for the *TARP Objects* tree. This capability is described in [Working with TARP Objects](#) section.

7.3 Group Output

MajorGroup	MinorGroup	SubGroup	Sub2Group	Sub3Group	Weighting	Node#	SS	SS	0	299.753964	599.508	899.2
Battery	Insulation	Insulation	Insulation	Insulation		1 HOKIES.1304	-15.000002	31.78666841	32.69777959	34.08833526	34.80277976	34.582224
Battery	Insulation	Insulation	Insulation	Insulation		1 HOKIES.1402	-15.000002	31.80277952	32.69166848	34.07944637	34.79111309	34.568833
Battery	Insulation	Insulation	Insulation	Insulation		1 HOKIES.1404	-15.000002	31.78389063	32.69444626	34.08500193	34.79944643	34.578890
Space	Space	Space	Space	Space		1 HOKIES.99999	-273.333356	-273.333356	-273.333356	-273.333356	-273.333356	-273.3333
					Major	PANELS	-15.000002	31.03053	33.41264	34.54465	34.97198	34.420
					Minor	OUTER	-15	31.03007	33.41681	34.5491	34.97653	34.422
					Sub	OUTERSIDES	-15	30.42953	32.80315	33.90981	34.3225	33.776
					Sub2	OUTERSIDES	-15	30.42953	32.80315	33.90981	34.3225	33.776
					Sub3	OUTERSIDES	-15	30.42953	32.80315	33.90981	34.3225	33.776
					Sub	OUTERTOP	-15	33.97556	37.59611	38.71667	39.05	38.238
					Sub2	OUTERTOP	-15	33.97556	37.59611	38.71667	39.05	38.238
					Sub3	OUTERTOP	-15	33.97556	37.59611	38.71667	39.05	38.238
					Sub	OUTERBOT	-15	31.68778	32.91945	34.21722	34.82722	34
					Sub2	OUTERBOT	-15	31.68778	32.91945	34.21722	34.82722	34
					Sub3	OUTERBOT	-15	31.68778	32.91945	34.21722	34.82722	34
					Minor	INNER	-15	31.03098	33.40848	34.54021	34.96743	34.418
					Sub	INNERSIDES	-15	30.42991	32.79158	33.89787	34.31046	33.771
					Sub2	INNERSIDES	-15	30.42991	32.79158	33.89787	34.31046	33.771
					Sub3	INNERSIDES	-15	30.42991	32.79158	33.89787	34.31046	33.771
					Sub	INNERTOP	-15	33.97611	37.59278	38.71111	39.04445	38.233
					Sub2	INNERTOP	-15	33.97611	37.59278	38.71111	39.04445	38.233

Sample Group output for a DataSet sheet is shown above. The actual group definitions themselves (i.e. which nodes are assigned to which groups) are stored on the NodeInfo sheet. These values are referenced by lookup formulas using the Excel® MATCH and INDEX functions to define the groups for each node on each DataSet sheet if TARP did not calculate the Groups. The groups assigned to each node are shown in columns 1 through 4, with Column 1 showing the MajorGroup, Column 2 the MinorGroup, Column 3 the SubGroup, and Column 4 the Sub2Group. For this case, the Max Allowable Group Level option under the Preferences form was set to 4. The calculated group values themselves are shown at the end of the node data. Formulas for the group values use the SUMIF and COUNTIF Excel functions and the SUMPRODUCTIF VBA function provided in the TARP.xls template. Any changes made to group definitions on the NodeInfo sheet propagate throughout the workbook via the formulas. If a weighting file is used for temperatures, then the group definition is as follows: $T_{avg} = \sum Weight_i * T_i / \sum Weight_i$. If no weighting file is used or the sum of the weighting factors is zero for temperature, then the group definition is $T_{avg} = \sum T_i / \# \text{ Nodes}$. Lastly, the group definition for heat loads or capacitance is $Q_{avg} = \sum Q_i$ and $C_{avg} = \sum C_i$ respectively.

If the *Allow TARP to Calculate Groups and Parameters* option is enabled under the Preferences form, then only the first cell (leftmost column, top most row) of the group values will contain the formulas. All other cells will contain only the values. Since TARP uses VBA functions within each cell to expand the functionality of Excel, there is an inherent performance loss compared to a more efficient algorithm to calculate the all the group values simultaneously. Hence, the default is to allow TARP to calculate but to still preserve the formulas. If the Group definitions are changed, then the formulas must be copied to recalculate the data, as the cells containing the values no longer any reference to the group definition on the NodeInfo sheet.

Recall that nodes are *defined* in only one group, but can be *included* in up to five groups based on Parent-Child relationships. Therefore, group names at each level are appended to the end of the node data rows, meaning that a group name may appear multiple times, but at different levels. The level for the group is indicated to the left of the Group Name. Group names at the MinorGroup level are preceded by 2 spaces; SubGroup names are preceded by 4 spaces and so on. The hierarchy and ordering is also shown to display relationships between child and parent groups. In the data above, nodes defined in a MajorGroup are also included in a MinorGroup, SubGroup,

and Sub2Group with the same name (as in the SPACE group above). Some group names may only exist at one level, where all the nodes included in the group are defined in child groups (such as the Panels group above). This preservation of nodes at all levels is necessary for ensuring that all nodes in a group are represented in [HeatMaps](#), regardless of what the group level where they are defined. Groups that are plotted or tabulated are based on the first occurrence. For example, if the user requested the Space group above, then the Major level Space group would be displayed.

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8. Parameters

Parameters return the result of a predefined formula applied to nodes contained in the Parameter. Five parameter types are supported: Difference, Min of Nodes, Max of Nodes, Min of Group, and Max of Group. The Difference parameter expects two values that may be Nodes, Groups, or other Parameters and returns the difference between them (e.g. Node2 – Node1). Some care must be taken when defining Difference parameters that reference other Difference parameters to ensure that the referenced parameter is defined before the difference parameter (e.g. Dif1 should not reference Dif2 if Dif2 was created after Dif1). All Difference parameters are generated in Excel after other Parameter types to minimize the risk associated with Difference parameter ordering. The Min/Max of Nodes returns the minimum and maximum value found in a collection of nodes respectively. The Min/Max of Group returns the Minimum and Maximum of nodes contained in the specified group. Similar to groups, each parameter created is available to be included in a Plot, StripChart, Table, or Graphical Table.

8.1 Parameter Output

MajorGroup	MinorGroup	SubGroup	Sub2Group	Sub3Group	Weighting	Node#	SS	SS	0	299.753964	599.508	899.262	1	
						Sub2	SPACE	-273.3333	-273.3333	-273.3333	-273.3333	-273.3333	-273.3333	-2
						Sub3	SPACE	-273.3333	-273.3333	-273.3333	-273.3333	-273.3333	-273.3333	-2
						MaxGroup	MaxPanels	-15.000002	36.59055768	38.92778009	40.0500024	40.48333577	39.97778018	38.62
						MaxGroup	MaxBattery	-15	31.98111	32.91611	34.30334	35.035	34.83333	3
						MaxGroup	MaxElec	-15	35.31889	39.16111	40.25556	40.54445	39.66111	3
						MaxGroup	MaxSpace	-273.3333	-273.3333	-273.3333	-273.3333	-273.3333	-273.3333	-2
						MaxGroup	MaxOuter	-15	36.31167	38.66111	39.77778	40.21667	39.7	3
						MaxGroup	MaxInner	-15	36.59056	38.92778	40.05	40.48334	39.97778	3
						MaxGroup	MaxOuterSides	-15	36.31167	38.66111	39.77778	40.21667	39.7	3
						MaxGroup	MaxOuterTop	-15	33.97556	37.59611	38.71667	39.05	38.23889	3
						MaxGroup	MaxOuterBot	-15	31.68778	32.91945	34.21722	34.82722	34.48	3
						MaxGroup	MaxInnerSides	-15	36.59056	38.92778	40.05	40.48334	39.97778	3
						MaxGroup	MaxInnerTop	-15	33.97611	37.59278	38.71111	39.04445	38.23333	3
						MaxGroup	MaxInnerBot	-15	31.69222	32.92556	34.22334	34.83222	34.485	3
						MaxGroup	MaxCells	-15	31.98111	32.91611	34.30334	35.035	34.83333	3
						MaxGroup	MaxInsulation	-15	31.805	32.69778	34.08834	34.80278	34.58223	3
						MaxGroup	MaxHousing	-15	31.94445	32.91611	34.22167	34.89722	34.67556	3
						MaxGroup	MaxBotElec	-15	31.73167	32.95778	34.255	34.86389	34.51722	3
						MaxGroup	MaxMidElec	-15	27.27445	29.63611	30.84278	31.36611	30.95833	2
						MaxGroup	MaxTopElec	-15	35.31889	39.16111	40.25556	40.54445	39.66111	3
						MinGroup	MinPanels	-15	26.04389	28.45111	29.53445	29.90833	29.30945	2
						MinGroup	MinBattery	-15	31.71056	32.69	34.07722	34.78889	34.505	3
						MinGroup	MinElec	-15	16.72722	20.32056	20.58778	20.30389	19.29667	1
						MinGroup	MinSpace	-273.3333	-273.3333	-273.3333	-273.3333	-273.3333	-273.3333	-2
						MinGroup	MinOuter	-15	26.16389	28.58889	29.66945	30.03778	29.42945	2
						MinGroup	MinInner	-15	26.04389	28.45111	29.53445	29.90833	29.30945	2

Sample Parameter output on a DataSet sheet is shown above. The parameter name is shown in the same column as Nodes and Group names. The column to the left contains a string value that defines the parameter type and the inputs to the parameter. If the parameter type is “Difference”, then native Excel® functions are used; for all other parameter types, a specialized VBA Function is called to compute the value for the parameter type, provided in the TARP.xls template. Similar to groups, if the *Allow TARP to Calculate Groups and Parameters* option is enabled under the Preferences form, then only the first cell (leftmost column, top most row) of the parameter values will contain the formulas. All other cells will contain only the values. Since TARP uses VBA macros to expand the functionality of Excel, there is an inherent performance loss compared to a more efficient algorithm to calculate the parameters. Hence, the default is to allow TARP to calculate but to still preserve the formulas. If the Parameter definitions are changed, then the formulas must be copied to recalculate the data, as the cells containing the values no longer any reference to the group definitions on the NodeInfo sheet.

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9. Plots

Plots are graphical representations of data as a function of time. Each plot consists of a Title, an X and a Y axis (and possibly a secondary Y axis), and a collection of data series. Each series is represented by one line on the plot, which may have varying Line properties (Line Type, Color, Weight) and Marker properties (Symbol, Fore Color, Back Color, Size, Frequency, and Shadow) as well as varying source data, plot axes, and labels. The Plot properties form is shown below.

Plot Properties for Plot1

Plot Title: XL Sheet: Plot1

Axes Properties

X-Axis

Minimum:

Maximum:

Major Division:

Minor Division:

Primary Y-Axis

Minimum:

Maximum:

Major Division:

Minor Division:

Secondary Y-Axis

Minimum:

Maximum:

Major Division:

Minor Division:

Series Properties

Data

Source:

LabelText:

Plot on Secondary Axis

Line

Syle:

Color:

Weight:

Marker

Symbol:

Fore Color:

Back Color:

Marker Size: pts Shadow

Mark every: data points

Marker has same Fore Color as Line

Marker has same Back Color as Fore Color

Set BackColor to None for Non-Fillable Markers

Apply Size/Freq changes to all Series

Series List

- Temps:HOKIES.503 (Pri)
- Temps:HOKIES.550 (Pri)
- Temps:HOKIES.601 (Pri)
- Temps:HOKIES.602 (Pri)

Use Descriptions as Labels

Set Current Line/Marker Properties as Default

OK Cancel

Apply Axes Properties to All Plot Apply Series Properties to All Plots

9.1 Axes Properties

The axes properties may be defined by the user including axis Maximum and Minimum, and Major and Minor Divisions. The Default Max or Default Min options determine the closest integer multiple of the Major Division for the Minimum and Maximum axes values. By default, both Major and Minor gridlines are displayed, unless the user sets the Major Division equal to the Minor Division. The axis titles and units are based on the source DataSets referenced by the Plot. If a DataSet is for Temperatures with units of °C, then the axis title reflects this. If two types of units are found on one axis, then both are indicated. A secondary axis is also available, but is only enabled if any series on the plot is set to the secondary axis. This is most useful for plotting two different units together on the same plot (e.g. Temperature and Heat to verify heater behavior). The axes properties may also be applied to all plots to ensure consistency across multiple plots.

9.2 Series Properties

The user also has control over individual series properties. Three types of series characteristics are available for modification: Data, Line, and Marker. Any changes made in the *Series Properties* frame are applied to all nodes selected in the *Series List*, allowing for multiple series to be changed at once. The Data characteristics include the Source DataSet, the axis on which to plot the series, and an optional user specified label. Line characteristics include *Line Style*, *Color*, and *Weight*. The marker characteristics include *Symbol*, *Fore Color*, *Back Color*, *Size*, *Shadow* and *Frequency*. Marker frequency is the only option available through TARP that is not readily changeable in Excel®. This option allows a user to place a marker every so many data points for series that are very dense and would have too many overlapping markers to be able to distinguish the marker symbol. The table below shows the options available for each characteristic.

<i>Style</i>	<i>Color</i>	<i>Weight</i>	<i>Symbol</i>
Solid	Too numerous to list	Hairline	Square
Dashed	56 Available	Thin	Diamond
Dotted		Medium	Triangle
Dash Dot		Thick	X ¹
Dash Dot Dot			Star ¹
Medium Density ²			Dot ¹
High Density ²			Dash ¹
Low Density ²			Circle
			Plus ¹

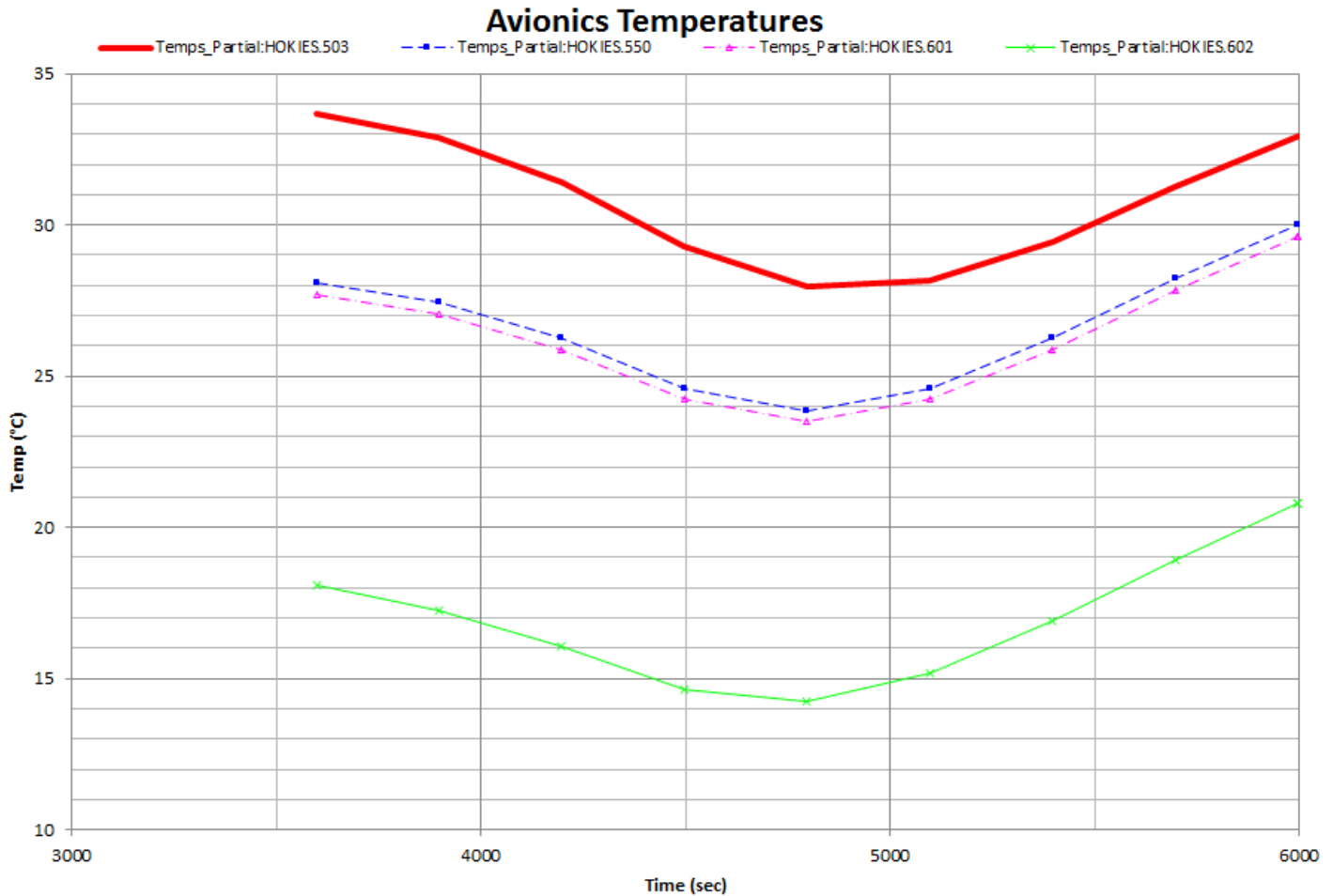
1 - Indicates "Non Fillable" Marker

2 - Indicates that these options are not available in Excel® 2007. Will be automatically converted to Solid if used

Certain options are available to help relate line and marker colors. The first option, *Marker has same Fore Color as Line*, automatically sets the marker Fore Color when the Line Color is changed. Furthermore, the *Marker has same Back Color as Fore Color*, sets the marker back color when the fore color is changed. The *Set BackColor to None for Non-Fillable Markers* option automatically sets the Back Color to None for X, Star, Dot, Dash, and Plus type markers. Lastly, the *Apply Size/Freq changes to all Series* option applies the Size or Frequency to all series when either of these options is changed.

Similar to axes properties, series properties may also be applied to all other plots to ensure consistency. However, since different plots can have different numbers of series, some care must be taken when using this feature. Assuming that Plot1 has 3 series and Plot2 has 7 series, applying series properties while on Plot1, would only affect the first 3 series on Plot2. Conversely, applying series properties on Plot2 would affect all 3 series on Plot1. Therefore, use of this feature is recommended when the plot being modified has the largest number of series.

9.3 Plot Output

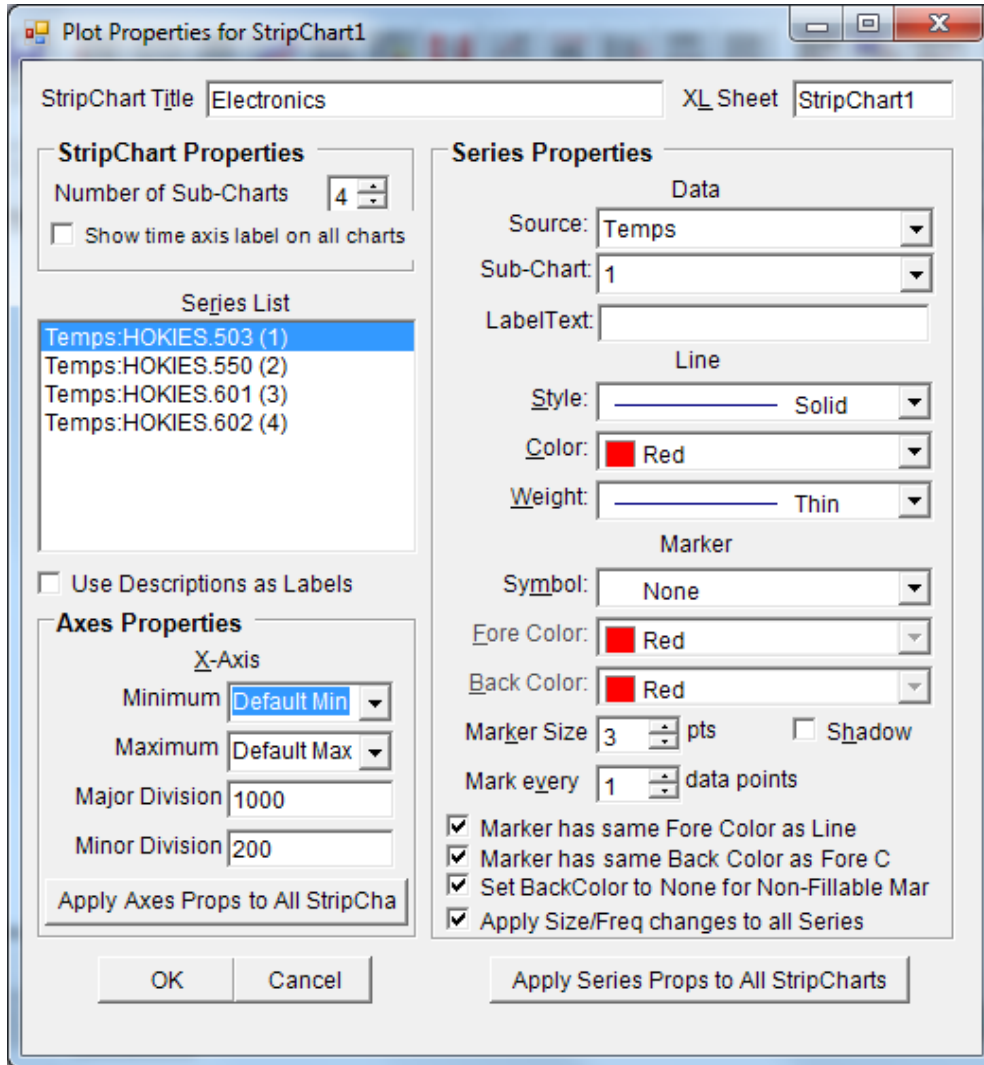


Sample Plot output is shown above. The units and data type (e.g. Temp) are determined based on the DataSets for the series on the plot. The legend is shown at the top of the plot. Major and Minor gridlines are also shown on the example plot. For this example, the Last Cycle Definition begins just before 3600 seconds and ends at 6000 seconds, while the X-Axis minimum and maximum values are 3000 and 6000 respectively. If the *Use Descriptions as Labels* option is enabled, then the Descriptions, defined by either the *Input File* or the *Description File*, are used instead of the default “SheetName: NodeNo” style label. If the *LabelText* is defined for a specific series, then that value will over ride both the default and data from a description file. The user has full control over the plot within Excel® and may modify any of the properties associated with the plot or its series after the workbook is created.

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10. StripCharts

StripCharts are stacked graphical representations of data as a function of time. Each sub-chart consists of an X-axis, Y-axis, and a collection of up to 3 data series. Up to 6 sub-charts may be displayed on any one StripChart. Additionally, the X-axis may be displayed on each sub-chart or only the bottom chart. Each series is represented by one line on the sub-chart, which may have varying Line properties (Line Type, Color, Weight) and Marker properties (Symbol, Fore Color, Back Color, Size, Frequency, and Shadow). StripCharts are useful for showing related trends for multiple points with largely varying scales (e.g. Temperature, Heat, Voltage, Current, etc.). The StripChart properties form is shown below.



The user may set the number of sub-charts to be displayed on the StripChart. Each series must be assigned to a sub-chart. As nodes are added to a StripChart at the main interface, each node is placed on a separate sub-chart until 6 sub-charts have been added. After this, the next two nodes are added to sub-chart one, the following two are added to sub-chart two and so on. The sub-chart and source DataSet may be assigned at the StripChart properties form or alternatively at the main interface, using the Context Menu on the *Nodes in Current Object* list box. An option also exists to place the Time axis label on each sub-chart; the default is for only the bottom sub-chart to have the axis label.

10.1 Axes Properties

The axes properties may be defined by the user including axis Maximum and Minimum, and Major and Minor Divisions. The Default Max or Default Min options determine the closest integer multiple of the Major Division for the Minimum and Maximum axes values. By default, both Major and Minor gridlines are displayed, unless the user sets the Major Division equal to the Minor Division. The axis titles and units are based on the source DataSets referenced by the StripChart. If a DataSet is for Temperatures with units of °C, then the axis title reflects this. If two types of units are found on one axis, then both are indicated.

10.2 Series Properties

The user also has control over individual series properties. Three types of series characteristics are available for modification: Data, Line, and Marker. Any changes made in the *Series Properties* frame are applied to all nodes selected in the *Series List*, allowing for multiple series to be changed at once. The Data characteristics include the Source DataSet and the axis on which to plot the series. Line characteristics include *Line Style*, *Color*, and *Weight*. The marker characteristics include *Symbol*, *Fore Color*, *Back Color*, *Size*, *Shadow* and *Frequency*. Marker frequency is the only option available through TARP that is not readily changeable in Excel®. This option allows a user to place a marker every so many data points for series that are very dense and would have too many overlapping markers to be able to distinguish the marker symbol. The table below shows the options available for each characteristic.

<i>Style</i>	<i>Color</i>	<i>Weight</i>	<i>Symbol</i>
Solid	Too numerous to list	Hairline	Square
Dashed	56 Available	Thin	Diamond
Dotted		Medium	Triangle
Dash Dot		Thick	X ¹
Dash Dot Dot			Star ¹
Medium Density ²			Dot ¹
High Density ²			Dash ¹
Low Density ²			Circle
			Plus ¹

1 - Indicates "Non Fillable" Marker

2 - Indicates that these options are not available in Excel® 2007. Will be automatically converted to Solid if used

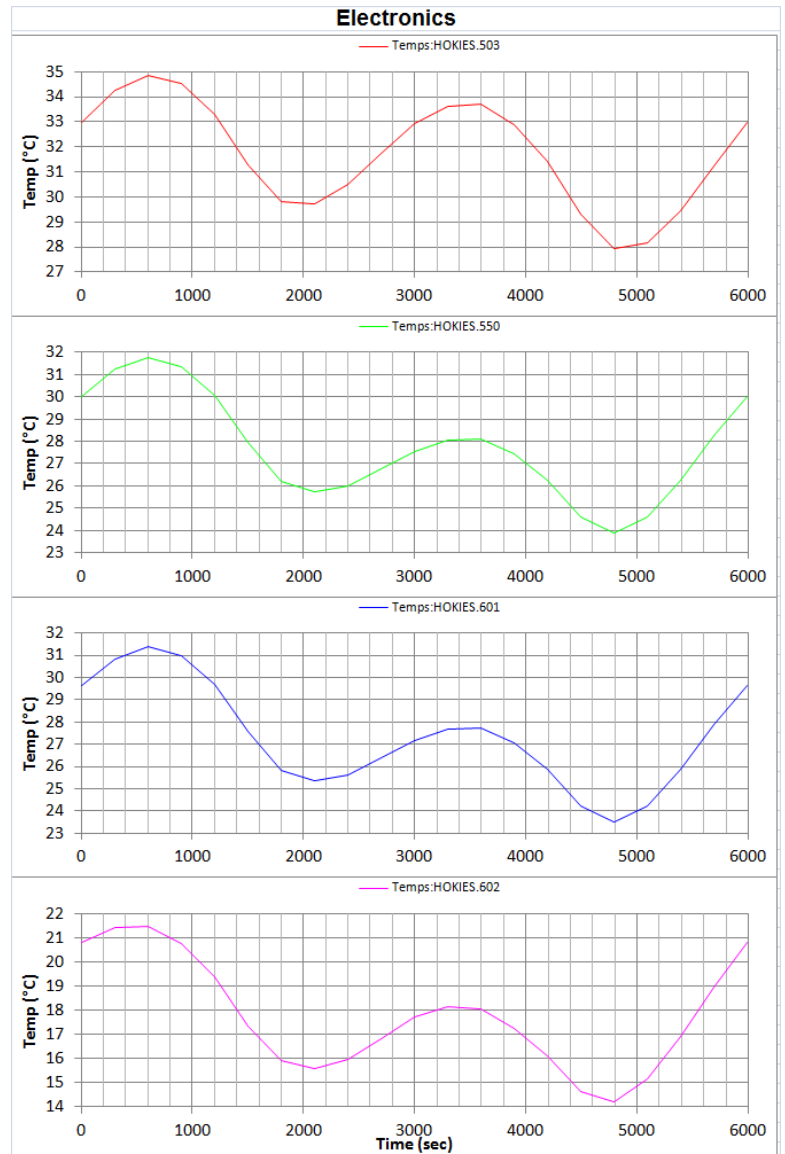
Certain options are available to help relate line and marker colors. The first option, *Marker has same Fore Color as Line*, automatically sets the marker Fore Color when the Line Color is changed. Furthermore, the *Marker has same Back Color as Fore Color*, sets the marker back color when the fore color is changed. The *Set BackColor to None for Non-Fillable Markers* option automatically sets the Back Color to None for X, Star, Dot, Dash, and Plus type markers. Lastly, the *Apply Size/Freq changes to all Series* option applies the Size or Frequency to all series when either of these options is changed.

Similar to axes properties, series properties may also be applied to all other StripCharts to ensure consistency. However, since different plots can have different numbers of series, some care must be taken when using this feature. Assuming that StripChart1 has 3 series and StripChart2 has 7 series, applying series properties while on StripChart1, would only affect the first 3 series on StripChart2. Conversely, applying series properties on StripChart2 would affect all 3 series on StripChart1. Therefore, use of this feature is recommended when the StripChart being modified has the largest number of series.

10.3 StripChart Output

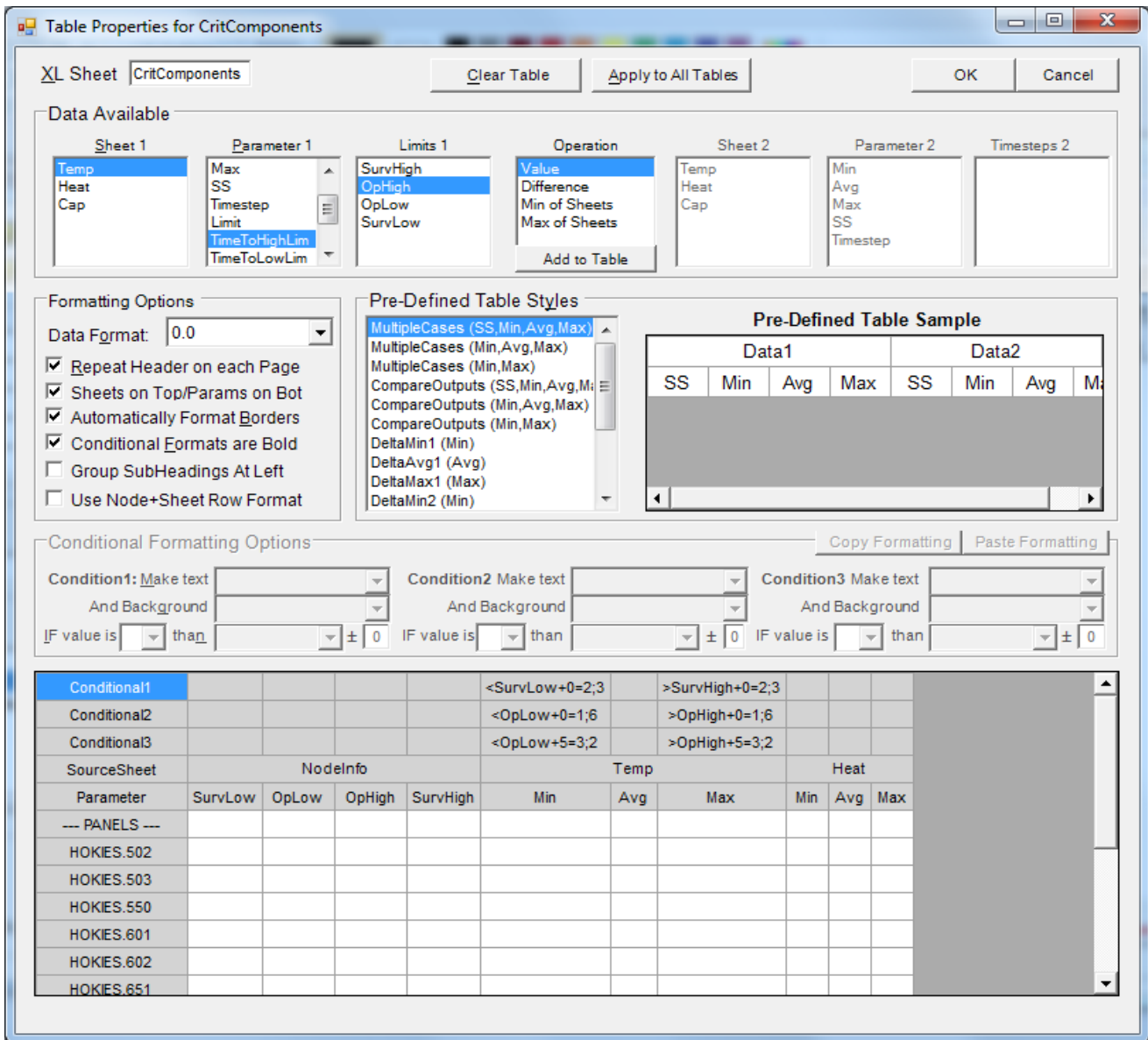
Sample StripChart output is shown to the right. The units and data type (e.g. Temp) are determined based on the DataSets for the series on each sub-chart. The legend is shown at the top of each sub-chart. Major and Minor gridlines are also shown on the time axis, but only Major Gridlines are shown for the Y-Axis. For this example, the Last Cycle Definition begins just before 3600 seconds and ends at 6000 seconds. If the *Use Descriptions as Labels* option is enabled, then the Descriptions, defined by either the *Input File* or the *Description File*, are used instead of the default “SheetName: NodeNo” style label. If the *LabelText* is defined for a specific series, then that value will over ride both the default and data from a description file. The user has full control over each sub-chart plot within Excel® and may modify any of the properties associated with the plot or its series after the workbook is created.

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11. Tables

Tables display nodal or group information at a static point in time. Tables can display Minimum, Average, or Maximum values, Steady-State data or any other timestep, as well as Limits from the specified [LimitFile](#). Each row in the table represents a single node, group, or parameter. Each column in the table shows the values for the display parameter requested by the user. Conditional formatting may be applied to highlight nodes that exceed a limit condition or are within a specified margin of a limit. The user also has a number of formatting options available to control the table display. The Table properties form is shown below.



11.1 Defining the Operation and Source Sheet(s)

To begin, a user selects all the defining characteristics for a column. These include: the operation (e.g. Value, Difference), the source sheet(s), the display parameter(s) to show, and additional information as needed (e.g. Timestep, Limit Name). Four different *Operations* are available: Value, Difference, Min of Sheets, and Max of Sheets. *Value* is a single datapoint from a single source DataSet. *Difference* allows a user to display the difference between two timesteps. This may be used to display a maximum change (Max-Min), a margin (Max-Limit), or the change

between two orbital points (Timestep 35 – Timestep 21). *Min of Sheets* and *Max of Sheets* returns the worst case value from a collection of sheets. This is used to display the maximum value from a selection of multiple cases (i.e. sheets). Once the *Operation* is selected, certain fields are enabled or disabled. For example, if a *Difference* operation is selected, then the *Sheet 2* and *Parameter 2* listboxes are enabled. Next, the user selects the source sheet (or sheets for *Min/Max of Sheets*) from the *Sheet 1* listbox. If a *Difference* operation is selected, then the user also selects the source sheet for *Sheet 2*.

11.2 Defining the Display Parameter and adding columns to the Table

After the Operation and Source sheets are defined, the display parameter is selected. Eleven types of display parameters are available: Min, Avg, Max, SS, Timestep, Limit, TimeToHighLim, TimeToLowLim, TimeAboveLim, TimeBelowLim, and TimeToHiOrLo. Min, Avg, and Max parameters are only available if the user included these values for the selected source DataSet. The SS display parameter is only available if steady-state output was detected in the selected DataSet. Limits, TimeToHighLim, TimeToLowLim, TimeAboveLim, TimeBelowLim, and TimeToHiOrLo are only available if the user has defined a [LimitFile](#) under the [AdditionalFiles](#) section at the main interface. For Timesteps, Limits, TimeToHighLim, TimeToLowLim, TimeAboveLim, TimeBelowLim, and TimeToHiOrLo, the user must further select the particular occurrence to tabulate; available Limits or Timesteps are shown in the listbox to the right of the *Parameter* listbox. TimeToHiOrLo requires two limits to be selected.

If the display parameter selected is “Timestep”, a list of all output timesteps is shown in the *TimeSteps* listbox. The user selects a single timestep to display in the resulting table column. If the display parameter is “Limit”, the user then selects the Limit Name from the *Limits* listbox. Limit Names are defined by the first row in the [LimitFile](#) specified by the user. Once all defining characteristics are set, the user then adds a column to the table using the *Add to Table* button. Alternatively, once all the necessary values are specified, a double click in the *Sheet*, *Parameter*, *Limit*, or *Timestep* listbox also adds the column to the Table.

If MaxGroup or MinGroup [parameters](#) have been defined for any groups included in the Table, Min table entries display the minimum of the MinGroup parameter. Similarly, a Max Table entry displays the maximum of the MaxGroup parameter. This is useful for determining the absolute minimum and/or maximum temperature of all nodes in a group over a period of time. If no MaxGroup or MinGroup parameters are found, then a Max table entry would display the maximum average temperature of all the nodes in the Group and similarly for Min. The sample output below explains this best. The Minimum temperature of Group1 is 1.67 (the minimum *average* of SUBMODEL.1-3 over the time range 0.0 to 4.0), whereas the minimum of the MinGroup parameter for Group1 is 0.0 (the minimum temperature of SUBMODEL.1-3 over the time range 0.0 to 4.0). Similarly the maximum for Group1 is 3.0, whereas the maximum of the MaxGroup parameter for Group1 is 5.0.

	A	B	C	D	E	F	G	H	I	J	K	L
1	MajorGroup	MinorGroup	SubGroup	Node	0.00	1.00	2.00	3.00	4.00	Min	Avg	Max
2	Group1	Group1	Group1	SUBMODEL.1	1.00	2.00	3.00	2.00	1.00	1.00	1.80	3.00
3	Group1	Group1	Group1	SUBMODEL.2	3.00	4.00	3.00	2.00	3.00	2.00	3.00	4.00
4	Group1	Group1	Group1	SUBMODEL.3	5.00	3.00	0.00	1.00	4.00	0.00	2.60	5.00
5				Group1	3.00	3.00	2.00	1.67	2.67	1.67	2.47	3.00
6				MaxGroup1	5.00	4.00	3.00	2.00	4.00	2.00	3.60	5.00
7				MinGroup1	1.00	2.00	0.00	1.00	1.00	0.00	1.00	2.00

11.3 Table Preview

A table preview is displayed under the *Conditional Formatting Options* frame. The first column shows the nodes in the table as added at the main interface. Each column added to the table is also displayed. Two fixed rows are reserved to display the Source Sheet and Parameter. In addition, if any limit has been added to the table, three additional fixed rows are reserved to display any applied conditional formatting. The user may delete columns in the table preview by selecting the column to delete and pressing the delete key. The order of the columns may also be adjusted in the table preview by selecting a column and dragging it to its new position using the **right mouse button**. If the column width is not sufficient to display the properties of a column, the column width can be changed by dragging its right edge. The cursor changes to a left-and-right arrow \leftrightarrow as the user moves over the column edge with the mouse in the fixed rows portion of the display. When this occurs, the column can be resized. Note that the column size has no effect on the table output. The user may resize columns within Excel[®] if needed.

11.4 Applying Conditional Formatting

Conditional formatting is available once any limit has been added to the table. If limits are defined in the table, the fields in the *Conditional Formatting Options* frame are enabled. A maximum of three conditions may be applied. However, if Condition 1 is satisfied, then Conditions 2 and 3 are not evaluated. The same applies for Condition 3 if Condition 2 is satisfied. Therefore, the user should take care and assign conditions in an order consistent with this behavior. Condition 3 can only be defined after Condition 2 is fully defined; Condition 2 can only be defined after Condition 1 has been fully defined.

Each condition consists of 5 basic parts: **Condition**, **LimitName**, **Margin**, **Text Color**, and **Back Color**. **Condition** is one of the following types: $>$, $>=$, $<=$, and $<$. **LimitName** is based on the limit selected by the user from the drop-down box. Therefore, the logic for Conditional Formatting is as follows: “IF value [$<$ | $<=$ | $>=$ | $>$] **LimitName** \pm **Margin** THEN APPLY **Text Color**; **Back Color**”. This may be used to highlight values that have violated a limit. Use of the margin can highlight values that are close to a limit. So, “ $>=$ LowLimit+5=3;0” would make the text red (color index 3) and the background the default color (color index 0) for values that were within 5 of the LowLimit. Note, that in general, the three Conditions are intended to be used as follows: Condition 1-Red Limit Violation, Condition 2-Yellow Limit Violation, Condition 3-Within specified Margin of Yellow Limit. Since a red limit is the most severe, values violating Condition 1 would not check Conditions 2 or 3. Conditions may be copied from one column and pasted into another.

11.5 Table Formatting Options

A number of formatting options are available to the user to control the output appearance of the table. The *DataFormat* may be changed to display more decimal places in the output (up to 6). Both standard numbers (0.0) and scientific notation (0.0E+00) are available. The user is also able to change this on the resulting Excel[®] worksheet. For tables that span multiple sheets when printing, the user may opt to *Repeat Header on Each Page*. This displays the first two rows on each printed page. Otherwise, the first two rows are shown only on the first page. The *Sheets on Top/Params on Bot* is the means by which data is grouped together. One way to group data is to combine identical DataSets (Case 1, Case 2, etc.) with varying display parameters (Min, Max).

Conversely, another way is to group identical display parameters (Min, Max) with varying DataSets (Case1, Case 2, etc.). The two table headers below best illustrate the two methods. The user may also *Automatically Format Borders*, which places thin gridlines around all the data and thick gridlines around sections with common Sheets or Parameters. In the headers below, the top sample would have thick gridlines around Case 1 and Case 2; the bottom sample would have thick gridlines around Min, Avg, and Max. The user may make the font bold for values satisfying conditional formats by selecting *Conditional Formats are Bold*. Lastly, the *Use Node+Sheet Row Format* reorganizes the data to allow for the Filter functionality of Excel® to be used to re-sort the data by Node, Sheet, or Value. This is shown in Section 11.6.

Case 1			Case 2			Min		Avg		Max	
Min	Avg	Max	Min	Avg	Max	Case 1	Case2	Case1	Case2	Case1	Case2

Sheets on Top/Params on Bot = True (Left), False (Right)

11.6 Table Output

	A	B	C	D	E	F	G
1		Sheet:	NodeInfo		Data1		
2		Parameter:	LowLimit	HighLimit	Min	Avg	Max
3		Node/Group			[°C]	[°C]	[°C]
4	Outer Panels	HOKIES.1	15.0	35.0	30.7	34.3	39.1
5		HOKIES.2	15.0	35.0	22.9	26.3	30.0
6		HOKIES.3	15.0	35.0	24.1	27.3	30.9
7		HOKIES.4	15.0	35.0	28.7	32.7	35.5
8		HOKIES.5	15.0	35.0	33.3	36.5	40.2
9		HOKIES.6	15.0	35.0	28.1	32.9	37.5
10		HOKIES.7	15.0	35.0	23.9	27.9	31.8
11		HOKIES.8	15.0	35.0	27.9	31.7	34.8
12	Inner Panels	HOKIES.101	15.0	35.0	30.7	34.3	39.1
13		HOKIES.102	15.0	35.0	22.8	26.2	29.9
14		HOKIES.103	15.0	35.0	23.9	27.2	30.7
15		HOKIES.104	15.0	35.0	28.7	32.8	35.6
16		HOKIES.105	15.0	35.0	33.6	36.8	40.5
17		HOKIES.106	15.0	35.0	28.1	33.0	37.6
18		HOKIES.107	15.0	35.0	23.8	27.7	31.7
19		HOKIES.108	15.0	35.0	27.9	31.8	34.8

With Table SubHeadings at left

	A	B	C	D	E	F	G
1		Sheet:	NodeInfo		Data1		
2		Parameter:	LowLimit	HighLimit	Min	Avg	Max
3		Node/Group			[°C]	[°C]	[°C]
4	Outer Panels	HOKIES.1	15.0	35.0	30.7	34.3	39.1
5		HOKIES.2	15.0	35.0	22.9	26.3	30.0
6		HOKIES.3	15.0	35.0	24.1	27.3	30.9
7		HOKIES.4	15.0	35.0	28.7	32.7	35.5
8		HOKIES.5	15.0	35.0	33.3	36.5	40.2
9		HOKIES.6	15.0	35.0	28.1	32.9	37.5
10		HOKIES.7	15.0	35.0	23.9	27.9	31.8
11		HOKIES.8	15.0	35.0	27.9	31.7	34.8
12	Inner Panels	HOKIES.101	15.0	35.0	30.7	34.3	39.1
13		HOKIES.102	15.0	35.0	22.8	26.2	29.9
14		HOKIES.103	15.0	35.0	23.9	27.2	30.7
15		HOKIES.104	15.0	35.0	28.7	32.8	35.6
16		HOKIES.105	15.0	35.0	33.6	36.8	40.5
17		HOKIES.106	15.0	35.0	28.1	33.0	37.6
18		HOKIES.107	15.0	35.0	23.8	27.7	31.7
19		HOKIES.108	15.0	35.0	27.9	31.8	34.8

Without Table SubHeadings at Left

Sample Table output is shown above, including Table SubHeadings for Outer and Inner Panels. For this table, no node descriptions were included, Conditional formats are applied to the max column to highlight any violation of the HighLimit by coloring the background in red and the text in white. A second condition is also applied which highlights any values not violating the HighLimit but are within 5 of the HighLimit by making the text red. The two styles of table subheadings are also shown.

If the user selected the *Enable Dynamic Columns* option under the [Preferences](#) form, the resulting table is shifted down by three rows. The first row includes a DynamicSheet label. This allows the user to select the Source DataSet for the column. Once this is selected, the user may then select the DynamicParameter, which is based on all columns on the selected DynamicSheet. These options allow the user to actually change the data that is displayed in the table without having to change the formulas. Note that if the worksheet names for DataSets are changed within Excel®, the validation list for the DynamicSheets drop-down boxes is not automatically updated. Output with Dynamic Columns enabled is shown next.

	A	B	C	D	E	F	G
1		DynamicSheet			Data1	Data1	Data1
2		DynamicParameter			(227) Min	(228) Avg	(229) Max
3							
4		Sheet:	NodeInfo		Data1	Data1	Data1
5		Parameter:	LowLimit	HighLimit	Min	Avg	Max
6	Description	Node/Group			[°C]	[°C]	[°C]
7	Outer Panels						
8	Outer Panel Top	HOKIES.1	15.0	35.0	30.7	34.3	39.1
9	Outer Panel Side	HOKIES.2	15.0	35.0	22.9	26.3	30.0
10	Outer Panel Side	HOKIES.3	15.0	35.0	24.1	27.3	30.9
11	Outer Panel Side	HOKIES.4	15.0	35.0	28.7	32.7	35.5
12	Outer Panel Side	HOKIES.5	15.0	35.0	33.3	36.5	40.2
13	Outer Panel Side	HOKIES.6	15.0	35.0	28.1	32.9	37.5
14	Outer Panel Side	HOKIES.7	15.0	35.0	23.9	27.9	31.8
15	Outer Panel Bottom	HOKIES.8	15.0	35.0	27.9	31.7	34.8
16	Inner Panels						
17	Inner Panel Top	HOKIES.101	15.0	35.0	30.7	34.3	39.1
18	Inner Panel Side	HOKIES.102	15.0	35.0	22.8	26.2	29.9
19	Inner Panel Side	HOKIES.103	15.0	35.0	23.9	27.2	30.7
20	Inner Panel Side	HOKIES.104	15.0	35.0	28.7	32.8	35.6
21	Inner Panel Side	HOKIES.105	15.0	35.0	33.6	36.8	40.5
22	Inner Panel Side	HOKIES.106	15.0	35.0	28.1	33.0	37.6
23	Inner Panel Side	HOKIES.107	15.0	35.0	23.8	27.7	31.7
24	Inner Panel Bottom	HOKIES.108	15.0	35.0	27.9	31.8	34.8

Dynamic Columns with Descriptions and without Table SubHeadings at Left

	A	B	C	D	E	F	G	H
1		DynamicSheet				Data1	Data1	Data1
2		DynamicParameter				(227) Min	(228) Avg	(229) Max
3								
4		Sheet:	NodeInfo		Data1	Data1	Data1	
5		Parameter:	LowLimit	HighLimit	Min	Avg	Max	
6		Description	Node/Group			[°C]	[°C]	[°C]
7	Outer Panels	Outer Panel Top	HOKIES.1	15.0	35.0	30.7	34.3	39.1
8		Outer Panel Side	HOKIES.2	15.0	35.0	22.9	26.3	30.0
9		Outer Panel Side	HOKIES.3	15.0	35.0	24.1	27.3	30.9
10		Outer Panel Side	HOKIES.4	15.0	35.0	28.7	32.7	35.5
11		Outer Panel Side	HOKIES.5	15.0	35.0	33.3	36.5	40.2
12		Outer Panel Side	HOKIES.6	15.0	35.0	28.1	32.9	37.5
13		Outer Panel Side	HOKIES.7	15.0	35.0	23.9	27.9	31.8
14		Outer Panel Bottom	HOKIES.8	15.0	35.0	27.9	31.7	34.8
15	Inner Panels	Inner Panel Top	HOKIES.101	15.0	35.0	30.7	34.3	39.1
16		Inner Panel Side	HOKIES.102	15.0	35.0	22.8	26.2	29.9
17		Inner Panel Side	HOKIES.103	15.0	35.0	23.9	27.2	30.7
18		Inner Panel Side	HOKIES.104	15.0	35.0	28.7	32.8	35.6
19		Inner Panel Side	HOKIES.105	15.0	35.0	33.6	36.8	40.5
20		Inner Panel Side	HOKIES.106	15.0	35.0	28.1	33.0	37.6
21		Inner Panel Side	HOKIES.107	15.0	35.0	23.8	27.7	31.7
22		Inner Panel Bottom	HOKIES.108	15.0	35.0	27.9	31.8	34.8

Dynamic Columns with Descriptions and with Table SubHeadings at Left

Lastly, the *Use Node+Sheet Row Format* produces output as shown below, but will ignore Dynamic Columns and Table Subheadings. The first image is the notional layout without using the alternate format. The second image displays the data in a Filter-able method, where any column may be selected as the sort key; the third image displays the data filtered by Node/Group.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	<i>Sheet:</i>	NodeInfo				Temp			Heat			Cap		
2	<i>Parameter:</i>	SurvLow	OpLow	OpHigh	SurvHigh	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
3	Node/Group					[°C]	[°C]	[°C]	[W]	[W]	[W]	[J/K]	[J/K]	[J/K]
4	HOKIES.502	15.0	20.0	30.0	40.0	27.9	31.8	34.8	4.8	8.6	15.2	0.0	0.0	0.0
5	HOKIES.503	15.0	20.0	30.0	40.0	27.9	31.8	34.9	2.1	2.6	3.5	0.0	0.0	0.0
6	HOKIES.550	15.0	20.0	30.0	40.0	23.9	27.8	31.8	5.5	5.6	5.7	0.0	0.0	0.0
7	BotElec					23.9	30.5	34.9	2.1	16.8	15.2	0.0	0.0	0.0

Normal view for Table Output

	A	B	C	D	E	F	G	H	I
1			SurvLow	OpLow	OpHigh	SurvHigh	Min	Avg	Max
2	Node/Group	Sheet					[°C]	[°C]	[°C]
3	HOKIES.502	Temp	15.0	20.0	30.0	40.0	27.9	31.8	34.8
4	HOKIES.503	Temp	15.0	20.0	30.0	40.0	27.9	31.8	34.9
5	HOKIES.550	Temp	15.0	20.0	30.0	40.0	23.9	27.8	31.8
6	BotElec	Temp					23.9	30.5	34.9
7	HOKIES.502	Heat	15.0	20.0	30.0	40.0	4.8	8.6	15.2
8	HOKIES.503	Heat	15.0	20.0	30.0	40.0	2.1	2.6	3.5
9	HOKIES.550	Heat	15.0	20.0	30.0	40.0	5.5	5.6	5.7
10	BotElec	Heat					2.1	16.8	15.2
11	HOKIES.502	Cap	15.0	20.0	30.0	40.0	0.0	0.0	0.0
12	HOKIES.503	Cap	15.0	20.0	30.0	40.0	0.0	0.0	0.0
13	HOKIES.550	Cap	15.0	20.0	30.0	40.0	0.0	0.0	0.0
14	BotElec	Cap					0.0	0.0	0.0

Table Output with Node+Sheet Row Format

	A	B	C	D	E	F	G	H	I
1			SurvLow	OpLow	OpHigh	SurvHigh	Min	Avg	Max
2	Node/Group	Sheet					[°C]	[°C]	[°C]
3	BotElec	Temp					23.9	30.5	34.9
4	BotElec	Heat					2.1	16.8	15.2
5	BotElec	Cap					0.0	0.0	0.0
6	HOKIES.502	Temp	15.0	20.0	30.0	40.0	27.9	31.8	34.8
7	HOKIES.502	Heat	15.0	20.0	30.0	40.0	4.8	8.6	15.2
8	HOKIES.502	Cap	15.0	20.0	30.0	40.0	0.0	0.0	0.0
9	HOKIES.503	Temp	15.0	20.0	30.0	40.0	27.9	31.8	34.9
10	HOKIES.503	Heat	15.0	20.0	30.0	40.0	2.1	2.6	3.5
11	HOKIES.503	Cap	15.0	20.0	30.0	40.0	0.0	0.0	0.0
12	HOKIES.550	Temp	15.0	20.0	30.0	40.0	23.9	27.8	31.8
13	HOKIES.550	Heat	15.0	20.0	30.0	40.0	5.5	5.6	5.7
14	HOKIES.550	Cap	15.0	20.0	30.0	40.0	0.0	0.0	0.0

Table Output Re-Sorted with Node+Sheet Row Format

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12. Graphical Tables (*TARP Pro only*)

Graphical Tables display the maximum/minimum temperature predictions as error bars within a bar graph which also highlights up to two sets of limits. Furthermore, a user may add up to 6 user points to indicate other temperatures of relevance (e.g. testing limits, steady state, etc.). The user points may be formatted as desired with numerous symbol, color and size choices. This method of display allows for many nodes or groups to be displayed in a single table without the need for displaying the actual numeric values. If a node has a value that exceeds its limits, then the error bar extends into that portion of the bar graph, clearly showing the violation. The Graphical Table Properties form is shown below.

Table Title: XL Sheet:

Lower Outer Limit	Lower Inner Limit	Pri Lower Temperature	Pri Upper Temperature	Upper Inner Limit	Upper Outer Limit
SurvHigh OpHigh OpLow SurvLow	-None- SurvHigh OpHigh OpLow SurvLow	Temps Heats	Temps Heats	-None- SurvHigh OpHigh OpLow SurvLow	SurvHigh OpHigh OpLow SurvLow

Error Bar: Style: Color: Weight:

User Point	Sheet Name (top) Description (bottom)	Timestep (top) Symbol (bottom)	Fore Color (top) Back Color (bottom)	Size Shadow
User Point 1	<input type="text" value="Temps"/> <input type="text" value="Steady State"/>	<input type="text" value="SS"/> <input type="text" value="Diamond"/>	<input type="text" value="Black"/> <input type="text" value="Black"/>	<input type="text" value="10"/> <input type="checkbox"/>
User Point 2	<input type="text"/> <input type="text" value="User Point 2"/>	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	<input type="text" value="5"/> <input type="checkbox"/>
User Point 3	<input type="text"/> <input type="text" value="User Point 3"/>	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	<input type="text" value="5"/> <input type="checkbox"/>
User Point 4	<input type="text"/> <input type="text" value="User Point 4"/>	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	<input type="text" value="5"/> <input type="checkbox"/>
User Point 5	<input type="text"/> <input type="text" value="User Point 5"/>	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	<input type="text" value="5"/> <input type="checkbox"/>
User Point 6	<input type="text"/> <input type="text" value="User Point 6"/>	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	<input type="text" value="5"/> <input type="checkbox"/>

Graphical Preview: A horizontal bar with red and yellow segments and a black error bar extending across the yellow segment.

12.1 Defining Limits and Data

Up to two sets of limits may be defined on the high and low side. The *Upper/Lower Outer* limits typically represent a red limit (or possibly a survival limit), while the *Upper/Lower Inner* limits typically represent a yellow (or possibly an operational limit). The available limit names are based on the user specified [LimitFile](#) defined in the [AdditionalFiles](#) section of the main interface. The Lower and Upper temperature predictions come from the selected sheet(s) in the *Lower Temperature* and *Upper Temperature* listboxes. If multiple sheets are selected, then the maximum temperature found for each node/group on the *Upper Temperature* sheets is reported. Similarly, if multiple sheets are selected for *Lower Temperature*, then the minimum temperature is selected. The maximum or minimum values may occur on different sheets for different nodes/groups.

If MaxGroup or MinGroup [parameters](#) are defined for any groups included in the Graphical Table, a *Lower Temperature* entry displays the minimum of the MinGroup parameter. Similarly, an *Upper Temperature* entry displays the maximum of the MaxGroup parameter. This is useful for determining the absolute minimum and/or maximum temperature of all nodes in a group over a period of time. If no MaxGroup or MinGroup parameters are found, then an *Upper Temperature* entry displays the maximum average temperature of all the nodes in the group, with similar behavior for Lower Temperatures. The table below explains this best.

	A	B	C	D	E	F	G	H	I	J	K	L
1	MajorGroup	MinorGroup	SubGroup	Node	0.00	1.00	2.00	3.00	4.00	Min	Avg	Max
2	Group1	Group1	Group1	SUBMODEL.1	1.00	2.00	3.00	2.00	1.00	1.00	1.80	3.00
3	Group1	Group1	Group1	SUBMODEL.2	3.00	4.00	3.00	2.00	3.00	2.00	3.00	4.00
4	Group1	Group1	Group1	SUBMODEL.3	5.00	3.00	0.00	1.00	4.00	0.00	2.60	5.00
5				Group1	3.00	3.00	2.00	1.67	2.67	1.67	2.47	3.00
6				MaxGroup1	5.00	4.00	3.00	2.00	4.00	2.00	3.60	5.00
7				MinGroup1	1.00	2.00	0.00	1.00	1.00	0.00	1.00	2.00

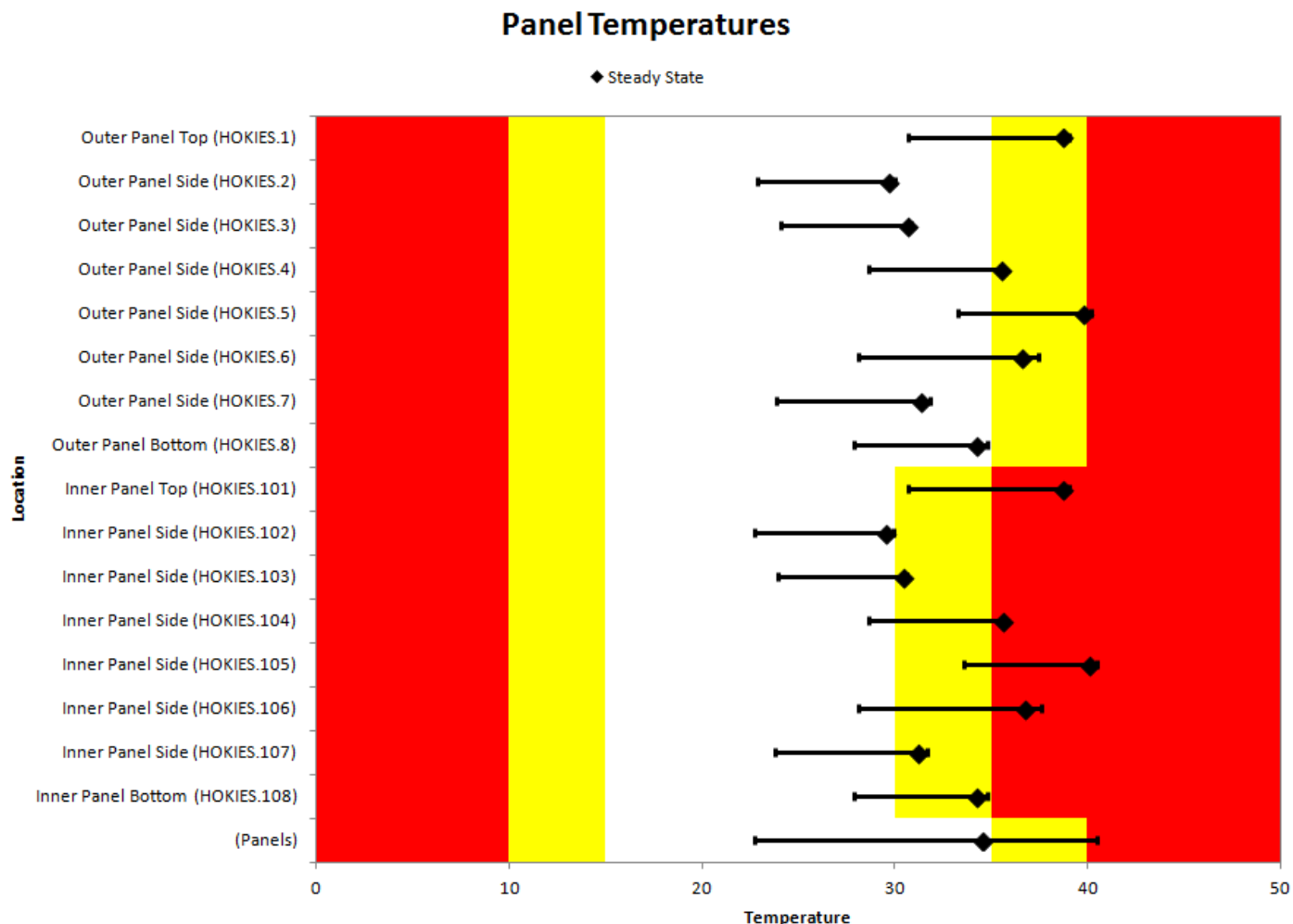
The Minimum temperature of Group1 is 1.67 (the minimum *average* of SUBMODEL.1-3 over the time range 0.0 to 4.0), whereas the minimum of the MinGroup parameter for Group1 is 0.0 (the minimum temperature of SUBMODEL.1-3 over the time range 0.0 to 4.0). Similarly the maximum for Group1 is 3.0, whereas the maximum of the MaxGroup parameter for Group1 is 5.0.

12.2 User Points

Up to six user points may be added to any GraphicalTable. These points may represent anything the user desires. Some examples may include what a component was tested to, steady state values, pre and post eclipse points, etc. These points are defined by a DataSet and a timestep (or Minimum, Average, or Maximum). The user may also specify a label to display on the table to identify the purpose of the point. The user may change the symbol, foreground color, background color, size, and shadow of the point. All fields must be specified in order to fully define the point. If any field (excepting the shadow checkbox) is left empty, then the User Point will be ignored.

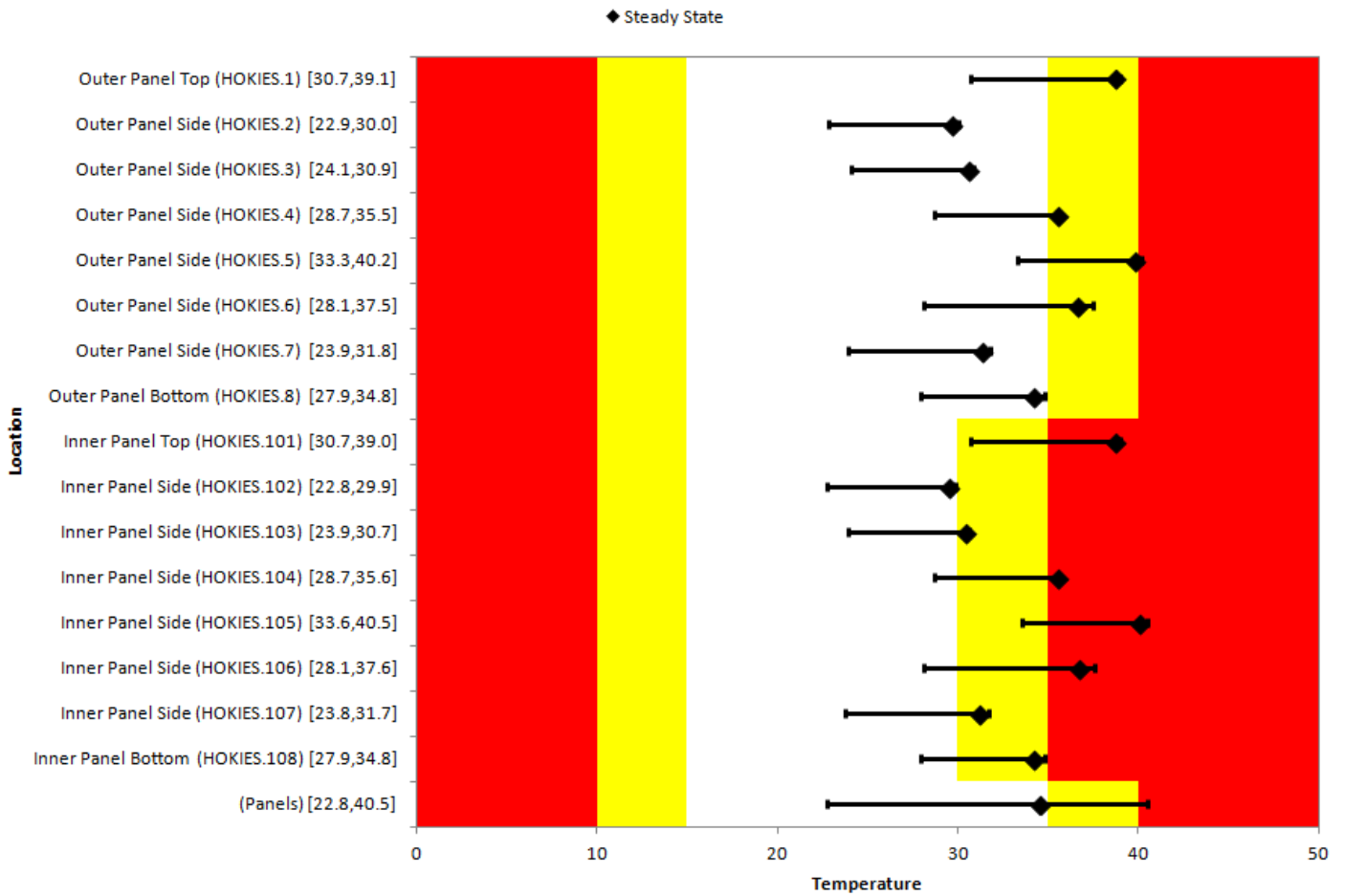
12.3 Graphical Table Output

Sample Graphical Table output is shown below. The Graphical Table includes two limits (Survival and Operational) and nodal descriptions. The upper limit for HOKIES.1-8 is 40, while the upper limit for HOKIES.101-108 is 35, as shown in the Graphical Table. The Graphical Table also shows a Group, with the displayed values being a MaxGroup and MinGroup parameter evaluation. The error bars on each row represent the maximum and minimum predicted temperatures from the specified DataSet. Lastly, a User Point is added to show the Steady State predictions. Setting Cell A1 to “Descriptions with Values” on the GraphicalTableData worksheet in the created workbook appends the maximum and minimum predict values to the description as shown in the second Graphical Table.



This Graphical Table shows the Descriptions with the Values.

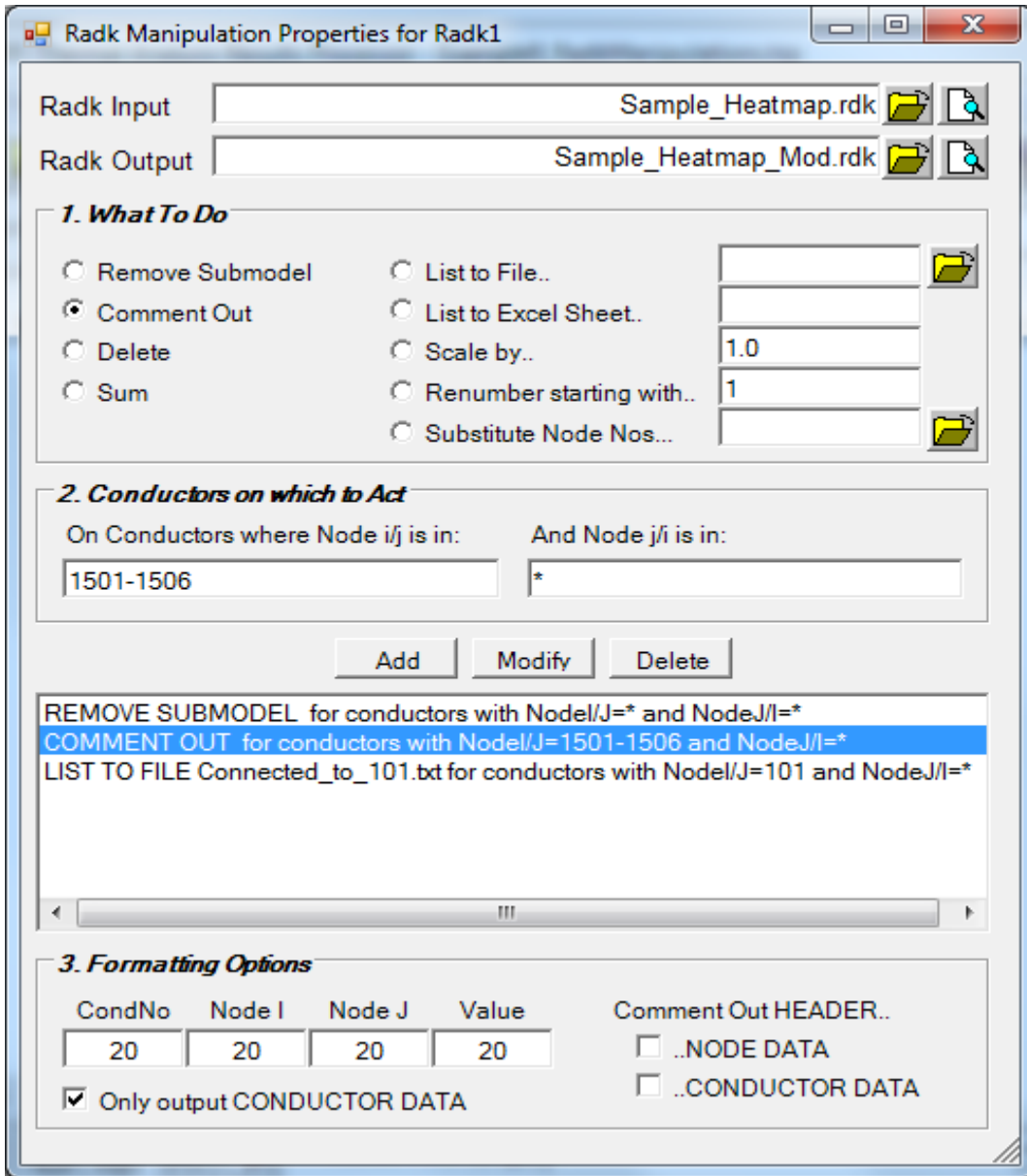
Panel Temperatures



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13. RadkManipulations (*TARP Pro only*)

RadkManipulations allow the user to post process radiation couplings from TSS or RadCad. The general approach is to perform some action(s) on some set(s) of radks and output according to the format specified. The RadkManipulation properties form is shown below.



13.1 File and Action Selection

The user first selects a *Radk Input* file to be processed. A *Radk Output* file should also be specified if it is needed. (If **only** outputting to an Excel sheet or file, the *Radk Output* file may not need to be specified). Next, the user selects an action to perform from the following list: Remove Submodel Names, Comment, Delete, Sum, List to a File, List to an Excel Worksheet, Scale, Renumber, or Substitute Node Nos. Some actions require further input (e.g. Scale Factor, Worksheet name, etc.), while others need no further information than the action itself. Once an action is selected, the conductor(s) on which to perform that action is selected.

13.2 Conductor Selection

Three methods exist for specifying the conductors to act upon: All Conductors, Conductors connected to one range of nodes, or conductors between two ranges of nodes. To select all conductors, enter * for both the Node i/j and Node j/i fields. To select a set of conductors connected to a particular range or a specific node, enter the range (e.g. 1-100, MAIN.200-299, SUB.2) into the Node i/j field and * in to the Node j/i field. Lastly to operate on conductors between particular node ranges, enter the two ranges into the Node i/j and Node j/i fields respectively. Note that a range may be only a single node, however ranges may only reference nodes and not groups. Once the action and the conductor(s) on which to act have been specified, they are added to the list by clicking the *Add* button. If the user needs to change something in an existing Action sequence, the radk request may be selected from the list, changed, and then updated by clicking the *Modify* button. Finally, if the action is no longer needed, it may be removed from the list using the *Delete* button.

13.3 Generating the Output

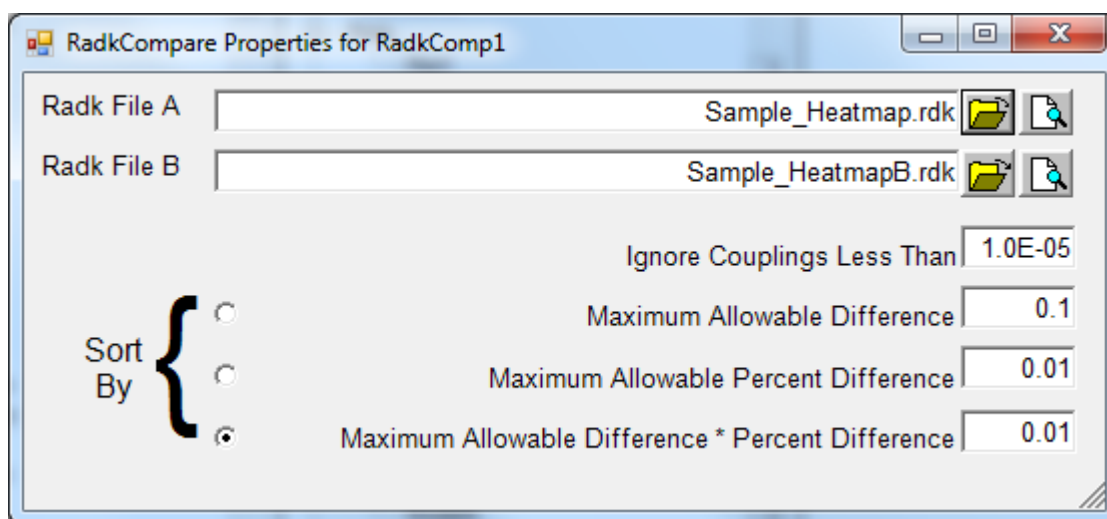
Each action and conductor set is processed in the order they were input. In this manner, a user may first remove the submodel, then comment out all conductors connected to a blocker node, then renumber, and finally scale all conductors connected to a particular node due to an emissivity change. The results of this sequence of actions would be produced in the final output file. The output would be spaced according to the column widths specified by the user under *Formatting Options*. Furthermore, if varying conductors were output and the *Only Output CONDUCTOR DATA* option checked, the time varying arrays and VARIABLES1 call statements are removed. Lastly, the *NODE DATA* or *CONDUCTOR DATA* headers may be commented out if desired. Sample output is shown below.

```
C TARP RadkManipulation performed the following actions:
C REMOVE SUBMODEL for all conductors where Node I/J is in range: * and Node J/I is i:
C COMMENT for all conductors where Node I/J is in range: 77777 and Node J/I is in
C DELETE for all conductors where Node I/J is in range: 88888 and Node J/I is in :
C LIST TO FILE C:\Program Files\TARP\Samples\To_101.rdk for all conductors where N
C LIST TO EXCEL SHEET 101 for all conductors where Node I/J is in range: 101 and N
C SCALE BY 1.15 for all conductors where Node I/J is in range: 1 and Node J/I is i:
C RENUMBER STARTING WITH 100000 for all conductors where Node I/J is in range: * a:
C
C
C *** Area units are          feet^2
C *** Multiplier              = 1.00000
C *** Bij cutoff fraction     = 0.00000
C *** Bij minimum fraction    = 0.00000
C *** Bij sum fraction        = 0.00000
C
C
C      -100000,          1,          99999, 0.0039628 * 1.15
C      -100001,          2,          99999, 0.032526
C      100000,           1,          99999, 0.000000
C      -100034,          1506,       99999, 0.0031090
C      -100035,          1,          2, 8.2108e-05 * 1.15
C      -100036,          1,          3, 0.00014425 * 1.15
C      -100037,          1,          4, 0.00015402 * 1.15
C      -100038,          1,          5, 0.000015337 * 1.15
```

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14. RadkCompares (*TARP Pro only*)

RadkCompares allow the user to compare two output Radk sets from either TSS or RadCad. Couplings must meet a user specified minimum Radk value to be output. Comparable couplings (i.e. between the same pair of nodes) are then output if any of the following exceed the user specified allowable criteria: (1) Maximum Allowable Difference $[\text{RadkA} - \text{RadkB}]$, (2) Maximum Allowable Percent Difference $[(\text{RadkA} - \text{RadkB})/\text{RadkA}]$, or (3) Maximum Allowable Difference * Percent Difference $[(\text{RadkA} - \text{RadkB})^2/\text{RadkA}]$. One of these three methods is also specified as the sort method for the output, with the latter being preferred as it highlights the largest radks with large percentage differences. Furthermore, any couplings found in FileA but not in FileB will be output as well as couplings in FileB but not FileA, so long as they meet the minimum radk value.



14.1 RadkCompare Output

RadkCompare Output is shown below. Radks in FileA only are shown on the left and Radks in FileB only are shown on the right. The differences between the two files are shown below.

Radk A:	C:\TARP\TARP\TARP\bin\Samples\Sample_Heatmap.rdk								
Radk B:	C:\TARP\TARP\TARP\bin\Samples\Sample_HeatmapB.rdk								
Conductors only in Radk A				Conductors only in Radk B					
<u>CondNoA</u>	<u>Node I</u>	<u>Node J</u>	<u>CondValA</u>	<u>CondNoB</u>	<u>Node I</u>	<u>Node J</u>	<u>CondValB</u>		
-5348	HOKIES.702	HOKIES.703	0.003918	-5348	HOKIES.702	HOKIES.1703	0.003918		
Dissimilar Conductors in Both A & B									
<u>CondNoA</u>	<u>CondNoB</u>	<u>Node I</u>	<u>Node J</u>	<u>CondValA</u>	<u>CondValB</u>	<u>Delta</u>	<u>% Delta</u>	<u>Delta * %</u>	
-5001	-5001	HOKIES.2	HOKIES.999	0.03	0.042526	0.01	30.74463506	0.307446	
-5002	-5002	HOKIES.3	HOKIES.999	0.04	0.04991	0.01	25.05637685	0.250564	
-5003	-5003	HOKIES.4	HOKIES.999	0.04	0.053327	0.01	23.08029635	0.230803	
-5000	-5000	HOKIES.1	HOKIES.999	0	0.004963	0.001	25.23468255	0.025235	

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15. Backloads and Equivalent Sinks (TARP Pro only)

Backloads and Equivalent Sinks (EqSinks) are methods of representing a complex radiative environment with a simple heat load or radiative coupling and temperature. To generate the Backloads or EqSinks, a subset of nodes (Backload List) for which to calculate the Backloads or EqSinks must first be added to the Backload object from the main interface. The Backload is computed as the $\sum_{j=1:N} \sigma(\text{Radk}_{ij})T_j^4$ for each (Node j) which is radiatively coupled to a (Node i) in the Backload List. The Radk_{ij} value is retrieved from the input Radk file, and the T_j retrieved from the Temperature file. EqSinks are similar but incorporate the environmental backloading into the equations as well to generate a single temperature and radk to that temperature that would produce an identical heat flow from Node i to the EqSink as in the integrated environment. Both Backloads and EqSinks are computed for **nodes only** and output to the specified file(s) in a format readily usable by thermal solvers. Backloads for groups are the sum of backloads for all nodes in the group, whereas EqSinks for groups is the average EqSink Temperatures of all nodes weighted by the Radk value for each node and are shown within the output Excel workbook if the output options are specified. The Backload properties form is shown below.

Calculate..

Use Toffset , Sigma , and Starting Array No

Use Starting Node No , and Starting Cond No for Eq Sinks

Imperfect Sink Emissvity (may result in temperatures being constrained to Lower Limit)

Constrain lower sink temperature to to account for hardware/testing limitations

Ignore Couplings where adjoining node is

Use TMM couplings instead for these nodes

Ignore couplings where both nodes are Backload Nodes

Using Files..

	Filename	Format		
Radk	<input type="text" value="Sample_Heatmap.rdk"/>	TSS	<input type="button" value="Folder"/>	<input type="button" value="Search"/>
Temperature	<input type="text" value="Sample_Heatmap.OUT"/>	SINDA85	<input type="button" value="Folder"/>	<input type="button" value="Search"/>
Heat File 1	<input type="text" value="Sample_Heatmap.hrt"/>	TSS	<input type="button" value="Folder"/>	<input type="button" value="Search"/>
Heat File 2	<input type="text"/>		<input type="button" value="Folder"/>	<input type="button" value="Search"/>
TMM Input	<input type="text"/>		<input type="button" value="Folder"/>	<input type="button" value="Search"/>
Output	<input type="text" value="Sample_Heatmap.bl"/>	SINDA85	<input type="button" value="Folder"/>	<input type="button" value="Search"/>
Validation	<input type="text" value="Sample_HeatMap_Validation.csv"/>		<input type="button" value="Folder"/>	<input type="button" value="Search"/>

Output Backloads to Excel Sheet

Output Equivalent Sinks to Excel Sheet

Use T⁴ Average

15.1 Specifying the Backload/EqSink Inputs

First, the temperature offset to absolute zero is specified along with the Stefan-Boltzmann constant. These values are based on the output units of the temperature and radk files. The starting numbers for the output arrays, equivalent sink nodes, and couplings to equivalent sinks may also be specified if the default values of 1 are not desired. The *Ignore couplings where both nodes are Backload Nodes* option allows the user to specify if the backloads/equivalent sinks include or exclude self-view (views of one backload surface to another). Often, nodes that are both part of the same subsystem have their views calculated by the subsystem stand-alone model. Therefore, it is typically desired to exclude the radiative exchange between the surfaces as it is computed by the stand-alone thermal model. The *Ignore Couplings where adjoining node is* and *Use TMM couplings instead for these nodes* options are reserved for future features to include interface boundary nodes and couplings and allow for better control of which nodes to include in the backload calculation.

The user must specify, at a minimum, the Radk and Temperature output files as well as their formats. If *Heat File 1* and *Heat File 2* are also specified, the arrays and steady state values associated with nodes in the Backload list are extracted and included in the output. The base name of the specified *Output* file is used to generate the .bl and .snk files which contain appropriate TMM syntax for direct use in a thermal model. Lastly, if a *Validation* file is specified, all individual conductor components used to calculate the backload or equivalent sink are output to a secondary file for further evaluation.

Further options are available that affect the output. Assumption of an imperfect emissivity sink requires a lower temperature than for a perfect emissivity sink. The equation below shows the estimation of the imperfect sink temperature:

$$(\Sigma \text{Radk}) * (T_i^4 - T_{\text{sink}}^4) \approx (\Sigma \text{Radk}) * \epsilon_{\text{sink}} * (T_i^4 - T_{\text{imperfect}}^4)$$

Rearranging yields...

$$T_{\text{imperfect}} \approx \{ [T_{\text{sink}}^4 + (\epsilon_{\text{sink}} - 1) * T_i^4] / \epsilon_{\text{sink}} \}^{1/4}$$

From this equation, the necessary sink temperature for an imperfect sink surface is shown to depend on the temperature of the surface itself. This may also be thought of as having dependence on the heat transferred from the surface, as the two are related. It is also worth noting that a low enough emissivity of the sink surface may result in an inability to maintain the same heat transfer and temperature conditions as the perfect equivalent sink (i.e. a temperature lower than absolute zero would be necessary to accept the amount of heat rejected). For these instances, the temperature is constrained to the lowest allowable value set by the user (or Temp Offset if it is applicable). The user may also opt to constrain the lower temperature, primarily for reasons of testing limitations. For example, a test cryo-panel may need to be -230°C to properly simulate the sink, but only be able to go to -180°C based on liquid nitrogen temperatures.

15.2 Creating and Using the Backload/EqSink Output

To use the backloads with a thermal model, the stand-alone subsystem model is used to generate radiation couplings. These radks include a larger view to space for the subsystem surfaces than the integrated model, therefore, an additional heatload must be added “back” to compensate, hence the term backload. The backloads are then included along with these radks to run the thermal model. This is the same method used by most thermal radiation codes to calculate the environmental loading.

To output the data in a format for further manipulation or plotting, use the *Output Backload / Equivalent Sink to Excel* options. This creates internal DataSets which generate worksheets in the output workbook with the Equivalent Sink temperatures and/or Backloads. These values may then be combined, manipulated, or plotted within Excel® manually.

Combining backloads is a simple summation. However, this is, in effect, averaging out local heat sources. If a large, subdivided panel had a few locations with high backloads and many locations with low backloads, the overall sum of backloads over the entire panel would show a relatively low backloading. Since the backload term already includes the area and emissivity, removing these terms provides the incident flux from backloading surfaces, which may be a better term to average and then apply to the composite receiving surface. (i.e. average based on an incident backload flux rather than a pure backload).

To combine nodal equivalent sinks to estimate a group equivalent sink for multiple nodes/surfaces, it is recommended to use a T^4 weighted average of the output nodes based on the Radk sum. $\{\Sigma(\text{Radk}_i * T_i^4) / \Sigma \text{Radk}_i\}^{1/4}$ Therefore, higher emissivity and larger area surfaces would be weighted higher than lower emissivity and smaller area surfaces for a composite equivalent sink. This is the default technique used by TARP when calculating the EqSink for a group. The user may override this and use a simple weighted average based on Radk values. $\{\Sigma(\text{Radk}_i * T_i) / \Sigma \text{Radk}_i\}$

15.3 Backload/EqSink Calculations and Derivation

Starting with the basic energy balance equation for node i in the node range (1:N)...

$$(i) \quad mCp \, dT/dt = Q_{in} - Q_{out} + Q_{dissipation} + Q_{env,radiative}$$

Q_{in} and Q_{out} can be further divided into $Q_{in,linear}$, $Q_{out,linear}$, and $Q_{in,radiative}$, $Q_{out,radiative}$ yielding...

$$(ii) \quad mCp \, dT/dt = (Q_{in,linear} - Q_{out,linear}) + (Q_{in,radiative} - Q_{out,radiative}) + Q_{dissipation} + Q_{env,radiative}$$

Extracting and expanding $(Q_{in,radiative} - Q_{out,radiative})$ yields...

$$(iii) \quad (Q_{in,radiative} - Q_{out,radiative}) = \sigma \sum_{j=1,N} \text{Radk}_{ij} (T_j^4 - T_i^4)$$

$$(Q_{in,radiative} - Q_{out,radiative}) = \sigma \sum_{j=1,N} \text{Radk}_{ij} (T_j^4) - \{\sigma (T_i^4) \sum_{j=1,N} \text{Radk}_{ij}\}$$

Assuming that $\sigma \sum_{j=1,N} \text{Radk}_{ij} \approx \sigma \text{Area}_i \varepsilon_i (\sum \mathcal{F}_{ij}=1)$ and $Q_{BL,radiative} = \sigma \sum_{j=1,N} \text{Radk}_{ij} (T_j^4)$ yields...

$$(iv) \quad mCp \, dT/dt = (Q_{in,linear} - Q_{out,linear}) + Q_{dissipation} + Q_{env,radiative} + Q_{BL,radiative} - \sigma \text{Area}_i * \varepsilon_i (T_i^4)$$

As seen in equation (iii), the radiative heat transfer now only depends on the area, emissivity, and temperature of Node i and the Backload ($Q_{BL,radiative}$). This may be further rearranged to find the equivalent sink temperature where...

$$(v) Q_{env,radiative} + Q_{BL,radiative} - \sigma Area_i \epsilon_i (T_i^4) = \sigma Area_i \epsilon_i (T_{sink}^4 - T_i^4)$$

The equivalent sink temperature is then found to be...

$$(vi) T_{sink} = \{ (Q_{env,radiative} + Q_{BL,radiative}) / (\sigma Area_i \epsilon_i) \}^{1/4}$$

These equations are all derived assuming that the entire field of view of node i is replaced with either a Backload or an Equivalent Sink. If only a partial field of view is to be replaced, a similar derivation can be made. This may be desirable when node j's in the field of view of node i are also included in the subsystem (e.g. 2 panels on an instrument). For this case, starting again the basic energy balance equation for node i, where the node range (1:n) includes all nodes in the Backload List, and (n+1:N) includes all nodes not in the Backload List...

$$(vii) \Delta Q_{radiative} = \sigma \sum_{j=1,n} Radk_{ij} (T_j^4 - T_i^4) + \sigma \sum_{j=n+1,N} Radk_{ij} (T_j^4 - T_i^4)$$

$$\Delta Q_{radiative} = \sigma \sum_{j=1,n} Radk_{ij} (T_j^4) + \sigma \sum_{j=n+1,N} Radk_{ij} (T_j^4) - \sigma (T_i^4) \{ \sum_{j=1,n} Radk_{ij} + \sum_{j=n+1,N} Radk_{ij} \}$$

$Q_{BL,radiative}$ is now defined as $\sigma \sum_{j=n+1,N} Radk_{ij} (T_j^4)$ yielding...

$$(viii) \Delta Q_{radiative} = \sigma \sum_{j=1,n} Radk_{ij} (T_j^4) + Q_{BL,radiative} - \sigma (T_i^4) \{ \sum_{j=1,n} Radk_{ij} + \sum_{j=n+1,N} Radk_{ij} \}$$

Further examination shows that the first and third terms are computed by the radiation model containing only nodes in the Backload List (e.g. instrument, subsystem). The fourth term $[\sigma (T_i^4) \sum_{j=n+1,N} Radk_{ij}]$ is also approximated with the stand alone model as a larger view to space, where previously nodes in the (n+1:N) range had been.

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16. HeatMaps

HeatMaps are the most powerful feature available in TARP™. HeatMaps are specialized workbooks with embedded VBA macros for computing and displaying heat flows within a model. Therefore, it is necessary to enable macros in Excel®. If macros have been automatically disabled, they may be enabled under Tools-Macro-Security in Excel® with the Medium security option. For XL2007, the macro settings can be found under Excel Options-Trust Center-Trust Center Settings...-Macro Settings. A HeatMap workbook is capable of displaying heat flow between two nodes, between two groups, from a group to nodes, and from a node to groups. With 5 levels of grouping plus an additional DynamicGroup option, a variety of heat flow paths may easily be investigated. A sample workbook for a node-to-group HeatMap is shown below.

Description	Inner Panel Top				SUMMARY:	In	Out		
Node i	HOKIES.101	Temp	93.16		Conduction	57.37	57.51		
Time	(2) SS	Format	0.00		Radiation	0.00	1.12		
Sigma	1.71E-09	Min Heat	0.001		Source	1.37	-		
Toffset	459.6	Heat to	MinorGroup		Sum	58.74	58.63		
Sort By	Type;Heat	Model	A						
<i>Heat Flows Sorted by Type (Asc), then Heat (Asc)</i>					<i>Heat Flows Sorted by Type (Asc), then Heat (Desc)</i>				
Node j	Type	Cond	Temp j	Heat j	Node j	Type	Cond	Temp j	Heat j
INNER	Lin	8.993401	87.86	-57.41	TOPELEC	Lin	176.044	93.80	57.37
OUTER	Lin	100	87.85	-0.10	OUTER	Lin	100	87.85	-0.10
TOPELEC	Lin	176.044	93.80	57.37	INNER	Lin	8.993401	87.86	-57.41
SPACE	Rad	0.006322	-460.00	-1.01	MISC	Rad	0.001622	-38.60	-0.11
MISC	Rad	0.001622	-38.60	-0.11	SPACE	Rad	0.006322	-460.00	-1.01

Node-to-Group HeatMap

16.1 Creating the HeatMap

To create a HeatMap workbook, the [HeatMap](#) option is first selected under [Workbook Properties](#) at the Main Interface. For TARP Pro users, a prompt is displayed to create [DataSets](#) or [Binary HeatMap Files](#). For TARP users, only the DataSet option is available and no prompt is issued. For DataSets, three DataSets are automatically created: Temp (Temperatures), Heat (Heat Loads), and Cond (Conductances). Therefore, each output timestep must include Temperatures, Heat Loads, and Conductances. Failure to do this may result in Temperatures from one timestep being used with Heat Loads from another, since HeatMaps assume that each column on the three DataSet sheets represents the same timestep. If too many data points are encountered (in particular for the conductances), the additional data “spills over” onto sequentially numbered sheets (e.g. Cond2, Cond3, etc.). While there is no technical limit on the number of sheets, a very large workbook may fail to open on a user’s system. The size of a workbook that can be opened is dictated by a number of factors, including available memory.

Enabling a HeatMap also enables the [Include Node Descriptions](#) option, and therefore requires the [InputFile](#) (for SINDA and TAK outputs) to be specified. This InputFile is used to extract the node pairs for each conductor number. For ESABLK outputs, the node pairs and descriptions are included in the output file; therefore, it is not required. The node pairs and conductor numbers are written to the Lin and Rad sheets for linear conductors and radiative conductors respectively. For SINDA models, the HeatMaps do not make any associations between which submodels are built

and which are not. Therefore, errors may occur if the user does not build all the submodels, since a conductor may exist on the Lin/Rad sheets but not on the Cond sheets. If this is the case, the user is advised to manually remove the conductors not built in the solution from the Lin/Rad sheets and select ReCalculateAll from the TARP menu.

16.2 Controlling the HeatMap Output

Description	Inner Panel Top		
Node i	HOKIES.101	Temp	93.08
Time	(2) SS	Format	0.00
Sigma	1.71E-09	Min Heat	0.0
Toffset	460	Heat to	SubGroup
Sort By	Type;Node	Model	A

All cells requiring input from the user are highlighted in red. When the workbook is initially opened, default values for *Sigma* and *Toffset* are entered. The user first sets these to the appropriate values for their model. Next, the

user selects the timestep of interest in the *Time* drop-down box. At this point, macros begin calculating the heat flow through each conductor and store the group-to-group and node-to-group heat flow components. When a value is specified for *Node i*, all values connected to it are displayed. *Node i* may be a group or a node; specifying a group results in Group-to-___ heat flows, while specifying a node results in Node-to-___ heat flows. Similarly, the *Heat To* field may be changed to Node, MajorGroup, MinorGroup, SubGroup, Sub2Group, Sub3Group,, or DynGroup. Setting the *Heat to* field to Node results in ___-to-Node heat flows, etc. Therefore, the user has a number of options available for displaying heat flows based on the *Node i* and *Heat to* values. For example, if a group is specified as *Node i* and the *Heat to* is set to MinorGroup, then the heat flows displayed are Group-to-Group at the MinorGroup level. Any nodes not included in a group are displayed in the MISC group by default. This preserves energy balances throughout the model. Double clicking a *Node j* value replaces *Node i* with the *Node j* value selected and outputs the new HeatMap.

The output data displayed includes the Node j description, Node/Group j, conductor type, conductance value, temperature of Node/Group j, and heat flow to each Node/Group j connected to Node/Group i. All linear conductors are grouped together as are all radiative conductors. The left hand side sorts the data from the largest quantity of heat leaving Node/Group i (negative heat) to the largest amount of heat entering Node/Group i (positive). Optionally, the data may be sorted by conductor type then node instead. The right hand side reverses the order. The user may control how many decimal places are shown for temperature and heat flow using the formats available in the *Format* field. Furthermore, the user may opt to only display heat flows above the cutoff specified in *Min Heat*. In the top right, a summary table is displayed, which includes the heat in and out by conduction and radiation, as well as the heat applied to node/group i. The sum in and sum out are also displayed, giving an idea of how balanced Node/Group i is. These values are based on the displayed values, so if the user has entered a *Min Heat* greater than 0.0, some energy is not be included in these sums. Note that energy storage/release is not included, as the difference between output timesteps is generally much larger than the calculation timesteps used and may not be a good indicator of *instantaneous* energy storage/release.

Description					INNER		SUMMARY:		
Node i	HOKIES.101	Temp	93.16			Conduction	67.26	67.40	
Time	(2) SS	Format	0.00			Radiation	0.00	1.12	
Sigma	1.71E-09	Min Heat	0.001			Source	1.37	-	
Toffset	459.6	Heat to	Node			Sum	68.63	68.52	
Sort By	Type;Heat	Model	A						

Heat Flows Sorted by Type (Asc), then Heat (Asc)						Heat Flows Sorted by Type (Asc), then Heat (Desc)					
Description j	Node j	Type	Cond	Temp j	Heat j	Description j	Node j	Type	Cond	Temp j	Heat j
Inner Panel Side	HOKIES.102	Lin	1.4989	78.88	-21.40	SBand PMod	HOKIES.703	Lin	20.076	95.57	48.52
Inner Panel Side	HOKIES.103	Lin	1.4989	80.56	-18.88	Inner Panel Side	HOKIES.105	Lin	1.4989	97.86	7.05
Inner Panel Side	HOKIES.107	Lin	1.4989	81.63	-17.28	PPU	HOKIES.701	Lin	29.215	93.37	6.22
Inner Panel Side	HOKIES.104	Lin	1.4989	90.66	-3.74	GPS Mod	HOKIES.704	Lin	97.496	93.21	5.46
Inner Panel Side	HOKIES.106	Lin	1.4989	91.04	-3.17	Outer Panel Top	HOKIES.1	Lin	100	93.16	-0.10
Crosslink	HOKIES.702	Lin	29.257	93.06	-2.84	Crosslink	HOKIES.702	Lin	29.257	93.06	-2.84
Outer Panel Top	HOKIES.1	Lin	100	93.16	-0.10	Inner Panel Side	HOKIES.106	Lin	1.4989	91.04	-3.17
GPS Mod	HOKIES.704	Lin	97.496	93.21	5.46	Inner Panel Side	HOKIES.104	Lin	1.4989	90.66	-3.74
PPU	HOKIES.701	Lin	29.215	93.37	6.22	Inner Panel Side	HOKIES.107	Lin	1.4989	81.63	-17.28
Inner Panel Side	HOKIES.105	Lin	1.4989	97.86	7.05	Inner Panel Side	HOKIES.103	Lin	1.4989	80.56	-18.88
SBand PMod	HOKIES.703	Lin	20.076	95.57	48.52	Inner Panel Side	HOKIES.102	Lin	1.4989	78.88	-21.40
SPACE	HOKIES.99999	Rad	0.006322	-460.00	-1.01	Inner Panel	HOKIES.109	Rad	0.001622	20.95	-0.11
Inner Panel	HOKIES.109	Rad	0.001622	20.95	-0.11	SPACE	HOKIES.99999	Rad	0.006322	-460.00	-1.01

Node-to-Node HeatMap

Description					INNER		SUMMARY:		
Node i	INNER	Temp	87.86			Conduction	176.78	115.72	
Time	(2) SS	Format	0.00			Radiation	0.00	535.29	
Sigma	1.71E-09	Min Heat	0.001			Source	476.94	-	
Toffset	459.6	Heat to	Node			Sum	653.72	651.01	
Sort By	Type;Heat	Model	A						

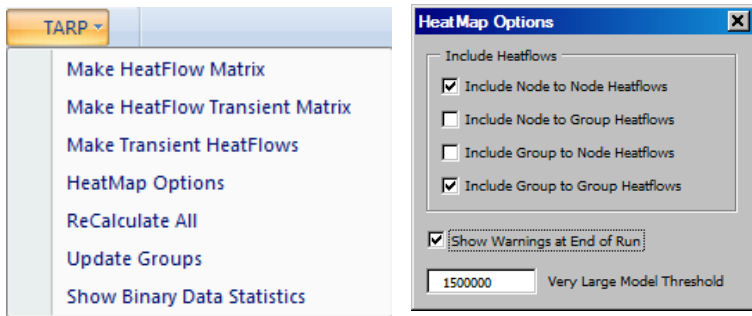
Heat Flows Sorted by Type (Asc), then Heat (Asc)						Heat Flows Sorted by Type (Asc), then Heat (Desc)					
Description j	Node j	Type	Cond	Temp j	Heat j	Description j	Node j	Type	Cond	Temp j	Heat j
Outer Panel Side	HOKIES.5	Lin	100	97.36	-50.20	SBand PMod	HOKIES.703	Lin	20.076	95.57	48.52
PPT-1 Capacitor	HOKIES.601	Lin	35.75	81.09	-19.20	Outer Panel Side	HOKIES.3	Lin	100	80.86	29.80
PPT-2 Capacitor	HOKIES.651	Lin	35.75	80.10	-16.48	Outer Panel Side	HOKIES.7	Lin	100	81.88	24.50
Outer Panel Side	HOKIES.4	Lin	100	90.53	-13.30	Outer Panel Side	HOKIES.2	Lin	100	79.10	21.60
Outer Panel Side	HOKIES.6	Lin	100	90.92	-12.80	Uplink	HOKIES.550	Lin	121.66	81.78	17.88
Crosslink	HOKIES.702	Lin	29.257	93.06	-2.84	CPU	HOKIES.502	Lin	260.44	89.08	10.16
Outer Panel Bottom	HOKIES.8	Lin	100	89.04	-0.80	Downlink	HOKIES.503	Lin	107.72	89.12	7.65
Outer Panel Top	HOKIES.1	Lin	100	93.16	-0.10	PPU	HOKIES.701	Lin	29.215	93.37	6.22
Battery Box External - Bottom	HOKIES.1503	Lin	151.13	89.08	4.99	GPS Mod	HOKIES.704	Lin	97.496	93.21	5.46
GPS Mod	HOKIES.704	Lin	97.496	93.21	5.46	Battery Box External - Bottom	HOKIES.1503	Lin	151.13	89.08	4.99
PPU	HOKIES.701	Lin	29.215	93.37	6.22	Outer Panel Top	HOKIES.1	Lin	100	93.16	-0.10
Downlink	HOKIES.503	Lin	107.72	89.12	7.65	Outer Panel Bottom	HOKIES.8	Lin	100	89.04	-0.80
CPU	HOKIES.502	Lin	260.44	89.08	10.16	Crosslink	HOKIES.702	Lin	29.257	93.06	-2.84
Uplink	HOKIES.550	Lin	121.66	81.78	17.88	Outer Panel Side	HOKIES.6	Lin	100	90.92	-12.80
Outer Panel Side	HOKIES.2	Lin	100	79.10	21.60	Outer Panel Side	HOKIES.4	Lin	100	90.53	-13.30
Outer Panel Side	HOKIES.7	Lin	100	81.88	24.50	PPT-2 Capacitor	HOKIES.651	Lin	35.75	80.10	-16.48
Outer Panel Side	HOKIES.3	Lin	100	80.86	29.80	PPT-1 Capacitor	HOKIES.601	Lin	35.75	81.09	-19.20
SBand PMod	HOKIES.703	Lin	20.076	95.57	48.52	Outer Panel Side	HOKIES.5	Lin	100	97.36	-50.20
SPACE	HOKIES.99999	Rad	3.508159	-460.00	-535.18	Inner Panel	HOKIES.109	Rad	0.001622	20.95	-0.11
Inner Panel	HOKIES.109	Rad	0.001622	20.95	-0.11	SPACE	HOKIES.99999	Rad	3.508159	-460.00	-535.18

Group-to-Node HeatMap

Description					INNER		SUMMARY:		
Node i	INNER	Temp	87.86			Conduction	98.05	36.98	
Time	(2) SS	Format	0.00			Radiation	0.00	535.29	
Sigma	1.71E-09	Min Heat	0.001			Source	476.94	-	
Toffset	459.6	Heat to	MinorGroup			Sum	574.98	572.27	
Sort By	Type;Heat	Model	A						

Heat Flows Sorted by Type (Asc), then Heat (Asc)					Heat Flows Sorted by Type (Asc), then Heat (Desc)				
Node j	Type	Cond	Temp j	Heat j	Node j	Type	Cond	Temp j	Heat j
MIDELEC	Lin	71.5	71.78	-35.68	TOPELEC	Lin	176.044	93.80	57.37
OUTER	Lin	800	87.85	-1.30	BOTELEC	Lin	489.82	86.66	35.69
HOUSING	Lin	151.13	89.27	4.99	HOUSING	Lin	151.13	89.27	4.99
BOTELEC	Lin	489.82	86.66	35.69	OUTER	Lin	800	87.85	-1.30
TOPELEC	Lin	176.044	93.80	57.37	MIDELEC	Lin	71.5	71.78	-35.68
SPACE	Rad	3.508159	-460.00	-535.18	MISC	Rad	0.001622	-38.60	-0.11
MISC	Rad	0.001622	-38.60	-0.11	SPACE	Rad	3.508159	-460.00	-535.18

Group-to-Group HeatMap



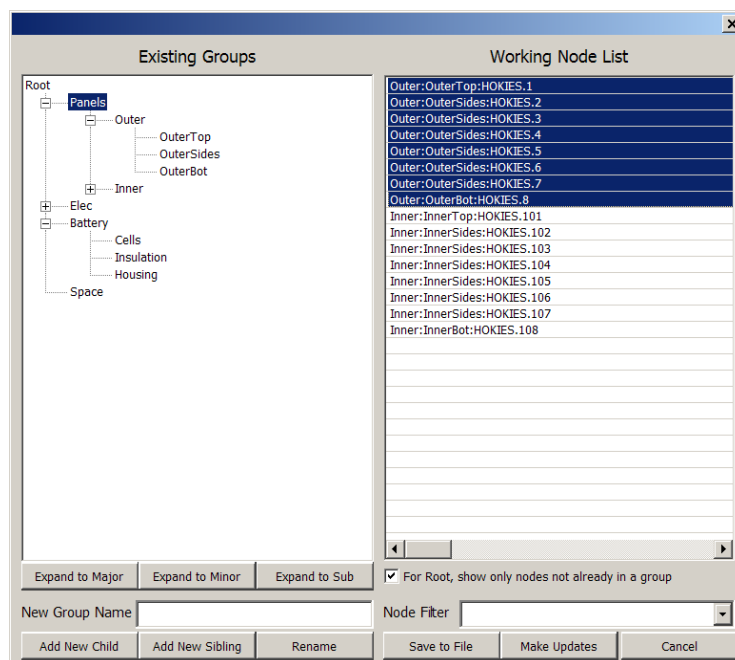
By default, the HeatMap options disable the Group to Node and Node to Group heat flow calculations to save memory and since these values are less used than node to node and Group to Group. These calculations can be reactivated using the HeatMap Options menu item under the Add-Ins: TARP menu. A ReCalculateAll should then be issued to ensure

that all data is properly calculated and available.

At times, particularly for cryo applications or small/isolating heat flow paths round off error can result in a heat flow not being displayed. Since the text output from the Output files is a finite precision, round off error may result in a temperature difference of zero, even where there is a non-zero heat flow path. To display these paths for a connectivity check, a negative Min Heat may be entered to ensure that all paths are displayed, even if the HeatFlow is calculated to be zero. Note that for Groups this will show all possible paths, even if the conductance is zero.

16.3 Dynamic Groups

The DynamicGroups option allows a user to expand some groups to detailed levels, while leaving other groups collapsed to simplistic representations. This is useful for investigating detailed heat flows in a specific portion of the model, without the need for detail throughout the remainder of the model. To change the DynamicGroups setting, the user double clicks the DynGroup cell on the *NodeInfo* sheet or selects *Update Groups* from the TARP menu. A group tree is shown similar to the one below. Only groups shown in the tree are considered “active”. For the case below, the Panels MajorGroup is expanded to include the Inner and Outer Minor groups, the Elec MajorGroup is expanded to include the Lower, Mid, and Upper MinorGroups, but the Battery group is collapsed to a single MajorGroup, even though it does have child groups defined under it. After the user closes the Dynamic Groups form, the heat flows are recalculated based on the new group definitions and the HeatMap is re-output.



16.4 Group to Group Heat Flow Matrix

An option exists to display heat flows between groups in a matrix format by selecting *Make HeatFlow Matrix* from the TARP menu in the Excel® workbook. This option creates up to six worksheets: *MajorGroup*, *MinorGroup*, *SubGroup*, *Sub2Group*, *Sub3Group*, and *DynGroup* based on the current timestep, Stefan-Boltzmann constant, and offset to absolute temperature. If any of these values are changed, the data must be regenerated, overwriting the existing sheets. Once the data is generated, the user may display: *Tot Heat*, *Lin Heat*, *Rad Heat*, *Lin Cond*, or *Rad Cond* by selecting the desired option from the drop down list in Cell A1 on each sheet. The average temperature of the group, source heat, and heat imbalance are also displayed, but may only be relevant when displaying total heat flows. A comment is added to each cell in the matrix which displays the Total Heat, Linear Heat, Radiative Heat, Linear Conductance, and Radiative Conductance. For Compare HeatMaps, the results for Model B are shown below the results for Model A. This may be useful for comparing the heatflows between groups at different timesteps or under different conditions. No more than 253 groups may be displayed in this format.

Tot Heat											
Model A:	Group j	MISC	OUTER	INNER	BOTELEC	MIDELEC	TOPELEC	CELLS	INSULATION	HOUSING	SPACE
Group i	Temp	-38.60	87.85	87.86	86.66	71.78	93.80	89.49	89.23	89.27	-460.00
MISC	-38.60		-1.226033	-0.1110104	-0.3491454	-1.868027	-1.724728	--	--	-0.1868054	16.46118
OUTER	87.85	1.226033		-1.299412	-0.04276291	0.7519588	-0.230347	--	--	-0.003573435	38.19921
INNER	87.86	0.1110104	1.299412		-35.68995	35.67933	-57.36848	--	--	-4.987996	535.1812
BOTELEC	86.66	0.3491454	0.04276291	35.68995		0.4479451	-0.02702989	--	--	-0.004077193	21.57201
MIDELEC	71.78	1.868027	-0.7519588	-35.67933	-0.4479451		-0.5350959	--	--	-0.3902279	55.77885
TOPELEC	93.80	1.724728	0.230347	57.36848	0.02702989	0.5350959		--	--	0.01007979	13.31021
CELLS	89.49	--	--	--	--	--	--		0.004804975	6.661455	--
INSULATION	89.23	--	--	--	--	--	--	-0.004804975		0.005069524	--
HOUSING	89.27	0.1868054	0.003573435	4.987996	0.004077193	0.3902279	-0.01007979	-6.661455	-0.005069524		7.303397
SPACE	-460.00	-16.46118	-38.19921	-535.1812	-21.57201	-55.77885	-13.31021	--	--	-7.303397	
SOURCE		11.06579971	38.76858139	476.9367981	57.95360184	20.10695076	73.17709351	6.653401375	0	6.180180073	0
BALANCE		0.070368913	0.167474935	2.712271696	-0.11710449	0.26463146	-0.028877074	-0.0128586	-0.000264549	-0.019292541	687.806057

MinorGroup Matrix showing Total Heat

Lin Cond											
Model A:	Group j	MISC	OUTER	INNER	BOTELEC	MIDELEC	TOPELEC	CELLS	INSULATION	HOUSING	SPACE
Group i	Temp	-38.60	87.85	87.86	86.66	71.78	93.80	89.49	89.23	89.27	-460.00
MISC	-38.60		--	--	--	--	--	--	--	--	--
OUTER	87.85	--		800	--	--	--	--	--	--	--
INNER	87.86	--	800		489.82	71.5	176.044	--	--	151.13	--
BOTELEC	86.66	--	--	489.82		--	--	--	--	--	--
MIDELEC	71.78	--	--	71.5	--		--	--	--	--	--
TOPELEC	93.80	--	--	176.044	--	--		--	--	--	--
CELLS	89.49	--	--	--	--	--	--		--	26.4992	--
INSULATION	89.23	--	--	--	--	--	--	--		1.4994	--
HOUSING	89.27	--	--	151.13	--	--	--	26.4992	1.4994		--
SPACE	-460.00	--	--	--	--	--	--	--	--	--	
SOURCE		11.06579971	38.76858139	476.9367981	57.95360184	20.10695076	73.17709351	6.653401375	0	6.180180073	0
BALANCE		11.06579971	838.7685814	2165.430798	547.7736018	91.60695076	249.2210935	33.15260137	1.4994	185.3087801	0

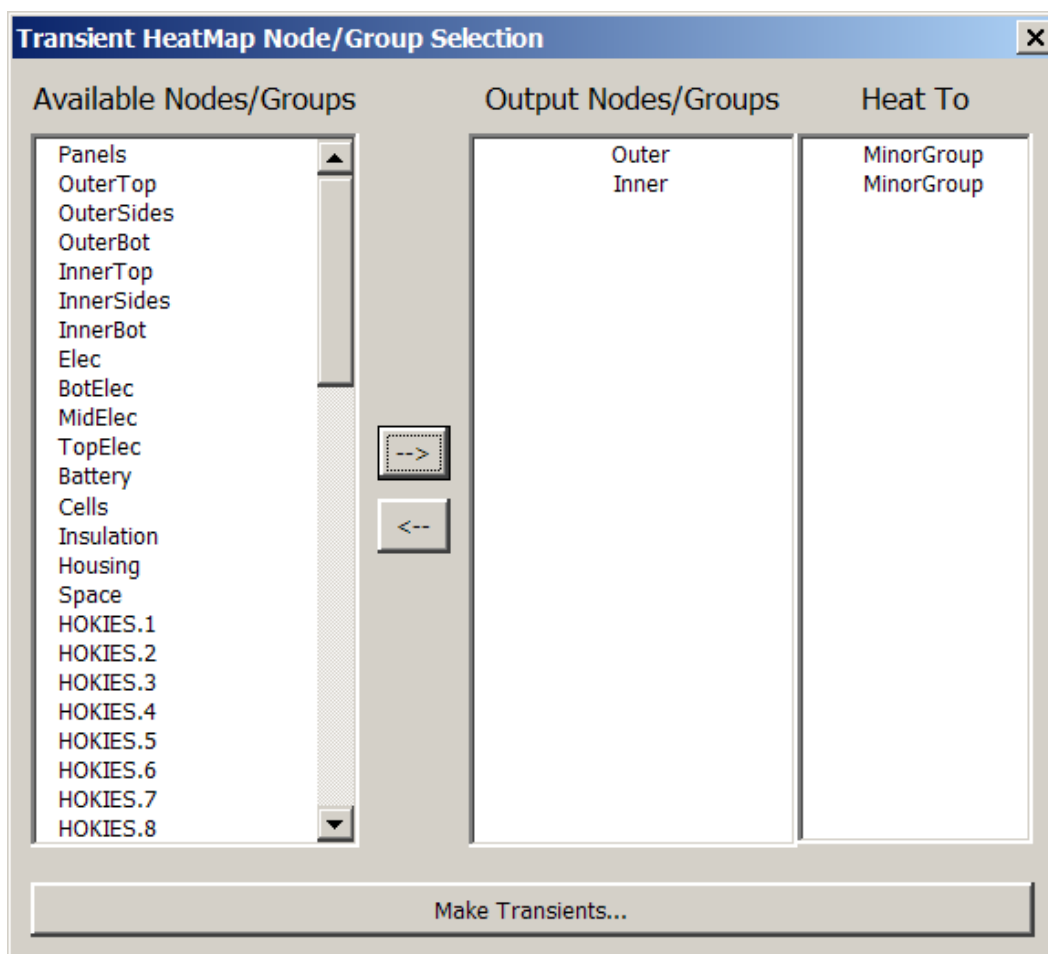
MinorGroup Matrix showing Linear Conductance

	A	B	C	D	E	F	G	H	I	J	K	L
1	Tot Heat											
2												
3	Model A:	Group j	MISC	OUTER	INNER	BOTELEC	MIDELEC	TOPELEC	CELLS	INSULATION	HOUSING	SPACE
4	Group i	Temp	-38.62	87.77	87.78	86.57	71.71	93.72	89.39	89.13	89.17	-460.00
5	MISC	-38.62		-1.23	-0.11	-0.35	-1.87	-1.73	--	--	-0.19	16.52
6	OUTER	87.77	1.23		-1.30	-0.04	0.75	-0.23	--	--	0.00	38.29
7	INNER	87.78	0.11	1.30		-35.32	35.68	-57.27	--	--	-4.84	536.45
8	BOTELEC	86.57	0.35	0.04	35.32		0.45	-0.03			0.00	21.62
9	MIDELEC	71.71	1.87	-0.75	-35.68	-0.45		-0.54			-0.39	55.91
10	TOPELEC	93.72	1.73	0.23	57.27	0.03	0.54				0.01	13.34
11	CELLS	89.39	--	--	--	--	--	--		0.00	6.63	--
12	INSULATION	89.13	--	--	--	--	--	--	0.00		0.00	--
13	HOUSING	89.17	0.19	0.00	4.84	0.00	0.39	-0.01	-6.63	0.00		7.32
14	SPACE	-460.00	-16.52	-38.29	-536.45	-21.62	-55.91	-13.34	--	--	-7.32	
15	SOURCE		11.07	38.77	476.94	57.95	20.11	73.18	6.65	0.00	6.18	0.00
16	BALANCE		0.02	0.08	0.83	0.20	0.13	0.03	0.02	0.00	0.09	689.45

MinorGroup Matrix showing Total Heat with comment displayed

16.5 Transient HeatMaps

Selecting *Make Transient HeatFlows* from the TARP menu displays a form allowing the user to specify nodes or groups for which to output transient heat flows. Nodes/Groups may be selected for output by either double clicking them in the *Available Nodes/Groups* listbox or selecting them and moving them to the Output Nodes/Groups listbox using the right arrow button (-->). Nodes/groups may be removed from the output by selecting the node and pressing the delete key or using the left arrow button (<--). By default, the *HeatTo* selection is automatically set to the appropriate group level (e.g. Major, Minor, Sub) where the Output Node/Group first appears. If a node is selected, then the *HeatTo* selection is set to Node. To change the default value, double click on the corresponding row in the *Heat To* listbox to toggle through MajorGroup, MinorGroup, SubGroup, Sub2Group, Sub3Group, DynGroup, and Node options. Once all desired nodes/groups have been added, and the *HeatTo* fields defined, click the *Make Transients...* button. The workbook calculates the heatflows at each timestep and outputs the corresponding connections to a worksheet with the same name as the Node/Group.



After all timesteps have been computed, the zero heatflow entries are removed and the worksheet is formatted. A summary table is shown at the top highlighting the Temperature of the requested Node/Group, Linear Heat In and Out, Radiative Heat In and Out, Applied Source, and the Imbalance. Changing the *What to Show* cell (B5) on the corresponding worksheet allows the user to display the heat flow to/from, conductance to, or temperature of each adjoining Node/Group. Sample output is shown next.

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Node/Group i	SUMMARY	Temperature i:	5	93.075	93.075	98.815	100.33	99.422	96.465	91.537	87.969	86.943	87.57	89.185	90.1
2	OUTERTOP		Linear Heat In:	0	0.099945	0.099945	0	0	0	0	0.19989	0.39978	0.39978	0.499725	0.600433	0.499
3			Linear Heat Out:	0	0	0	-0.40054	-1.00021	-0.29984	-0.09995	0	0	0	0	0	0
4	What to Show		Radiative Heat In:	0	0.000414	0.000414	0.000549	0.000529	0.000484	0.000417	0.000339	0.000337	0.000338	0.000343	0.000347	0.00
5	HeatFlow		Radiative Heat Out:	-0.31659	-0.73373	-0.73373	-0.7746	-0.78407	-0.77721	-0.75679	-0.72389	-0.70118	-0.69404	-0.6967	-0.70539	-0.71
6			Source:	0.61328	0.61328	1.5057	1.3825	1.216	0.93918	0.5767	0.15437	0.17422	0.20925	0.25997	0.29827	C
7			Imbalance:	0.296686	-0.02009	0.872328	0.207902	-0.56776	-0.13738	-0.27962	-0.36929	-0.12684	-0.08467	0.063334	0.19366	0.114
8																
9																
10	Node/Group j	Type	Max / Min	SS	SS	0	8.33E-02	0.16653	0.249795	0.33306	0.416325	0.49959	0.582855	0.66612	0.749385	0.832
11	INNERTOP	Lin	6.00E-01 / -1.00E+00	0.00	0.10	0.10	-0.40	-1.00	-0.30	-0.10	0.20	0.40	0.40	0.50	0.60	0.50
12	BOTELEC	Rad	1.17E-04 / -2.43E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	HOUSING	Rad	7.20E-05 / -1.34E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	INNERTOP	Rad	6.76E-09 / -1.18E-08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	MIDELEC	Rad	3.92E-04 / -3.35E-02	0.00	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.0
16	MISC	Rad	5.30E-04 / -7.54E-02	0.00	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.06	-0.06	-0.06	-0.06	-0.06	-0.0
17	OUTERBOT	Rad	5.12E-06 / -1.01E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	OUTERSIDES	Rad	2.48E-04 / -7.24E-03	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
19	SPACE	Rad	-4.39E-04 / -6.77E-01	-0.32	-0.63	-0.63	-0.66	-0.67	-0.66	-0.65	-0.63	-0.61	-0.61	-0.61	-0.62	-0.6
20	TOPELEC	Rad	5.65E-04 / 0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Transient Heatflows for Groups connected to OUTERTOP

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Node/Group i	SUMMARY	Temperature i:	5	93.075	93.075	98.815	100.33	99.422	96.465	91.537	87.969	86.943	87.57	89.185	90.1
2	OUTERTOP		Linear Heat In:													
3			Linear Heat Out:													
4	What to Show		Radiative Heat In:													
5	Temperature j		Radiative Heat Out:													
6			Source:	0.61328	0.61328	1.5057	1.3825	1.216	0.93918	0.5767	0.15437	0.17422	0.20925	0.25997	0.29827	C
7			Imbalance:													
8																
9																
10	Node/Group j	Type	Max / Min	SS	SS	0	8.33E-02	0.16653	0.249795	0.33306	0.416325	0.49959	0.582855	0.66612	0.749385	0.832
11	INNERTOP	Lin	1.02E+02 / 1.67E-01	5.00	93.08	93.08	98.81	100.32	99.42	96.46	91.54	87.97	86.95	87.58	89.19	91.0
12	BOTELEC	Rad	9.29E+01 / 1.67E-01	5.00	86.57	86.57	89.03	90.84	90.76	88.95	85.57	82.97	82.72	83.94	85.95	87.8
13	HOUSING	Rad	9.47E+01 / 1.67E-01	5.00	89.17	89.17	90.54	92.49	92.69	91.11	87.98	85.39	85.27	86.77	89.13	91.1
14	INNERTOP	Rad	1.02E+02 / 1.67E-01	5.00	93.08	93.08	98.81	100.32	99.42	96.46	91.54	87.97	86.95	87.58	89.19	91.0
15	MIDELEC	Rad	7.86E+01 / 1.67E-01	5.00	71.71	71.71	75.89	76.88	76.08	73.80	70.10	67.46	66.95	67.87	69.60	71.4
16	MISC	Rad	0.00E+00 / 0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	OUTERBOT	Rad	9.47E+01 / 1.67E-01	5.00	88.94	88.94	90.72	92.55	92.54	90.79	87.49	85.05	85.03	86.54	88.82	90.9
18	OUTERSIDES	Rad	9.38E+01 / 1.67E-01	5.00	86.70	86.70	90.34	91.90	91.46	89.33	85.63	82.64	81.93	82.75	84.45	86.2
19	SPACE	Rad	0.00E+00 / -4.60E+02	-460.00	-460.00	-460.00	-460.00	-460.00	-460.00	-460.00	-460.00	-460.00	-460.00	-460.00	-460.00	-460.00
20	TOPELEC	Rad	1.03E+02 / 1.67E-01	5.00	93.72	93.72	99.64	101.12	100.15	97.11	92.08	88.52	87.50	88.13	89.74	91.5

Transient Temperatures for Groups connected to OUTERTOP

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		Node/Group i	SUMMARY	Temperature i:	5	93.075	93.075	98.815	100.33	99.422	96.465	91.537	87.969	86.1
2		HOKIES.1		Linear Heat In:										
3				Linear Heat Out:										
4		What to Show		Radiative Heat In:										
5		Conductance		Radiative Heat Out:										
6				Source:	0.61328	0.61328	1.5057	1.3825	1.216	0.93918	0.5767	0.15437	0.17422	0.20
7				Imbalance:										
8														
9														
10	Description j	Node/Group j	Type	Max / Min	SS	SS	0	8.33E-02	0.16653	0.249795	0.33306	0.416325	0.49959	0.5821
11	Inner Panel Top	HOKIES.101	Lin	1.00E+02 / 1.00E+02	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
12	Inner Panel Top	HOKIES.101	Rad	9.73E-07 / 9.73E-07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	Inner Panel	HOKIES.109	Rad	9.49E-04 / 9.49E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	Battery Box External - Top	HOKIES.1501	Rad	1.12E-04 / 1.12E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	Battery Box External - Side	HOKIES.1502	Rad	5.69E-06 / 5.69E-06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	Battery Box External - Bottom	HOKIES.1503	Rad	1.14E-09 / 1.14E-09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	Battery Box External - Side	HOKIES.1504	Rad	4.30E-06 / 4.30E-06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	Battery Box External - End	HOKIES.1505	Rad	5.16E-06 / 5.16E-06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	Battery Box External - End	HOKIES.1506	Rad	3.75E-06 / 3.75E-06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	Outer Panel Side	HOKIES.2	Rad	8.21E-05 / 8.21E-05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	Outer Panel Side	HOKIES.3	Rad	1.44E-04 / 1.44E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	Outer Panel Side	HOKIES.4	Rad	1.54E-04 / 1.54E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	Outer Panel Side	HOKIES.5	Rad	1.53E-04 / 1.53E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	CPU	HOKIES.502	Rad	1.95E-04 / 1.95E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	Downlink	HOKIES.503	Rad	1.49E-05 / 1.49E-05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	Uplink	HOKIES.550	Rad	2.31E-05 / 2.31E-05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	Outer Panel Side	HOKIES.6	Rad	1.36E-04 / 1.36E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	PPT-1 Capacitor	HOKIES.601	Rad	6.02E-04 / 6.02E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	PPT-1 Fuel Bar	HOKIES.602	Rad	1.78E-04 / 1.78E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Transient Conductances for Nodes connected to HOKIES.101

16.6 Transient Group to Group Heat Flow Matrix

An option also exists to display transient heat flows between groups in a matrix format by selecting *Make Heatflow Matrix Transient* from the TARP menu in the Excel® workbook. This option creates up to six worksheets: *MajorGroupTrans*, *MinorGroupTrans*, *SubGroupTrans*, *Sub2GroupTrans*, *Sub3GroupTrans*, and *DynGroupTrans* based on all timesteps, Stefan-Boltzmann constant, and offset to absolute temperature. If any of these values are changed, the data must be regenerated, overwriting the existing sheets. This data is technically a 3 dimensional array (Group I, Group J and Timestep). To access this, a Group I vs. Group J matrix is provided for the user to select the heat flow path of interest. Once created, the user selects an entry in the group to group matrix starting in column J. Once selected, the transient heatflow between the group in the selected row (Group i) and the group in the selected column (Group j) will be displayed on the left including the temperatures and applied heat for each group. Selecting a different cell in the matrix will update the data to the left in column A-F.

Current Row	8	Click Cells inside Matrix starting in Column J to select Heat Flow Path					SS SS 0 8	Group j	MISC	OUTER	INNER	BOTELEC	MIDELEC	TOPELEC	CELLS	INSULATIC	HOUSING
Current Col	11	Transient Results will be shown in Table below for Ti, Tj, Qi, Qj and Qij					Group i	Temp									
Group i	TOPELEC																
Group j	OUTER																
Average	93.86	87.74	75.11	41.04	0.24												
Time	T(TOPELEC)	T(OUTER)	Q(TOPELEC)	Q(OUTER)	Qij												
SS	5.00	5.00	73.18	38.77													
SS	93.80	87.85	73.18	38.77	0.23												
0	93.80	87.85	95.76	65.99	0.23												
8.326502E-02	99.70	91.51	93.92	61.67	0.29												
0.16653	101.16	93.08	90.57	54.29	0.29												
0.249795	100.19	92.62	84.03	40.42	0.28												
0.33306	97.12	90.42	73.69	24.74	0.25												
0.416325	92.09	86.61	61.20	8.01	0.22												
0.49959	88.53	83.62	61.11	19.36	0.20												
0.582855	87.50	82.95	61.44	30.73	0.19												
0.66612	88.13	83.83	61.95	40.76	0.18												
0.749385	89.75	85.59	62.35	47.47	0.18												
0.83265	91.56	87.45	62.67	52.19	0.19												
0.915916	92.98	88.77	62.55	48.53	0.19												
0.999181	93.51	89.15	62.24	42.59	0.19												
1.08245	92.84	88.28	61.55	31.80	0.20												
1.16571	91.12	86.33	61.13	20.00	0.20												
1.24897	88.57	83.52	60.86	7.73	0.20												
1.33224	88.12	82.03	74.04	23.04	0.23												

16.7 Compare HeatMaps

The CompareHeatMaps option allows the user to specify two separate models for the generation of HeatMaps: Model A and Model B. Using the *Map2* worksheet, results from two models can be displayed side by side. This may also be used to display different *Node i* or Timestep values for a single model HeatMap. Each side has independent controls for *Sigma*, *Toffset*, *Format*, *Min Heat*, and *Heat To* parameters and heat balance summaries.

To compare differences between heat flows the user may turn on the Compare option in cell F4. This signals to the heatmap to sequence the two sides. When either *Node i* is changed in this mode, the *Node i* for the opposite model is also updated. The data is output and sequenced with each line containing heat paths of the same type (Lin, Rad), Node, and Conductance. In cases where a conductor may exist in one model but not in the other, the output attempts to synchronize the two sets of outputs matching the closest conductance value found for the same node and conductor type. If no match can be made, then a blank line is output where the heat path is missing from the other model. This is useful when comparing two models that do not include the exact same environments (e.g. flight vs. test).

A		B				C				D		E		F		G		H		I		J		K		L				
1		Description		Inner Panel Side													Description		Outer Panel Side											
2		Node i		HOKIES.102				Temp A	78.80								Node i		HOKIES.2				Temp B	77.64						
3		Time A		(2) SS				Model A	A								Time B		(8) 0.416325				Model B	B						
4		Sort By		Type:Heat				Compare	Off								Sort By		Type:Heat											
5																														
6		Sigma		Toffset		Format		Min Heat		Heat To							Sigma		Toffset		Format		Min Heat		Heat To					
7		1.71E-09		460		0.00		0.001		Node							1.71E-09		460		0.00		0.0		Node					
8																														
9				SUMMARY:				In	Out								SUMMARY:				In	Out								
10				Conduction				73.99	0.00								Conduction				17.28	17.40								
11				Radiation				0.00	83.92								Radiation				0.24	4.73								
12				Source				10.10	-								Source				0.44	-								
13				Sum				84.09	83.92								Sum				17.96	22.13								
14																														
15		Heat Flows Sorted by Type (Asc), then Heat (Asc)										Heat Flows Sorted by Type (Asc), then Heat (Asc)																		
17		Description j		Node j		Type	Cond	Temp j		Heat j						Description j		Node j		Type	Cond	Temp j		Heat j						
18		Inner Panel Side		HOKIES.103		Lin	3.5577	80.49		5.99						Inner Panel Side		HOKIES.102		Lin	100	77.47		-17.40						
19		Inner Panel Side		HOKIES.107		Lin	3.5577	81.55		9.79						Outer Panel Side		HOKIES.3		Lin	3.5577	78.37		2.60						
20		Inner Panel Bottom		HOKIES.108		Lin	1.4989	88.95		15.21						Outer Panel Side		HOKIES.7		Lin	3.5577	81.77		14.68						
21		Inner Panel Top		HOKIES.101		Lin	1.4989	93.08		21.40						SPACE		HOKIES.99999		Rad	0.032526	-460.00		-4.65						
22		Outer Panel Side		HOKIES.2		Lin	100	79.02		21.60						Inner Panel		HOKIES.109		Rad	0.001281	20.97		-0.07						
23		SPACE		HOKIES.99999		Rad	0.5823	-460.00		-83.92						PPT-2 Fuel Bar		HOKIES.652		Rad	0.000512	59.12		-0.01						
24																PPT-1 Fuel Bar		HOKIES.602		Rad	0.000546	62.63		-0.01						
25																Battery Box External - Bottom		HOKIES.1503		Rad	3.15E-08	87.56		0.00						

Different Nodes (HOKIES.102 and HOKIES.2), Different Timesteps, Compare Off

A		B				C				D		E		F		G		H		I		J		K		L				
1		Description		Outer Panel Side													Description		Outer Panel Side											
2		Node i		HOKIES.2				Temp A	79.02								Node i		HOKIES.2				Temp B	77.64						
3		Time A		(2) SS				Model A	A								Time B		(8) 0.416325				Model B	B						
4		Sort By		Type:Heat				Compare	On								Sort By		Type:Heat											
5																														
6		Sigma		Toffset		Format		Min Heat		Heat To						Sigma		Toffset		Format		Min Heat		Heat To						
7		1.71E-09		460		0.00		0.001		Node						1.71E-09		460		0.00		0.0		Node						
8																														
9				SUMMARY:				In	Out								SUMMARY:				In	Out								
10				Conduction				16.18	21.60								Conduction				17.28	17.40								
11				Radiation				0.24	4.78								Radiation				0.24	4.73								
12				Source				9.96	-								Source				0.44	-								
13				Sum				26.38	26.38								Sum				17.96	22.13								
14																														
15		Heat Flows Sorted by Type (Asc), then Heat (Asc)										Heat Flows Sorted by Type (Asc), then Heat (Asc)																		
17		Description j		Node j		Type	Cond	Temp j		Heat j						Description j		Node j		Type	Cond	Temp j		Heat j						
18		Inner Panel Side		HOKIES.102		Lin	100	78.80		-21.60						Inner Panel Side		HOKIES.102		Lin	100	77.47		-17.40						
19		Outer Panel Side		HOKIES.3		Lin	3.5577	80.78		6.28						Outer Panel Side		HOKIES.3		Lin	3.5577	78.37		2.60						
20		Outer Panel Side		HOKIES.7		Lin	3.5577	81.80		9.90						Outer Panel Side		HOKIES.7		Lin	3.5577	81.77		14.68						
21		SPACE		HOKIES.99999		Rad	3.25E-02	-460.00		-4.70						SPACE		HOKIES.99999		Rad	3.25E-02	-460.00		-4.65						
22		Inner Panel		HOKIES.109		Rad	1.28E-03	20.89		-0.07						Inner Panel		HOKIES.109		Rad	1.28E-03	20.97		-0.07						
23		PPT-2 Fuel Bar		HOKIES.652		Rad	5.12E-04	62.04		-0.01						PPT-2 Fuel Bar		HOKIES.652		Rad	5.12E-04	59.12		-0.01						
24		PPT-1 Fuel Bar		HOKIES.602		Rad	5.46E-04	63.75		-0.01						PPT-1 Fuel Bar		HOKIES.602		Rad	5.46E-04	62.63		-0.01						
25																Battery Box External - Bottom		HOKIES.1503		Rad	3.15E-08	87.56		0.00						
26																Inner Panel Top		HOKIES.101		Rad	1.43E-06	91.54		0.00						
27																Battery Box External - End		HOKIES.1505		Rad	1.56E-05	88.11		0.00						
28																Battery Box External - Side		HOKIES.1504		Rad	2.24E-05	87.98		0.00						
29																Battery Box External - Side		HOKIES.1502		Rad	6.22E-05	87.96		0.00						
30																GPS Mod		HOKIES.704		Rad	5.75E-05	91.58		0.00						
31																Battery Box External - End		HOKIES.1506		Rad	8.17E-05	88.12		0.00						
32		Outer Panel Bottom		HOKIES.8		Rad	1.07E-04	88.94		0.00						Outer Panel Bottom		HOKIES.8		Rad	1.07E-04	87.49		0.00						

Same node (HOKIES.2), Different Timesteps, Compare On

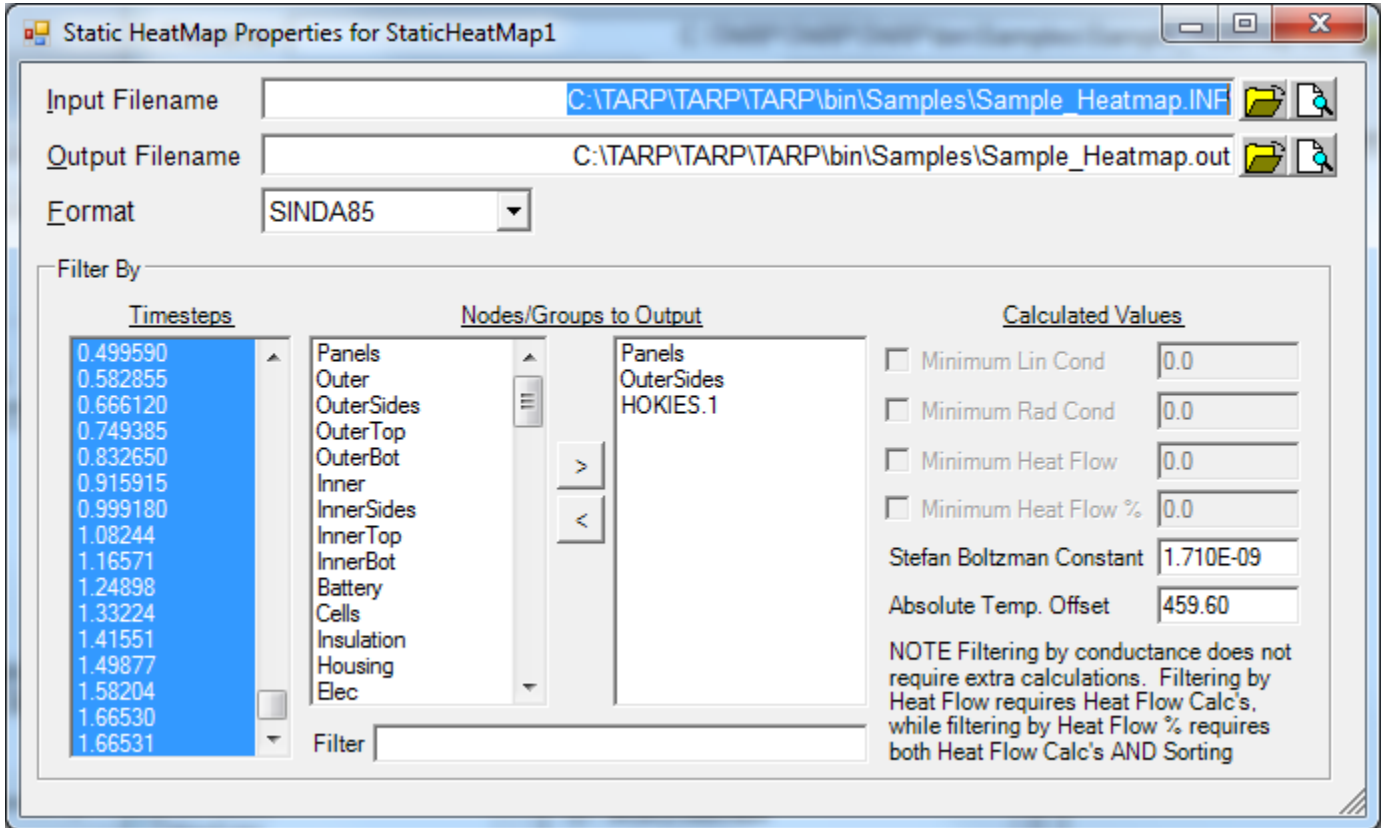
A	B	C	D	E	F	H	I	J	K	L	
1	Description	Outer Panel Side				Description	#N/A				
2	Node i	HOKIES.2		Temp A	79.02	Node i	INNER		Temp B	86.62	
3	Time A	(2) SS		Model A	A	Time B	(8) 0.416325		Model B	B	
4	Sort By	Type;Heat		Compare	Off	Sort By	Type;Heat				
5											
6	Sigma	Toffset	Format	Min Heat	Heat To	Sigma	Toffset	Format	Min Heat	Heat To	
7	1.71E-09	460	0.00	0.001	Node	1.71E-09	460	0.00	0.0	MinorGroup	
8											
9		SUMMARY:			In	Out	SUMMARY:			In	Out
10		Conduction			16.18	21.60	Conduction			74.97	48.42
11		Radiation			0.24	4.78	Radiation			0.00	532.53
12		Source			9.96	-	Source			472.20	-
13		Sum			26.38	26.38	Sum			547.17	580.95
14											
15	Heat Flows Sorted by Type (Asc), then Heat (Asc)					Heat Flows Sorted by Type (Asc), then Heat (Asc)					
16											
17	Description j	Node j	Type	Cond	Temp j	Heat j	Node j	Type	Cond	Temp j	Heat j
18	Inner Panel Side	HOKIES.102	Lin	100	78.80	-21.60	MIDELEC	Lin	71.5	70.10	-36.32
19	Outer Panel Side	HOKIES.3	Lin	3.5577	80.78	6.28	OUTER	Lin	800	86.60	-12.10
20	Outer Panel Side	HOKIES.7	Lin	3.5577	81.80	9.90	HOUSING	Lin	151.13	87.98	9.67
21	SPACE	HOKIES.99999	Rad	0.032526	-460.00	-4.70	BOTELEC	Lin	489.82	85.57	19.96
22	Inner Panel	HOKIES.109	Rad	0.001281	20.89	-0.07	TOPELEC	Lin	176.044	92.08	45.34
23	PPT-2 Fuel Bar	HOKIES.652	Rad	0.000512	62.04	-0.01	SPACE	Rad	3.508159	-460.00	-532.42
24	PPT-1 Fuel Bar	HOKIES.602	Rad	0.000546	63.75	-0.01	MISC	Rad	0.001622	-38.19	-0.11
25	Outer Panel Bottom	HOKIES.8	Rad	0.000107	88.94	0.00	MIDELEC	Rad	3.99E-05	70.10	0.00
26	Outer Panel Top	HOKIES.1	Rad	8.21E-05	93.07	0.00	OUTER	Rad	2.27E-05	86.60	0.00
27	Downlink	HOKIES.503	Rad	0.000173	89.02	0.00	BOTELEC	Rad	5.94E-06	85.57	0.00
28	Outer Panel Side	HOKIES.3	Rad	0.001016	80.78	0.00	HOUSING	Rad	3.06E-06	87.98	0.00
29	Outer Panel Side	HOKIES.7	Rad	0.00129	81.80	0.00	TOPELEC	Rad	2.56E-05	92.08	0.00
30	Battery Box External - Top	HOKIES.1501	Rad	0.000477	89.16	0.01					
31	SBand PMod	HOKIES.703	Rad	0.000312	95.49	0.01					
32	PPT-1 Capacitor	HOKIES.601	Rad	0.002815	81.02	0.01					
33	Crosslink	HOKIES.702	Rad	0.000454	92.98	0.01					
34	PPT-2 Capacitor	HOKIES.651	Rad	0.007011	80.02	0.01					
35	Outer Panel Side	HOKIES.8	Rad	0.000702	80.94	0.01					

One Node/One Group (HOKIES.2, INNER), Different Timesteps, Compare Off

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17. StaticHeatMaps

StaticHeatMaps show heat flows between nodes and or groups depending on what has been added to the StaticHeatMap object. StaticHeatMaps create a worksheet for each node or group added to the object. The worksheets contain a block showing the heat flows to all connected nodes/groups, a second block containing the temperatures of all connections, and a third block showing the conductances to all the connections. The Properties form for a StaticHeatMap is shown below:



17.1 Defining the StaticHeatMap Object

StaticHeatMaps need at a minimum: the output *Format*, the *Input Filename* and the *Output Filename*, definitions of the Stefan Boltzmann constant and the offset to absolute temperatures, and lastly, one or more nodes or groups to output. The *Output Filename* must reference a file which contains all the nodal temperatures, nodal heat loads, and conductors output in a consistent format (i.e. whenever one is output, the other two need to be as well). Once the *Output Filename* is specified, the file will be processed to determine the available nodes and timesteps. These values will then populate the corresponding list boxes. By default, all timesteps found in the output file are selected for output; the user may then deselect or select any of the output timesteps desired for the output to the StaticHeatMap. A list of groups and available nodes are displayed in the listbox to the left. Entries from this list may be selected and added to the listbox of Nodes/Groups to create StaticHeatMap sheets. Alternatively, the *Working Node List* at the Main Interface can also be used to add nodes to the Static HeatMap. The *Filter* may be used to only show available nodes that meet the user specified criteria. One worksheet is created for each Node or Group listed to output.

17.2 StaticHeatMap Output

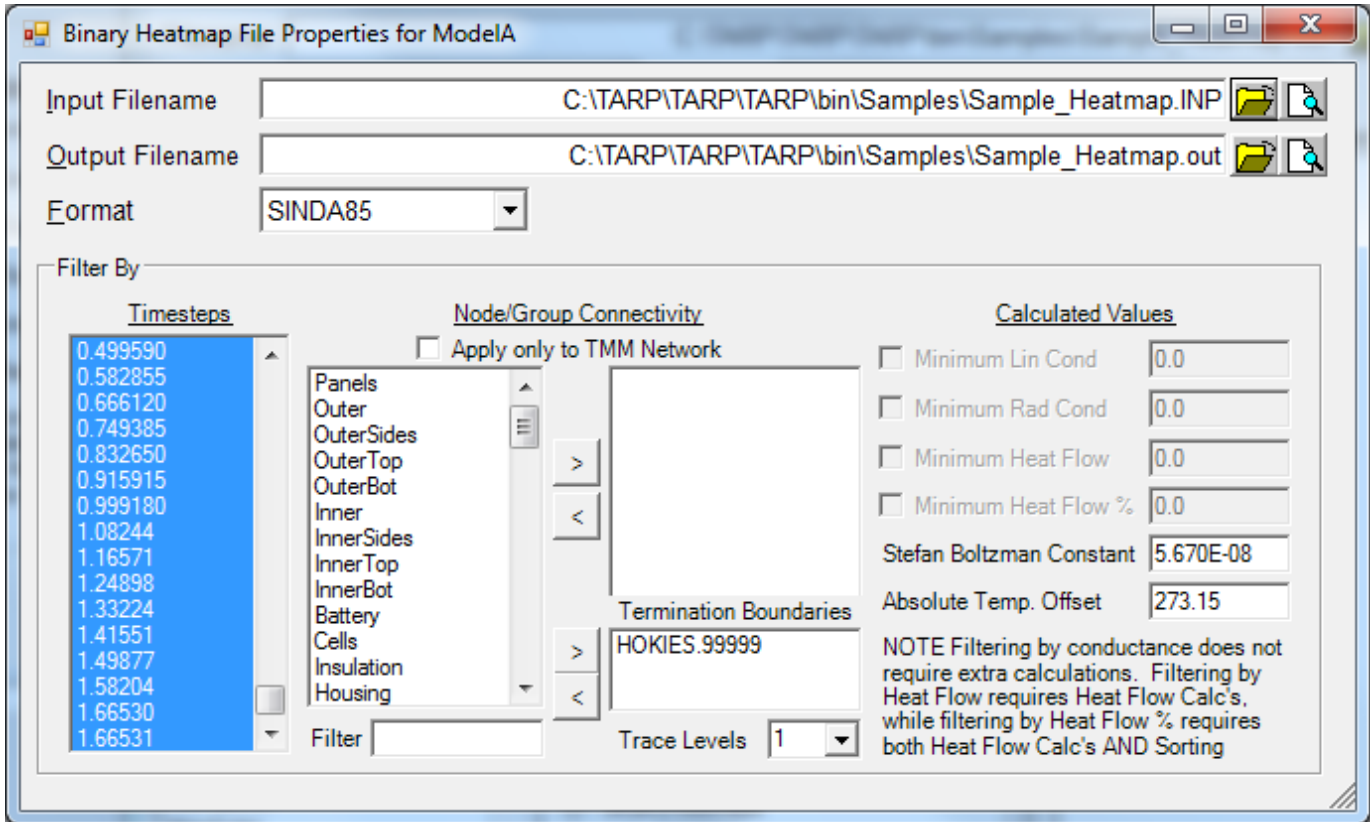
		SS	SS	0	8.33E-02	0.16653	0.249795	0.33306	0.416325	0.499
Temp/Source:		515.71	515.71	559.81	553.49	543.06	524	502.77	480.27	489.
Lin Heat In:		0.00E+00	62.368	62.368	70.523	63.188	57.779	49.266	38.848	50.2
Lin Heat Out:		0.00E+00	0.00E+00	0.00E+00	-1.21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E
Rad Heat In:		0.00E+00	0.00356	0.00356	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E
Rad Heat Out:		-299.37	-575.2	-575.2	-590.56	-597.28	-595.4	-586.23	-570.62	-558
Node	Type	Heat j	Heat j	Heat j	Heat j	Heat j	Heat j	Heat j	Heat j	Hea
Battery	L	0.00E+00	4.988	4.988	-1.21	0.60419	4.081	7.103	9.673	6.9
Elec	L	0.00E+00	57.38	57.38	70.523	62.584	53.698	42.164	29.176	43.
Space	R	-299.37	-573.38	-573.38	-588.66	-595.32	-593.43	-584.31	-568.78	-556
Elec	R	0.00E+00	-0.47964	-0.47964	-0.45725	-0.47997	-0.49792	-0.51353	-0.5266	-0.50
Battery	R	0.00E+00	0.00356	0.00356	-0.01894	-0.01803	-0.01432	-0.01066	-0.00614	-0.00
Misc	R	0.00E+00	-1.337	-1.337	-1.428	-1.464	-1.45	-1.395	-1.304	-1.2
		SS	SS	0	8.33E-02	0.16653	0.249795	0.33306	0.416325	0.499
Temp/Source:		5	87.855	87.855	91.502	93.074	92.62	90.419	86.62	83.1
Node	Type	Temp j	Temp j	Temp j	Temp j	Temp j	Temp j	Temp j	Temp j	Temp
Battery	L	5	89.394	89.394	90.734	92.686	92.913	91.345	88.248	85.5
Elec	L	5	83.847	83.847	88.174	89.543	88.87	86.418	82.322	79.3
Space	R	-460	-460	-460	-460	-460	-460	-460	-460	-46
Elec	R	5	83.847	83.847	88.174	89.543	88.87	86.418	82.322	79.3
Battery	R	5	89.394	89.394	90.734	92.686	92.913	91.345	88.248	85.5
Misc	R	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unkn
		SS	SS	0	8.33E-02	0.16653	0.249795	0.33306	0.416325	0.499
Node	Type	Cond j	Cond j	Cond j	Cond j	Cond j	Cond j	Cond j	Cond j	Con
Battery	L	151.13	151.13	151.13	151.13	151.13	151.13	151.13	151.13	151.
Elec	L	737.36	737.36	737.36	737.36	737.36	737.36	737.36	737.36	737.
Space	R	3.758	3.758	3.758	3.758	3.758	3.758	3.758	3.758	3.7
Elec	R	0.11648	0.11648	0.11648	0.11648	0.11648	0.11648	0.11648	0.11648	0.11
Battery	R	0.00787	0.00787	0.00787	0.00787	0.00787	0.00787	0.00787	0.00787	0.00
Misc	R	0.02097	0.02097	0.02097	0.02097	0.02097	0.02097	0.02097	0.02097	0.02

StaticHeatMap output is shown above. A summary of the energy balance is shown in the first 5 rows including the heat in and out by radiation and conduction as well as any applied heat loads. Below that, all connected nodes/groups (depending on what was requested) are shown, grouping all linear connection together followed by all radiative connections. Each timestep represents the heat flows at the indicated timestep. The next block of rows shows the temperatures for the adjoining connections as well as the selected node/group, and the last block shows the conductance values. Unlike the HeatMap workbook, however, this data is fixed and cannot be changed for different nodes or groups of interest.

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18. Binary HeatMap Files (*TARP Pro only*)

Binary Heatmap files move the necessary heatmap data (Temperatures, Heat Loads, Conductances, and Conductor Node pairs) into an external binary file. This file is then read by the HeatMap workbook and the data is loaded from the file and processed internally. The advantage of this approach is that much larger models may be loaded in a much shorter time than if the data is stored on worksheets. See the [HeatMaps](#) section for a full description of the HeatMap capabilities. The Properties form for a Binary Heatmap File is shown below:



18.1 Creating the Binary HeatMap File Object

Binary HeatMap Files objects may be created in one of two ways. First, if a TARP Pro user checks the [HeatMap](#) (or [CompareHeatMap](#)) option under [Workbook Properties](#), they are prompted to either create Binary HeatMap Files or the three (or six) corresponding DataSets (Temp, Heat, Cond). If Binary HeatMap File is selected, a new object is created under the Binary HeatMaps branch of the *TARP Objects* Tree. The name of the [ExcelOutputFile](#) is automatically set to the same name as the Output Filename for the first Binary HeatMap object. Alternately, a user may create Binary Heatmap file objects manually, but they may not necessarily be linked to the output workbook, depending on the name of the [ExcelOutputFile](#). See section 18.4 for details on this.

18.2 Specifying the BinaryHeatMap Files

Binary HeatMap Files require the same output as HeatMaps using DataSets, namely Temperature, Heat Load, and Conductor output at each timestep. In addition, the Binary HeatMap object also requires the input file and its format. When the *Output Filename* is specified, the file is processed to determine the available timesteps and nodes. This then populates the corresponding list boxes for further selection by the user. By default, all timesteps are selected, but the user may deselect

ones not desired for output. The available nodes and groups are also listed once the *Output Filename* is processed. If no nodes or groups are specified for output, then TARP defaults to outputting all nodes and connections. If nodes or groups are specified for output, then only a portion of the network is output that references the nodes specified or contained in the groups specified; this allows for a much smaller network in very large models, but is also a bit less useful for tracing any and all heat flows.

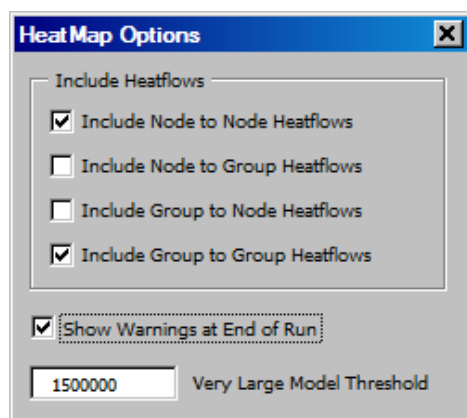
18.3 Adding Nodes for Sub-Network Output

An option exists to allow the user to add nodes or groups to the Binary HeatMap file. If nodes are added, then only couplings to these nodes are included in the Binary HeatMap file. If a group is added, then the nodes contained in that group (or any children of that group) are internally added before beginning the trace procedure. The *Filter* may be used to list only available nodes/groups that meet the criteria, which can then be added to the Binary HeatMap. Nodes or groups may also be added at the main GUI as any other TARP object that accepts nodes. The user may opt to trace to additional depth layers, up to 5 levels deep. To clarify, suppose nodes 1-10 are added to a Binary HeatMap. Tracing one level may find that nodes 1-50 are all coupled to nodes 1-10. Tracing another level may show that nodes 1-150 and a Space Node are all coupled to 1-50. Tracing yet another level may show that nodes 1-10000 are coupled to nodes 1-150 and the Space Node. At this point, the couplings from numerous other locations to space are likely not relevant to the heat flows of the original nodes 1-10. Therefore, it is recommended to terminate any traces when they reach a boundary node. When the *Output Filename* is processed, the boundary nodes are identified and automatically added to this list. Lastly, an option exists to only apply the sub-network reduction to the TMM results. This may result in faster creation of the bhf file, but with the added temperature, heat load, and conductance values included for nodes and conductors that were eliminated.

18.4 Linking to Excel

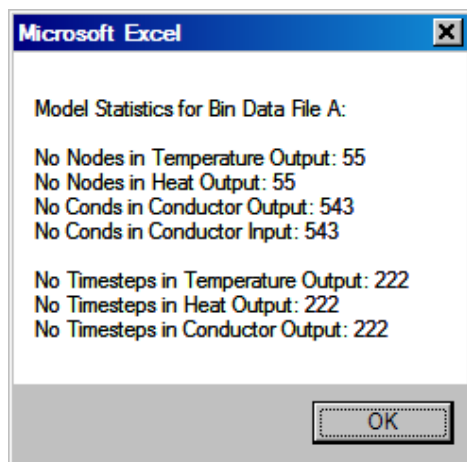
Once created, a binary formatted file (.bhf) file is output which may be linked to the Excel workbook by its filename. Upon opening a HeatMap workbook, the current directory is checked to see if a .bhf file is found with the same basename. If files with the same basename and an A.bhf and B.bhf appended are found, then the workbook is assumed to be a Compare Heatmap and both files are loaded. If all three files exist, the user is prompted to select either a single HeatMap mode or a Compare HeatMap mode. For example, a workbook named Test_HeatMap.xls would search for a Test_HeatMap.bhf file to retrieve data. If it finds instead Test_HeatMapA.bhf and Test_HeatMapB.bhf, the workbook loads both files and assumes a Compare Heatmap is desired. If the name of the Excel workbook or binary heatmap file is changed in Windows, then the corresponding filename of the other file(s) must also be changed to retain the connection. This allows a user to create only binary heatmap files without a corresponding workbook and then access them via a previously created Excel workbook. For example, a user may first create a heatmap workbook called Case1. Then a Binary HeatMap file could be created called Case2; changing the Case1.xls to Case2.xls would now access the Case2.bhf data.

18.4 Internal Storage in HeatMap Workbook



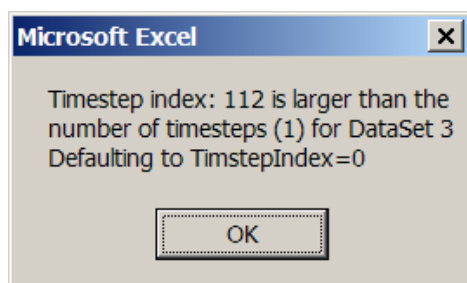
For models with less than 1.5 million conductors, the entire thermal network is loaded and stored in memory based on the requested heat flow calculations: Node to Node, Group to Group, Node to Group, and Group to Node heat flow matrices. For very large models (more than 1.5 million conductors), only the requested Group to Group, Node to Group, and Group to Node heat flow matrices are stored internally. When a user specifies a node on the Map1 sheet, the bhf file is processed and a subset of conductors is identified that is connected to the specified node. These couplings are then processed to determine the heat flow to and from the specified node. While this approach may have some

degradation in performance, it does allow for much larger models to be processed at the nodal level without exceeding memory limitations. The threshold for what is considered a large model may be changed by the user by setting the *Very Large Model Threshold* in the HeatMap Options form under the TARP menu in the resulting workbook.



To see basic statistics from the binary heatmap file, select the *Show Binary Data Statistics* option from the TARP menu in Excel. A message box similar to the one shown to the left will be displayed with the number of nodes and timesteps found in each bhf file in use. Note that if all submodels are built for SINDA85 output, then the number of Conds in the Conductor output and Conductor Input should match. Also, for SINDA85, the number of Nodes in the Temperature Output and Heat Output should also match. For SINDA/G, the number of Nodes in the Temperature output is typically smaller than the number of Nodes in the Heat output, since Heat values are not output for boundary nodes. Lastly, if only one output timestep is found for the conductor

data, a warning message (shown below) will be displayed indicating that the first timestep (Index 0) will be used for determining the conductor values. This is acceptable so long as the model contains only constant conductors or the variation of the conductors is negligible.



The performance improvement of using a binary heatmap file instead of storing the data on worksheets in the output workbook is approximately 10:1. A model with about 1800 nodes and 94,500 conductors took 9:38 minutes to load the data, evaluate the heat flows and output the worksheet with the data stored on worksheets; the same model took 1:00 minute with the data stored in a Binary HeatMap File. For larger models, the performance

improvement should be greater, since a significant amount of time is spent retrieving the conductance values, which is much faster with the binary format.

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19. Session Files

Session files are a means to save and recall properties of a TARP™ session based on an ASCII text file. This saves the user time if the same objects are to be re-created with only a few modifications. The formats for each object are shown below. In general, each object begins with a [Section] and ends with a blank line. Any object properties not specified are set to their default values; as such, only portions of the object need to be defined. Advanced users can use this to modify existing sessions or to create new ones.

19.1 Session File Data Types

Generic data types are listed below. Object types specific to particular objects are specified in the section for that object.

<i>{Boolean}</i>	either True or False should be specified
<i>{File Path}</i>	the full path including drive letter must be specified (spaces are allowed)
<i>{XXX YYY ZZZ}</i>	one of XXX, YYY, OR ZZZ are allowed as inputs (single)
<i>{XXX,YYY,ZZZ}</i>	any of XXX, YYY, OR ZZZ are allowed as inputs (multiple)
<i>{Valid String}</i>	a sequence of alpha-numeric characters
<i>{Valid Integer}</i>	a numeric entry with no decimal point (e.g.15)
<i>{Valid Float}</i>	a numeric entry with a decimal point (e.g.15.0)
<i>{Valid Sheet}</i>	a {Valid String} that does not contain / \ [] ? or *
<i>{Valid Range}</i>	Comma separated list of nodes and ranges (e.g. SUB1.5,SUB2.5-10) or * for all nodes

19.2 WorkBook Properties

Only one WorkBook Properties block may exist in a session and is defined as follows:

```
[WorkBook Properties]
  IncDesc = {Boolean}
  HeatMap = {Boolean}
  CompareHeatMap = {Boolean}
  UpdateExisting = {Boolean}
```

19.3 Additional Files

Only one Additional Files block may exist in a session and is defined as follows:

```
[Additional Files]
  InputFile = {File Path}
  InputFileA = {File Path}
  InputFileB = {File Path}
  LimitFile = {File Path}
  WeightingFile = {File Path}
  DescriptionFile = {File Path}
  GroupLinkFile = {File Path}
  UnitConversionFile = {File Path}
  ExcelOutputFile = {File Path}
```

The InputFileA and InputFileB options would appear for a CompareHeatMap only. All other instances of an input file would be InputFile.

19.4 DataSet

Numerous DataSet blocks may exist in a session file, each defined as follows:

```
[DataSet]
  File = {File Path}
  Format = {SINDA85|SINDA/G|ESABLK|ESATBL|TMG|TAK|TSS|DESKTOP|CSV|SPACE|TAB|COVER|FLUINT}
  Parameter = {T|Q|G|C|Q"|QA|QA|QE|QI|QR|GL|GR|LT|LP|LX|LV|LD|LH|LQ|LM}
  SheetName = {Valid Sheet}
  Convert Time From = {Valid Integer}
  Convert Time To = {Valid Integer}
  Convert Param1 From = {Valid Integer}
  Convert Param1 To = {Valid Integer}
  Convert Param2 From = {Valid Integer or -1}
  Convert Param2 To = {Valid Integer or -1}
  Transpose = {Boolean}
  Filter = {Boolean}
  FilterCriteria = {Valid Range} or blank
  ReferencedNodes = {Boolean}
  IncludeMin = {Boolean}
  IncludeAvg = {Boolean}
  IncludeMax = {Boolean}
  IncludeTimeMin = {Boolean}
  IncludeTimeMax = {Boolean}
  IncludeDelta = {Boolean}
  SS Timestep Index = {Valid Index or -1}
  TR Timestep Start Index = {Valid Index or -1}
  TR Timestep End Index = {Valid Index or -1}
  Output Timesteps = {Timestep Output}
```

DataSet Data Types:

{Valid Criteria} a special version of *{Valid String}* based on the rules for [node filtering](#)

{Valid Index} a special version of *{Valid Integer}* that requires an index to a particular array (e.g. timesteps)

{Timestep Output} a string listing of T or F indicating for each timestep if it is to be output. (e.g. TTFFTTFT would output timesteps 1,2,5, 6, and 8). Alternately, the keyword ALL may be used to specify that all timesteps should be output. Lastly, a (X,Y) format such as (1,1) would specify to output 1 timestep, skip one timestep and repeat this pattern until the last timestep is reached. A user is cautioned that changing filenames without updating the Timestep Indexes or Output Timestep may result in unexpected behavior. When in doubt, make the fields blank and allow TARP to select the defaults, which may then be changed through the interface.

19.5 Group

Numerous Group blocks may exist in a session file., each defined as follows:

```
[Group]
  GroupName= {Group Name}
  ParentName= {Group Name}
  Filter= {Valid Range}
  Nodes= {Node1},{Node2},{Node3},..., {NodeN}
```

Group Data Types:

{Group Name} a {Valid String} that does not contain any comma characters (,)

{Node#} valid Node on DataSet sheets

19.6 Parameter

Numerous Parameter blocks may exist in a session file, each defined as follows:

```
[Parameter]
  ParameterName= {Valid String}
  ParameterType= {MaxNodes|MinNodes|MaxGroup|MinGroup|Difference}
  Nodes= {Node/Group1},{Node/Group2},{Node/Group3},..., {Node/GroupN}
```

19.7 Plot

Numerous Plot blocks may exist in a session file, each defined as follows:

```
[Plot]
  Title={Valid String}
  SheetName={Valid Sheet}
  X Axis={Axis String}
  Y Axis Pri={Axis String}
  Y Axis Sec={Axis String}
  Series={SheetName}/{Node/Group}/{Pri|Sec}/{Valid String}
  Line={Color},{LineType},{Weight}
  Marker={Symbol},{Color},{Color},{Size},{Freq},{Shadow|NoShadow}
  ...
  Series={SheetName},{Node/Group},{Pri|Sec}/{Valid String}
  Lline={Color},{LineType},{Weight}
  Marker={Symbol},{Color},{Color},{Size},{Freq},{Shadow|NoShadow}
```

**** Note that the Series are delimited by “/”. This is to allow a comma in a SheetName which would be interpreted as a delimiter if a “,” were used instead of a “/”.**

Plot Data Types:

{Axis String} AxisMin or -100000 for Default, AxisMax or 100000 for Default, MajorDivision, MinorDivision (e.g. -100000, 100000, 5, 1)

{SheetName} String value representing a valid DataSet

{Data} String value representing a valid Node or Group in the {SheetName} DataSet

{Size} Integer value for marker size

{Freq} Integer value for marker frequency

{LineType} any entry in the table below

Solid	Dashed	Dotted	Dash-Dot	Dash-Dot-Dot	
-------	--------	--------	----------	--------------	--

{Color} any entry in the table below

Default	None	Black	White	Red	DarkRed
Blue	DarkBlue	LightBlue	BlueGray	OceanBlue	SkyBlue
Yellow	DarkYellow	LightYellow	Gold	PaleBlue	IceBlue
Green	DarkGreen	LightGreen	BrightGreen	OliveGreen	SeaGreen
Turquoise	LightTurquoise	Aqua	Violet	DarkPurple	Lime
Teal	DarkTeal	Indigo	Periwinkle	Rose	Lavender
Orange	LightOrange	Brown	Tan	Coral	Pink
Gray25	Gray40	Gray50	Ivory	Plum	

{Weight} any entry in the table below

Hairline	Thin	Medium	Thick		
----------	------	--------	-------	--	--

{Symbol} any entry in the table below

None	Square	Diamond	Triangle	X	Star
Dot	Dash	Circle	Plus		

19.8 StripChart

Numerous StripChart blocks may exist in a session file, each defined as follows:

```
[StripChart]
  Title={Valid String}
  SheetName={Valid Sheet}
  NoCharts={Valid Integer}
  X Axis={Axis String}
  Series={SheetName}/{Node/Group}/{ChartNo}/{Valid String}
    Line={Color},{LineType},{Weight}
    Marker={Symbol},{Color},{Color},{Size},{Freq},{Shadow|NoShadow}
  ...
  Series={SheetName},{Node/Group},{ChartNo}/{Valid String}
    Line={Color},{LineType},{Weight}
    Marker={Symbol},{Color},{Color},{Size},{Freq},{Shadow|NoShadow}
```

**** Note that the Series are delimited by “/”. This is to allow a comma in a SheetName which would be interpreted as a delimiter if a “,” were used instead of a “/”.**

StripChart Data Types:

{Axis String} AxisMin or -100000 for Default, AxisMax or 100000 for Default, MajorDivision, MinorDivision (e.g. -100000, 100000, 5, 1)

{SheetName} String value representing a valid DataSet

{Data} String value representing a valid Node or Group in the {SheetName} DataSet

{ChartNo} Integer value for Chart Number Index

{Size} Integer value for marker size

{Freq} Integer value for marker frequency

{LineType} any entry in the table below

Solid	Dashed	Dotted	Dash-Dot	Dash-Dot-Dot	
-------	--------	--------	----------	--------------	--

{Color} any entry in the table below

Default	None	Black	White	Red	DarkRed
Blue	DarkBlue	LightBlue	BlueGray	OceanBlue	SkyBlue
Yellow	DarkYellow	LightYellow	Gold	PaleBlue	IceBlue
Green	DarkGreen	LightGreen	BrightGreen	OliveGreen	SeaGreen
Turquoise	LightTurquoise	Aqua	Violet	DarkPurple	Lime
Teal	DarkTeal	Indigo	Periwinkle	Rose	Lavender
Orange	LightOrange	Brown	Tan	Coral	Pink
Gray25	Gray40	Gray50	Ivory	Plum	

{Weight} any entry in the table below

Hairline	Thin	Medium	Thick		
----------	------	--------	-------	--	--

{Symbol} any entry in the table below

None	Square	Diamond	Triangle	X	Star
Dot	Dash	Circle	Plus		

19.9 Table

Numerous Table blocks may exist in a session file, each defined as follows:

```
[Table]
SheetName= {Valid Sheet}
Nodes= {Node/Group1},{ Node/Group2},{Node/Group3},...,{Node/GroupN}
SourceSheet= {SheetName1}/{SheetName2}/.../{SheetNameM}
Parameter= {Parameter1},{Parameter2},...,{ParameterM}
Conditional 1= {Condition1},{Condition2},...,{ConditionM}
Conditional 2= {Condition1},{Condition2},...,{ConditionM}
Conditional 3= {Condition1},{Condition2},...,{ConditionM}
Options= {BoldConditionals,SheetsOnTop,FormatBorders,RepeatHeaders,
          GroupSubHeadingsAtLeft}
NumericFormat= {Valid Format String}
```

**** Note that the sheet names are delimited by "/". This is to allow a comma in a SheetName which would be interpreted as a delimiter if a "," were used instead of a "/".**

Table Data Types:

{SheetName#} the sheet name for a particular DataSet
{Data#} valid Node or Group from a DataSet
{Parameter#} Table parameter (e.g. Min, Max, etc.)
{Condition#} {<|<=|>=|>}LimitName+{Margin}={ForeColorIndex},{BackColorIndex} or leave blank
 (see [Conditional Formatting](#) section)
{ColorIndex} any numeric entry in the table below

1	Black	2	White	3	Red	4	BrightGreen	5	Blue
6	Yellow	7	Pink	8	Turquoise	9	DarkRed	10	Green
11	DarkBlue	12	DarkYellow	13	Violet	14	Teal	15	Gray25
16	Gray50	17	Periwinkle	18	Plum	19	Ivory	20	LightTurquoise
21	DarkPurple	22	Coral	23	OceanBlue	24	IceBlue	25	DarkBlue
26	Pink	27	Yellow	28	Turquoise	29	Violet	30	DarkRed
31	Teal	32	Blue	33	SkyBlue	34	LightTurquoise	35	LightGreen
36	LightYellow	37	PaleBlue	38	Rose	39	Lavender	40	Tan
41	LightBlue	42	Aqua	43	Lime	44	Gold	45	LightOrange
46	Orange	47	BlueGray	48	Gray40	49	DarkTeal	50	SeaGreen
51	DarkGreen	52	OliveGreen	53	Brown	54	Plum	55	Indigo
56	DarkBlue								

19.10 GraphicalTable

Numerous Table blocks may exist in a session file, each defined as follows:

```
[GraphicalTable]
SheetName= {Valid Sheet}
Title= {Valid String}
NodeNos= {Data1},{Data2},{Data3},...,{DataN}
LowerOuterLimit= {ValidLimit}
LowerInnerLimit= {ValidLimit}
MinSheet(s)= {SheetName1}/{SheetName2}/.../{SheetNameN}
MaxSheet(s)= {SheetName1}/{SheetName2}/.../{SheetNameN}
UpperInnerLimit= {ValidLimit}
UpperOuterLimit= {ValidLimit}
ErrorBar={Color},{LineType},{Weight}
UserPoint1={Valid Sheet}/{Max|Avg|Min|TS(Index)}/{Valid String}
Marker={Symbol},{Color},{Color},{Size},{Shadow|NoShadow}
UserPoint2={Valid Sheet}/{Max|Avg|Min|TS(Index)}/{Valid String}
Marker={Symbol},{Color},{Color},{Size},{Shadow|NoShadow}
UserPoint3={Valid Sheet}/{Max|Avg|Min|TS(Index)}/{Valid String}
Marker={Symbol},{Color},{Color},{Size},{Shadow|NoShadow}
```

```
UserPoint4={Valid Sheet}/{Max|Avg|Min|TS(Index)}/{Valid String}
Marker={Symbol},{Color},{Color},{Size},{Shadow|NoShadow}
UserPoint5={Valid Sheet}/{Max|Avg|Min|TS(Index)}/{Valid String}
Marker={Symbol},{Color},{Color},{Size},{Shadow|NoShadow}
UserPoint6={Valid Sheet}/{Max|Avg|Min|TS(Index)}/{Valid String}
Marker={Symbol},{Color},{Color},{Size},{Shadow|NoShadow}
```

** Note that the sheet names are delimited by “/”. This is to allow a comma in a SheetName which would be interpreted as a delimiter if a “,” were used instead of a “/”.

GraphicalTable Data Types:

{Data#} valid Node or Group from a DataSet
 {SheetName#} the sheet name for a particular DataSet
 {Valid Limit} valid limit name from [Limit File](#)
 {TS(Index)} Timestep indicator and zero-based timestep array index
 {Color} any entry in the table below

Default	None	Black	White	Red	DarkRed
Blue	DarkBlue	LightBlue	BlueGray	OceanBlue	SkyBlue
Yellow	DarkYellow	LightYellow	Gold	PaleBlue	IceBlue
Green	DarkGreen	LightGreen	BrightGreen	OliveGreen	SeaGreen
Turquoise	LightTurquoise	Aqua	Violet	DarkPurple	Lime
Teal	DarkTeal	Indigo	Periwinkle	Rose	Lavender
Orange	LightOrange	Brown	Tan	Coral	Pink
Gray25	Gray40	Gray50	Ivory	Plum	

{Weight} any entry in the table below

Hairline	Thin	Medium	Thick		
----------	------	--------	-------	--	--

19.11 RadkManipulation

Numerous RadkManipulation blocks may exist in a session file, each defined as follows:

```
[RadkManipulation]
ObjectName= {Valid String}
InputRadkFile= {File Path}
OutputRadkFile= {File Path}
Action= {Valid Radk Action}
...
Action= {Valid Radk Action}
CondNoWidth= {Valid Integer}
NodeIWidth= {Valid Integer}
NoedJWidth= {Valid Integer}
CondValWidth= {Valid Integer}
OutputOnlyConductorData= {Boolean}
CommentNodeHeader= {Boolean}
CommentCondHeader= {Boolean}
```

RadkManipulation Data Types:

{Valid Radk Action} string that consists of: {RadkActionStr} for conductors with NodeI/J= {Valid Range} and Node J/I = {Valid Range}
 {RadkActionStr} REMOVE SUBMODEL | COMMENT OUT | DELETE | SUM |
 LIST TO FILE {File Path} | LIST TO EXCEL {Valid Sheet} |
 RENUMBER STARTING WITH {Valid Integer} | SCALE BY {Valid Float}

19.12 RadkCompare

Numerous RadkCompare blocks may exist in a session file, each defined as follows:

```
[RadkCompare]
  SheetName= {Valid Sheet}
  RadkFilenameA= {File Path}
  RadkFilenameB= {File Path}
  MinimumRadk= {Valid Float}
  AllowableDelta= {Valid Float}
  AllowablePercentDelta= {Valid Float}
  AllowableDeltaTimePercentDelta= {Valid Float}
  SortBy={1 for sort by Allowable Delta
          2 for sort by Allowable Percent Difference
          3 for sort by Allowable Delta * Allowable Percent Delta}
```

19.13 Backload

Numerous Backload blocks may exist in a session file, each defined as follows:

```
[Backload]
  SheetName= {Valid Sheet}
  BLNodes= {Node1},{Node2},{Node3},...,{NodeN}
  TempOffset= {Valid Float}
  StefanBoltzman= {Valid Float}
  StartingArrayNo= {Valid Integer}
  StartingCondNo= {Valid Integer}
  StartingNodeNo= {Valid Integer}
  DegradedEmissivity= {Valid Float}
  LowerTemperatureConstraint= {Valid Float}
  IgnoreNodes= {Valid Range}
  UseTMMNodes= {Valid Range}
  IgnoreSelfView= {Boolean}
  RadkFilename= {File Path}
  RadkFormat= {TSS|Desktop|Esarad}
  TempFilename= {File Path}
  TempFormat= {SINDA85|SINDA/G|ESABLK|ESATBL|TAK2000|TMG}
  HeatRateFilename1= {File Path}
  HeatRateFormat1= {TSS|Desktop|Esarad}
  HeatRateFilename2= {File Path}
  HeatRateFormat2= {TSS|Desktop|Esarad}
  TMMFilename= {File Path}
  TMMFormat= {SINDA85|SINDA/G|ESATAN}
  OutputFilename= {File Path}
  OutputFormat= {SINDA85|SINDA/G|ESATAN}
  ValidationFilename= {File Path}
  OutputBackloadsToExcel= {Boolean}
  OutputSinksToExcel= {Boolean}
  UseT^4Average= {Boolean}
```


19.14 StaticHeatMaps

Numerous StaticHeatMap blocks may exist in a session file, each defined as follows:

```
[StaticHeatMap]
  SheetName= {Valid String}
  NodeSubNetwork= {Node1},{Node2},{Node3},...,{NodeN}
  TMMFormat= {SINDA85|SINDA/G|ESABLK|TAK}
  TMMInputFileName= {File Path}
  TMMOutputFileName= {File Path}
  TempFileName= {File Path}
  TempFormat= {SINDA85|SINDA/G|ESABLK|TAK}
  HeatFileName= {File Path}
  HeatFormat= {SINDA85|SINDA/G|ESABLK|TAK}
  CondFileName= {File Path}
  CondFormat= {SINDA85|SINDA/G|ESABLK|TAK}
  TimeStepsToOutput= {Timestep Output}
  Sigma= {Valid Float}
  Toffset= {Valid Float}
  OnlyReduceTMMNetwork= {Boolean}
```

StaticHeatMap Data Types:

{Timestep Output} a string listing of T or F indicating for each timestep if it is to be output. (e.g. TTFFTTFT would output timesteps 1,2,5, 6, and 8). Alternately, the keyword ALL may be used to specify that all timesteps should be output. Lastly, a (X,Y) format such as (1,1) would specify to output 1 timestep, skip one timestep and repeat this pattern until the last timestep is reached. A user is cautioned that changing filenames without updating the Timestep Indexes or Output Timestep may result in unexpected behavior. When in doubt, make the fields blank and TARP selects the defaults, which may then be changed through the interface.

19.15 BinaryHeatMaps

Numerous Binary HeatMap blocks may exist in a session file, each defined as follows:

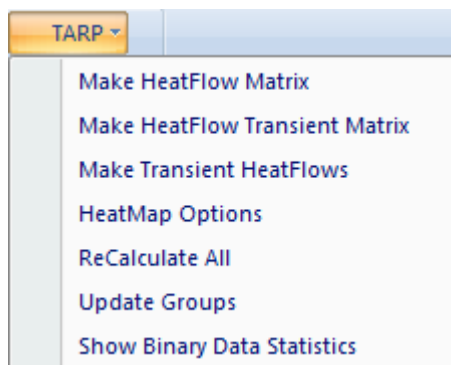
```
[BinaryHeatMap]
  ObjectName= {Valid String}
  NodeSubNetwork= {Node1},{Node2},{Node3},...,{NodeN}
  SubNetworkLevels= {Valid Integer 1-5}
  BoundaryNodes= {Node1},{Node2},{Node3},...,{NodeN}
  TMMFormat= {SINDA85|SINDA/G|ESABLK|TAK}
  TMMInputFileName= {File Path}
  TMMOutputFileName= {File Path}
  TempFileName= {File Path}
  TempFormat= {SINDA85|SINDA/G|ESABLK|TAK}
  HeatFileName= {File Path}
  HeatFormat= {SINDA85|SINDA/G|ESABLK|TAK}
  CondFileName= {File Path}
  CondFormat= {SINDA85|SINDA/G|ESABLK|TAK}
  TimeStepsToOutput= {Timestep Output}
  Sigma= {Valid Float}
  Toffset= {Valid Float}
  OnlyReduceTMMNetwork= {Boolean}
```

Temp, Heat, and Cond Filename and Format are reserved for future use to allow variable formats for Temperatures, Heat, and Conductances.

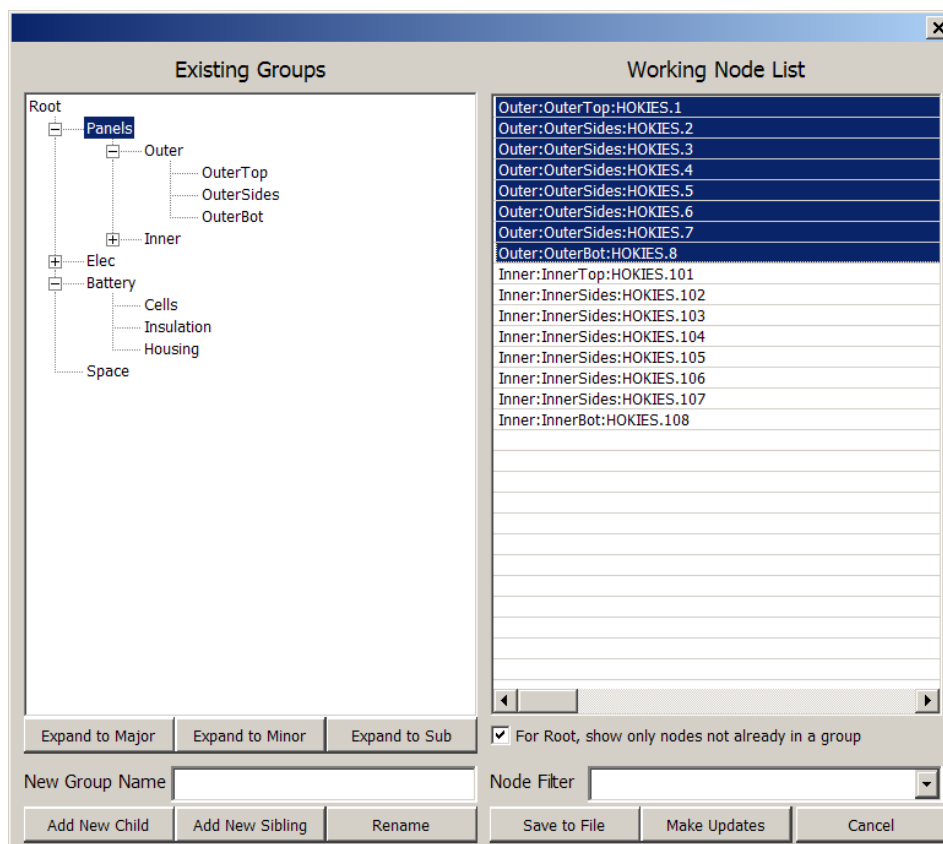
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20. Creating and Using the Workbook

Once all objects and their properties are defined, the *Make XL* button is used to create the output Excel® workbook. During each step, progress is indicated in a progress bar for the subtask currently being performed. The program begins by processing the input file (if Node Descriptions were requested). Next, it reads the input files for each DataSet and outputs the data to the specified worksheets. Then the NodeInfo sheet is created, merging node descriptions, groups definitions, limits, and weighting factors onto a single worksheet. The group and parameter definitions are then appended to each DataSet worksheet as well as any Minimum, Average, Maximum formulas. All Plots are created next, followed by all StripCharts, Tables, Graphical Tables, RadkManipulations, RadkCompares, Backloads, StaticHeatMaps, and Binary HeatMap Files. Lastly, if HeatMaps with DataSets are being generated, the Lin and Rad conductor sheets are created. Finally, the workbook is saved and the final workbook is opened in Excel® for examination by the user.



In Excel®, some macros may be available to the user if: (1) a request was made to *Allow Group Modifications in Excel* under the [Preferences](#) form, (2) any [Group](#) or [Parameter](#) type object was defined, or (3) the output workbook is a [HeatMap](#). If any of these conditions are satisfied, a TARP menu item is displayed in Excel® under the Add-Ins menu. Each of these items is discussed in the [Heatmaps](#) section, with the exception of the *Update Groups*, which displays the form below.



Selecting a group in the tree under *Existing Groups* displays all nodes contained in that group in the *Working Node List*. Nodes contained in child groups are indicated by displaying their full path. Nodes may be moved to another group simply by dragging them from the *Working Node List* and dropping them into the new group in the *Existing Groups* tree. Similarly, groups in the tree may also be dragged and dropped into new groups to change the hierarchy. Groups may be deleted from the tree if they are no longer needed by pressing delete when the desired group is selected; a prompt is issued to delete or promote any child groups. Groups may also be renamed by entering the new group name into the *New Group Name* text box and clicking the *Rename* button. New groups may also be added as Siblings or Children of the selected group, with the new group name as specified in the New Group Name textbox. The entire group structure may be expanded/collapsed to the Major, Minor, or Sub group level. Lastly, the final collapse/expand state of the group hierarchy serves as the definition for the [DynamicGroups](#) as described in the [HeatMaps](#) section.

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21. Miscellaneous

TARP.exe may also be run in command line mode for batch processing. Three arguments are accepted at the command line: -ds, -ls, and -nd. These options are described in the usage below. The -nd option is recommended when processing in batch mode to prevent TARP from awaiting a GUI response from the user.

TARP.EXE

Usage: TARP.exe -parameter [-parameter]

Where: parameter = ds : Diagnose Startup Subroutine
parameter = ls filename : Load specified session
parameter = nd : Don't display GUI

The -ds option allows for troubleshooting TARP startup issues by displaying a number of message boxes indicating progress up to a point where the main GUI is displayed. The -nd option should be used when multiple sequential batch jobs are submitted, since otherwise the TARP window will not close out upon completion of a session.

Furthermore, three additional utilities are included: ToCSV.exe, Expand.exe, Collapse.exe. ToCSV is used to create a comma separated value file from an output file. This is useful for very large outputs which may not fit onto an Excel sheet. The user specifies the parameter to retrieve and the filename. The format is assumed based on the headers found in each type of output file (SINDA85, ESATAN, etc). The output is sent to a file with the same basename as filename, but with a .CSV extension. Expand.exe processes and executes all the INCLUDE and INSERT commands, producing an expanded file and overwriting the specified input file. Special identifying comment lines are placed at the beginning and end of an included file in order for the Collapse.exe program to be able to recognize which lines should be collapsed back to the original include file structure. Collapse.exe is the antithesis of Expand.exe and outputs a file with all the INCLUDE/INSERT commands restored. These files are all found in the installation directory.

Usage: ToCSV.exe -parameter filename

Where: parameter = T, Q, QS, QA, QE, QI, QR, Q", G, GL, GR, or C
filename = Valid output file including path

Usage: Collapse.exe filename

Usage: Expand.exe filename

Where: filename = Valid Input file including path

Under the Utility Menu item at the TARP main interface, options may be found to execute the Expand.exe and Collapse.exe functions on the file selected by the user. Furthermore, an option exists to scan a SINDA/FLUINT input file and list any duplicate nodes found after expanding all include/insert files. Lastly, a Batch Creator option is available that allows a user to select all the session files to be run sequentially and generates a Batch file accordingly with the option to generate and run or just to generate.

Lastly, a ToCVR.exe file is also provided to allow for command line generation of a COVeR data file. This application will work for users who do not have a license for COVeR, but the resulting file cannot be loaded into the COVeR environment without proper licensing. However, the resulting COVeR file may be loaded into TARP and can result in faster generation of TARP workbooks rather than reading the direct thermal model output files into TARP. The benefit of

generating the COVeR file through the command line is that this may be executed as a shell command from within the thermal model execution as part of an overnight run rather than requiring user inputs to convert the output file to COVeR format manually. The usage format is shown below:

```
Usage: ToCVR.exe [Option Filename] [Option Filename] ...
Where: [Option Filename] may be:
      [-T{Q|G|C} OutputFileName] for Temps, Heats, Conds, or Caps
      [-N InputFileName] for HeatFlows
      [-H EnvHeatFilename] for Env Heat Rates
      [-R RadkFilename] for External Radks
      [-{B,S,or BS} Sigma Toffset] for Backloads, Sinks, or Both
```

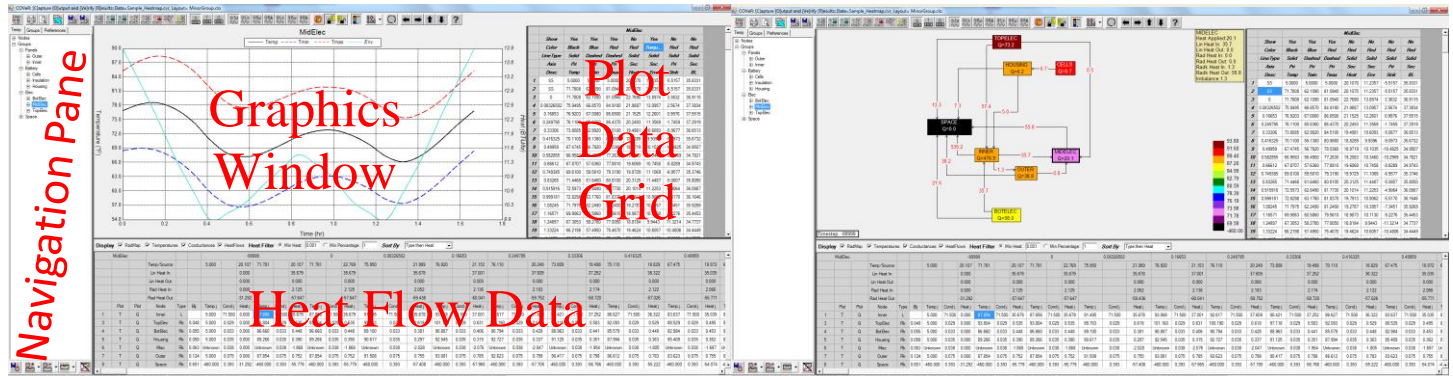
At a minimum, the T option and OutputFile must be specified. Usage of the -N option, also requires the T,Q, and G options for OutputFilename

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22. COVeR: Capture Output and Verify Results

COVeR™ is a stand-alone environment for the evaluation of thermal model results. Results from standard ASCII output of various commercial thermal solvers are imported for further investigation, including: Nodal Temperatures, Heat Loads, Capacitances, Environmental Heat Loads, Backloads, and Equivalent Sink Temperatures. This data is stored in a binary file (.cvr) for future retrieval again if needed. Furthermore, this nodal data may be combined with conductance data to investigate heat flows. All of this can be further extended to Groups, which are a collection of nodes that represent subsystems or components of interest. The data itself is stored independently of the Group definitions, allowing refinement or redistribution of nodes within the Group hierarchy without the need to reimport the data from the solver output file.

The Graphical User Interface features a Navigation Pane, a Graphics Window (for displaying Plots or Graphical HeatMaps), Plot Data Grid, and Heat Flow Data. The .cvr file is loaded into the COVeR environment shown below. Once loaded, nodes, submodels, and groups are available for display, including transient plots and data such as temperatures, applied heat loads, and heat flows to/from connections. The heat flows may also be displayed in block diagram form between groups with various options to show only relevant data.



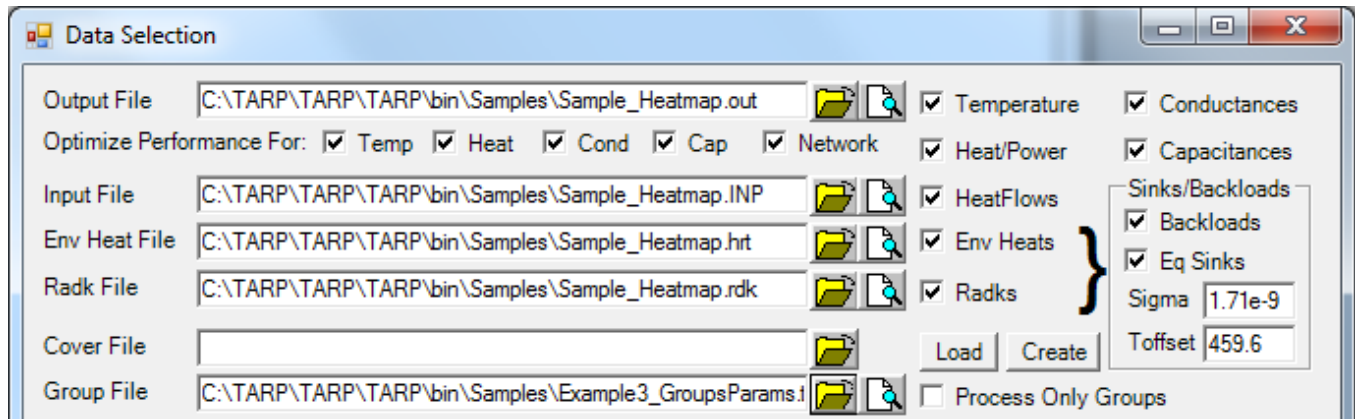
Plots allow control over the display of Temperature, Capacitance, Heat Load, Environmental Heat Load, Backload, or Equivalent Sink. Color, linetype, axis, and visibility for each of the series on the plot can be set by the user. Lastly, the scale and divisions of the X and Y axes can be set by the user. The plot data itself is displayed in the *Plot Data Grid* and may be copied to the clipboard and pasted into other applications.

Graphical HeatMaps allow for the display of heat flows for the entire model or portions of the model as needed in a block diagram form for the defined groups. Groups added to the Canvas are displayed with Connectors to indicate the magnitude and direction of heat flow. Connectors stay attached to their corresponding GroupBoxes and may be updated for their line type, visibility, and color. The layout of the entire Graphical HeatMap (line types, colors, positions) may be stored for later application to updated results.

Lastly, the *Heat Flow Data* grid displays all the connections in a matrix format for the selected Node/Group. This data can be customized based on magnitude and data to show Temperature, Heat Flow and/or Conductance and may also be copied to the clipboard.

22.1 Selecting the Data

To begin, a user first creates a .cvr file, which processes the standard ASCII output file from the thermal solver and stores the data in an efficient, binary format. Depending on the user inputs, multiple data values may be stored in the .cvr file, including any combination of: temperatures, heat loads, conductances, capacitances, equivalent sinks, backloads, environmental heats, radiative couplings, and network connections. Once this file is created, it may be reloaded as needed assuming the thermal model output has not changed.



Four separate output files may be processed to extract or compute the requested data. The Nodal *Temperature*, *Heat/Power*, and *Capacitance* values are extracted from the *Output file*, as well as the *Conductance* value for the conductors. If *HeatFlows* are requested, the *Input File* is also needed to determine the nodes connected by the conductor definitions. Combining this data with the *Conductance* values from the *Output File* allows for heat flows to be calculated.

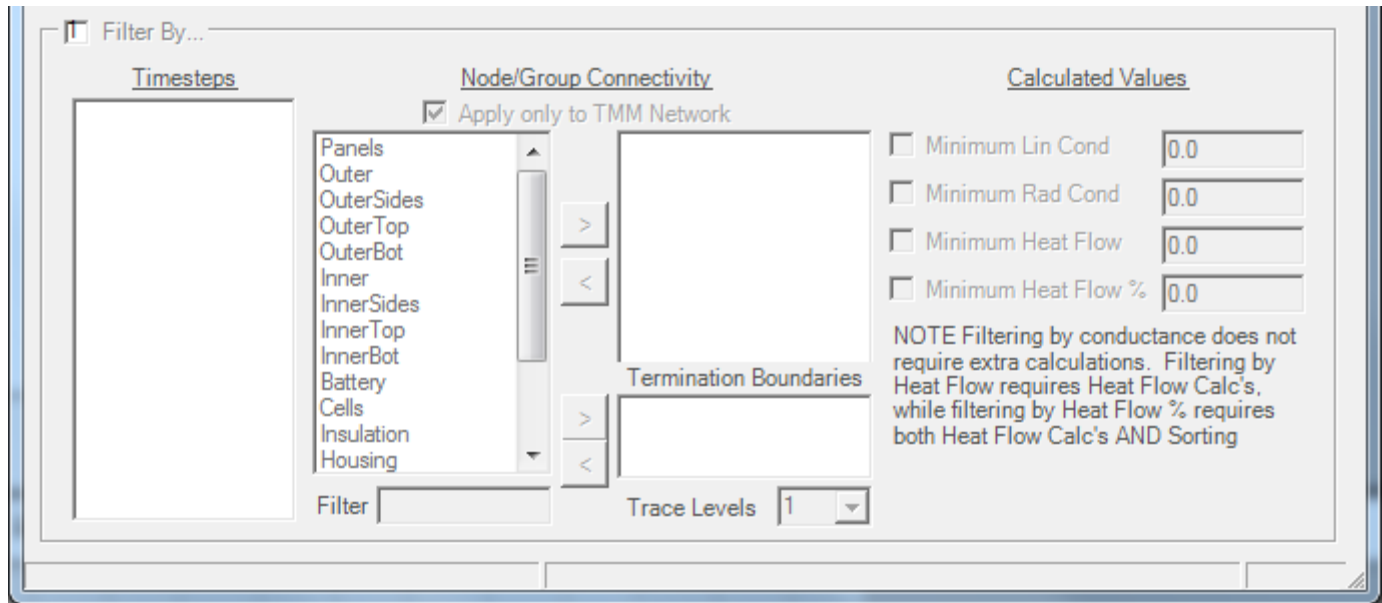
Furthermore, the Environmental Heat Rates and External Radk values can be specified in the *Env Heat File* and *Radk File* respectively. Knowing the *Env Heat* can be useful to separate environmental heating from the total nodal power to infer heater or dissipated power. Furthermore, identification of the External Radks can help to separate internal radiation from external radiation when investigating *HeatFlows*.

Lastly, combining the *Env Heat* and *Radk* data and specifying the Stefan Boltzmann constant (*Sigma*) and the Absolute Temperature Offset (*Toffset*) allows for the computation of the IR Backloads and Equivalent Sink Temperature for each node. All of this data gets processed and saved to the specified *Cover File* when the *Create* button is pressed. If this step has been performed previously, the *Load* button is used to retrieve this data from an existing .cvr file.

A *Group File* may be specified to define the combination of nodes into Groups. Temperatures for all nodes in a Group are averaged to determine the Group Temperature. The local nodal maximum and minimum temperatures are also identified for each Group. Capacitances and Heat Loads (including Backloads and Env Heats) are summed to determine the respective Group values. The Group Sink Temperature is based on a T^4 averaging with a RadkSum weighting factor applied. Finally, HeatFlows between Groups are based on processing the individual nodal heat flows and compiling the net HeatFlow between the Group definitions. Similar values are calculated for Submodels as well, with the exception of *Env Heats*, *Backloads*, and *Eq Sinks*, since Submodels are seldom discretized for this data to be meaningful.

22.2 Filtering the Output

The user also has the option reduce the data output to the .cvr file by selecting timesteps for output based on those available in the *Output File*. Furthermore, the connections may also be reduced by selecting nodes or groups of importance. If this is done, then only connections to these nodes will be output in the network portion. The user has an option to apply this filtering only to the network portion or to extend the filtering to include only the data associated with the connected nodes.



The *Trace Levels* option allows the user to trace connections beyond the immediate connections to the specified nodes or groups. By default, tracing one level will find all the immediate connections to the specified node or group (Subset A). Tracing a second level will find all connections to Subset A, and so on up to 5 trace levels. However, once a boundary node, such as the node representing deep space, is reached, it is generally undesirable to trace back in. Therefore the boundary nodes are identified and listed in the termination boundaries. The user may specify or change these nodes to terminate the trace for a smaller subnetwork if desired.

Lastly, future development plans include the placeholders for filtering by linear or radiative conductance, minimum heat flow, or minimum heat flow as a percentage of total heat flow.

22.3 Loading the COVeR file

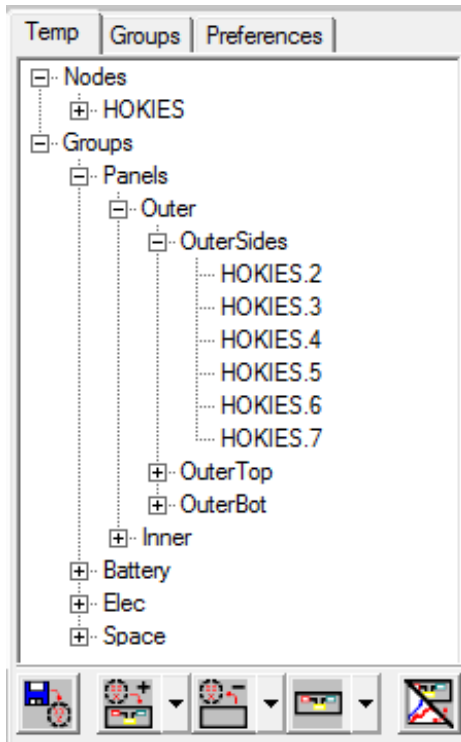
Once the .cvr file has been loaded, all the nodal temperatures, heat loads, capacitances, environmental heat loads, backloads, and equivalent sinks are stored along with the conductor nodal connections and conductance values. Once this data is stored in memory, a number of simultaneous threads are launched to perform the following actions if applicable:

- Calculate Group Minimum, Average, and Maximum Temperatures
- Calculate Group Heat Loads
- Calculate Group Capacitances
- Calculate Group Environmental Heat Loads
- Calculate Group Backloads
- Calculate Group Equivalent Sinks
- Calculate Submodel Minimum, Average, and Maximum Temperatures
- Calculate Submodel Heat Loads
- Calculate Submodel Capacitances
- Calculate Node to Node HeatFlows
- Calculate Group to Group Heat Flows
- Calculate Submodel to Submodel Heat Flows

Submodel Environmental Heat Loads, Backloads, and Equivalent sinks are not calculated, since the submodel discretization is generally not to a sufficient level to make these values useful.

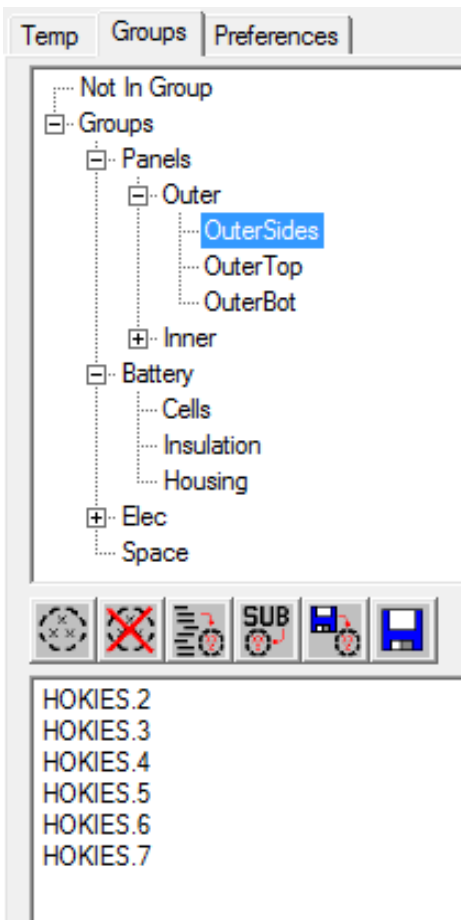
All of these threads run in parallel and as such are completed at varying times. To determine if any of these have completed, the user can look at the status bar at the bottom of the interface to see which are completed and which are still running. The first six panels of the status bar display the nodal and network data loaded from the .cvr file. If the status bars does not show one panel for “Conds Loaded” and another for “Network Loaded”, then heat flows will not be displayed. Threads that have not yet completed will be indicated by flashing text, whereas threads that have completed remain fixed are usually indicated with “ZZZ Ready”. Once necessary threads are completed, data associated with the threads may be displayed. For example, once Nodal Temperatures are ready, nodal temperatures may be plotted, even if the nodal heat flows have not yet completed. Similarly, once Group Temperatures are ready, they may also be displayed, even if Group to Group heat flows have not yet completed. The threads that take the longest time to complete are typically the heat flow calculations; these threads indicate the percent completed in the status bar. The Group and Submodel heat flows can also be saved for future retrieval if desired. Once the calculation is complete, click in the StatusBar panel for Group HeatFlows or Submodel HeatFlows and the matrix of heat flow values will be saved to a binary .chf file with the same name and path as the .cvr file. Assuming that the Groups and data have not changed in a future session, these cells can be clicked while still flashing/calculating to abort the current calculations and simply load the file. At this time, there is no error checking, so verification that the HeatFlows are still valid for the current configuration is up to the user.

22.4 Navigation Pane



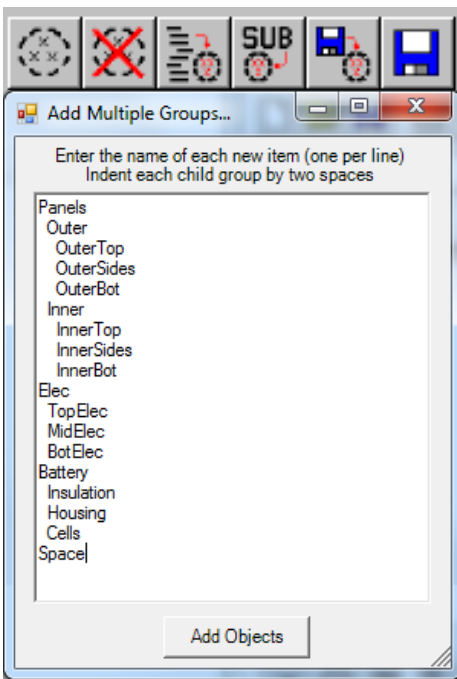
The *Temp* tab of the navigation pane on the left is used to allow the user to select the Node, Submodel, or Group of interest. Two top level options exist at the tree root: Nodes and Groups. The entries in the tree may be expanded to show the constituent Nodes of Groups contained therein. Selecting any of the entries under the Groups branch will display the corresponding Group data. Under the Nodes branch, either Submodels or Nodes may be selected for display. When an item is selected in the tree, the corresponding Temperature, Heat Load, Capacitance, and Environmental Heat are displayed in the Plot Data Grid and the Temperature is displayed on the Plot (if Plots are shown). If the entry is a Submodel or Group, the Minimum and Maximum Temperature are also displayed. Lastly, if the entry is a Group, then the Backload and Equivalent Sink is included in the Plot Data Grid. The data added to the table can be customized by the user. If the data has not been loaded by the user when the COVeR file was defined it will not be available. Below the Node/Group Tree is the toolbar to add Groups to the Canvas for

Graphical Heat Maps. This toolbar includes buttons to Load Groups from File, Add Groups to selected Canvas, Clear Selected Canvas, Show Selected Canvas, and toggle between Plots and Graphical Heat Maps in the Graphics Window.



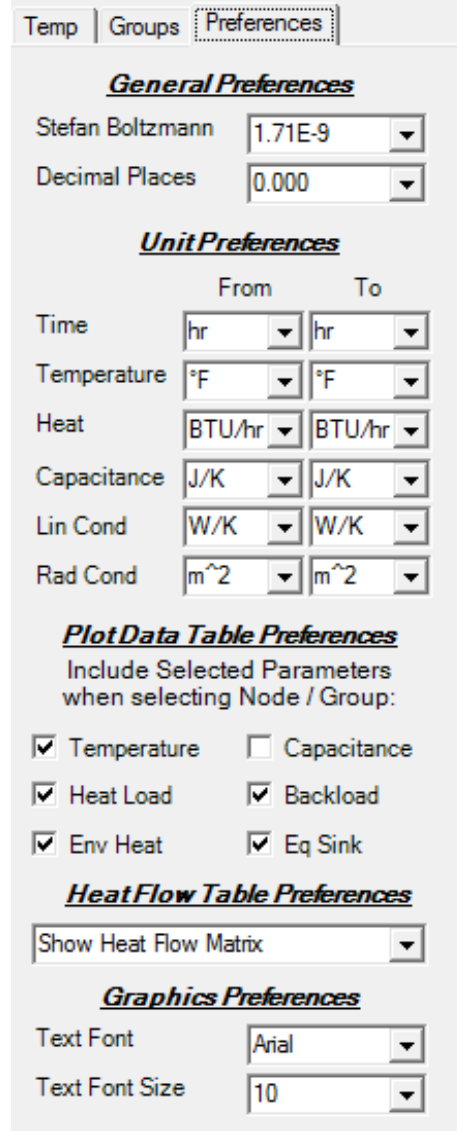
The *Groups* tab of the Navigation Pane is used to load or modify groups. Groups have a child-parent relationship with nodes in a child group being included in the parent group implicitly. As such, nodes may only be defined in one group, but may be implicitly included in up to 4 more groups based on the parent-child hierarchy based on up to five levels of depth allowed. Groups represent the average temperature of all the nodes contained therein (directly or implicitly), the total heat, capacitance, environmental heat, or backload, and a $\text{RadkSum} \cdot T^4$ weighted average for the Equivalent Sink. Furthermore, the minimum nodal or maximum nodal temperatures are also available.

Once a group is created, nodes should be added to it. Selecting the *Not In Group* entry will display a list of all nodes not in a group. Selecting these nodes from the list box and dragging and dropping them onto the desired Group in the Group Tree will add them to the group. Similarly, nodes may be moved from one group to another in a similar manner. Groups may also be dragged and dropped to change the hierarchy. Deleting a group prompts for the deletion or promotion of any child groups.



The toolbar between the Group Tree and the Node List can be used to create or delete groups. An option also exists to create multiple groups by entering in one group per line with two spaces to indicate a child group of the parent. Submodels may also be directly converted to Groups and further subdivided from there if necessary. Lastly, group definitions may be loaded from or saved to a text file based on the Group format for TARP.

The *Preferences* tab contains the preferences for the current session. The value for the *Stefan Boltzmann* constant should be set in order to display the radiative heat flows correctly. The default value is $5.67E-8 \text{ W/m}^2 \text{ K}^4$. Changing this value will only affect the radiative calculations after the fact as it is used as a multiplier for the calculated radiative values. The units of temperature are implied from the temperature data itself. If all values found are above zero, then Kelvin or Rankine are assumed (i.e. no offset). If a temperature is found below -273 , then $^{\circ}\text{F}$ is assumed; otherwise, temperature data is assumed to be in $^{\circ}\text{C}$.

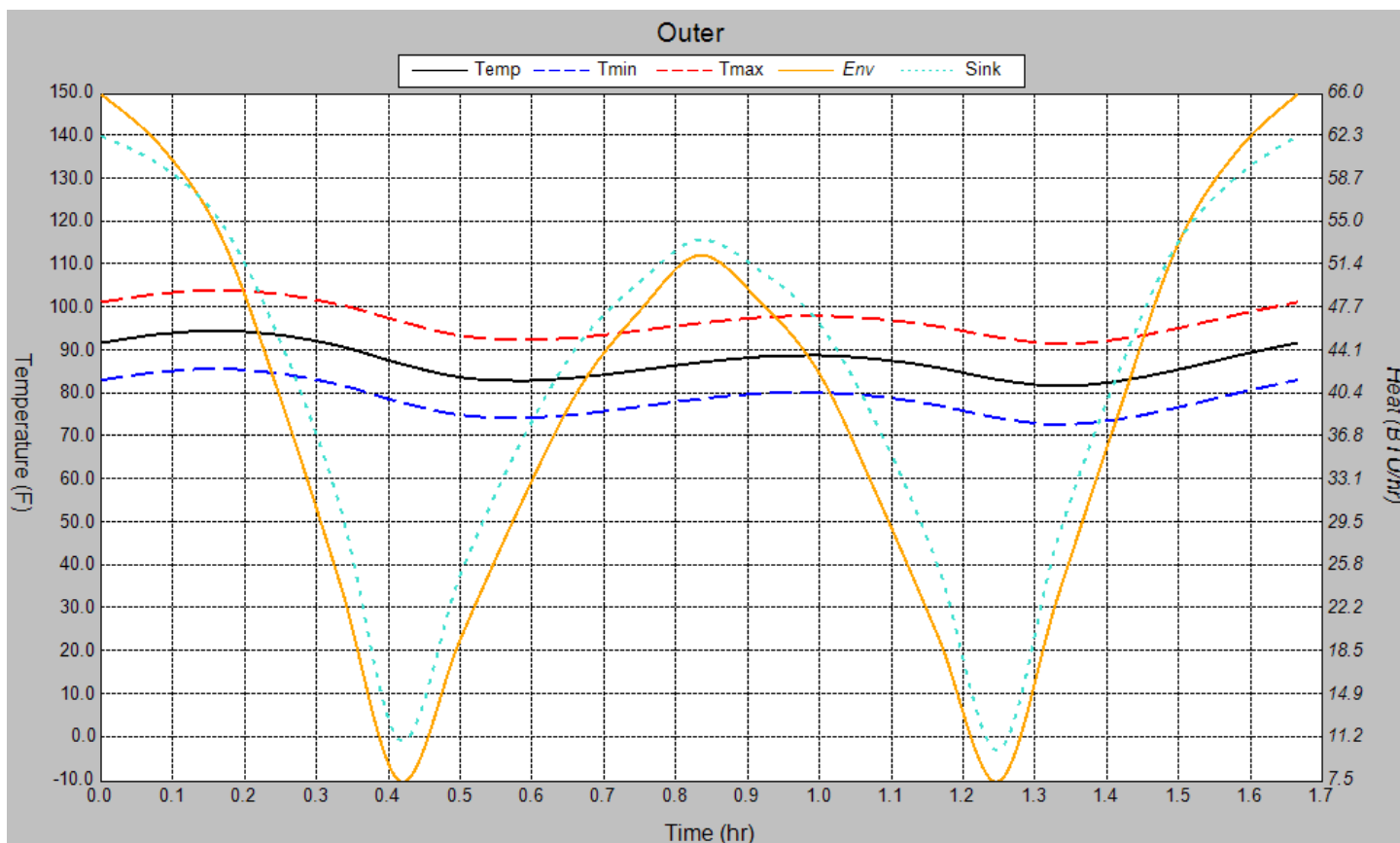


Decimal Places is used to control the number of digits shown on Plots. If this value is insufficient to show enough discretization due to zooming in to a plot or setting the axes properties, it will be overridden temporarily to ensure that duplicate axes values are not shown due to rounding errors. The *Units* specifications are only for display on the Plots to ensure the correct labels are displayed. The *Plot Data Table Preferences* checkboxes control the data that is displayed in the Plot Data Window and from that the series that can be displayed in plots in the Graphics Window.

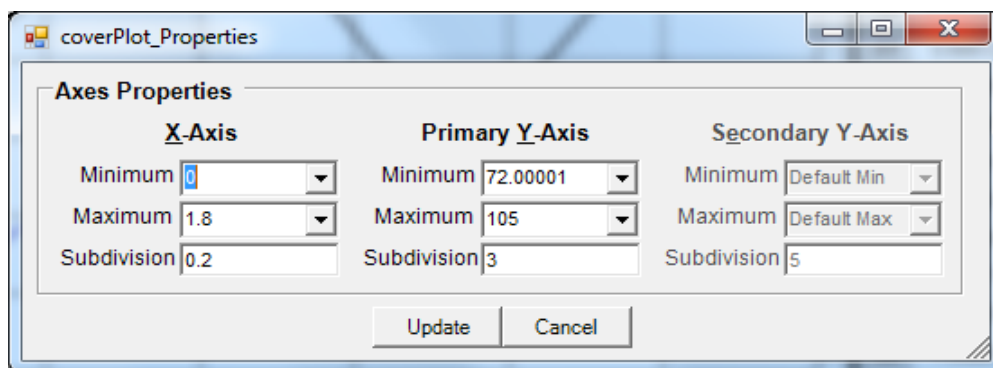
Lastly, the Font and Size for Graphical HeatMaps and Plots can be controlled through the drop down boxes under Graphics Preferences. GroupBoxes in a Graphical HeatMap will be automatically enlarged to accommodate an increase in the Font Size.

22.5 Transient Results Plot

The Transient Results Plot displays the time variation of the data listed in the Plot Data Grid. The visibility and properties of the series are adjusted using the Plot Data Grid. Series plotted on the secondary axis are indicated by italics in the Legend at the top. The time and temperature values at the cursor are displayed in the bottom right panel of the status bar.



Holding the control key down while dragging will display a dashed line and change the status bar information to the delta X and delta Y values. The user may zoom into sections by dragging a window around the desired



range of time and scale to reset the X and Y axes range. Clicking the plot while holding down the shift key will return to the autoscaled ranges. Lastly, clicking in the gray area around the white interior will display the axis properties window where the X and Y axis values may be directly set. Alternatively, a right click context menu will also show this dialog.

The plot image may be copied to the clipboard and pasted as a bitmap into other applications by hitting Ctrl-C or using the *Copy to Clipboard* option in the context menu.

22.6 Plot Data Grid

		<i>Outer</i>					▲
<i>Show</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>No</i>	<i>No</i>		
<i>Color</i>	<i>Black</i>	<i>Blue</i>	<i>Red</i>	<i>Red</i>	<i>Red</i>		
<i>Line Type</i>	<i>Solid</i>	<i>Dashed</i>	<i>Dashed</i>	<i>Solid</i>	<i>Solid</i>		
<i>Axis</i>	<i>Pri</i>	<i>Pri</i>	<i>Pri</i>	<i>Sec</i>	<i>Sec</i>		
<i>Desc</i>	<i>Temp</i>	<i>Tmin</i>	<i>Tmax</i>	<i>Heat</i>	<i>Env</i>		
1	SS	5.0000	5.0000	5.0000	38.7686	38.7685	
2	SS	87.8541	79.0950	97.3610	38.7686	38.7685	
3	0	87.8541	79.0950	97.3610	65.9907	65.9875	
4	0.08326502	91.5081	82.7590	100.9600	61.6731	61.5506	
5	0.16653	93.0805	84.2290	102.5500	54.2895	53.9679	
6	0.249795	92.6225	83.6620	102.1500	40.4162	40.0952	
7	0.33306	90.4174	81.4270	100.0800	24.7396	24.3083	
8	0.416325	86.6121	77.6530	96.4690	8.0118	7.5660	
9	0.49959	83.6226	74.8450	93.3510	19.3635	19.5925	
10	0.582855	82.9515	74.3300	92.4770	30.7301	30.9625	
11	0.66612	83.8300	75.2930	93.1820	40.7595	41.0194	
12	0.749385	85.5936	77.0950	94.8110	47.4666	47.5430	
13	0.83265	87.4484	78.9690	96.5820	52.1936	52.3005	
14	0.915916	88.7737	80.2310	97.9240	48.5289	48.4498	
15	0.999181	89.1520	80.5400	98.3720	42.5853	42.3008	
16	1.08245	88.2808	79.5720	97.6570	31.7994	31.5563	

The Plot Data Grid pane displays the data values shown on the plot. The user may also control what data is shown and the formatting for the series. The Visibility, Color, Linetype, and Axis can be toggled by selecting the cells for the appropriate series column (e.g. to change the color of the Heat series, click the cell in the Color Row and Heat column). The plot display is updated automatically after each update. The columns displayed in the grid may vary based on selection made on the Preferences tab (Section 22.4).

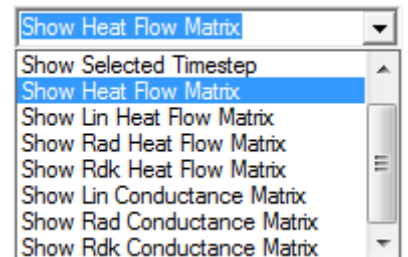
Show toggles between Yes and No for visibility control. *Color* toggles through Black, Red, Green, Blue, Yellow, Turquoise, Pink, Orange, Brown, and White. *Linetype* toggles through Solid, Dashed, Dotted, Ditted, DashDit, DashDotDot, and DashDitDit. *Axis* toggle between Pri and Sec; by default, the primary Y axis represents Temperatures and the secondary Y axis represents Heat. Holding the Shift key while clicking the *Color* or *Linetype* row toggles in reverse order.

Selecting a timestep row sets the current timestep for display of heat flow values on a Graphical Heat Map. Lastly, Ctrl-C can be used to copy the data values in the grid to the clipboard for pasting into an external application.

22.7 Heat Flow Data

Display <input checked="" type="checkbox"/> RadMap <input checked="" type="checkbox"/> Temperatures <input checked="" type="checkbox"/> Conductances <input checked="" type="checkbox"/> HeatFlows Heat Filter <input checked="" type="radio"/> Min Heat: 0.001 <input type="radio"/> Min Percentage: 1 Sort By Type then Heat																		
Outer			-99999						0			0.08326502			0.16653			
		Temp/Source:	5.000		38.769	87.854		38.769	87.854		65.991	91.508		61.673	93.081			
		Lin Heat In:			0.000E+00			1.299			1.299			0.000E+00				
		Lin Heat Out:			0.000E+00			0.000E+00			0.000E+00			-10.199				
		Rad Heat In:			0.000E+00			0.27668			0.27668			0.29864				
		Rad Heat Out:			-19.866			-40.177			-40.177			-41.296				
Plot	Plot	Node	Type	Temp j	Cond j	Heat j	Temp j	Cond j	Heat j	Temp j	Cond j	Heat j	Temp j	Cond j	Heat j	Temp j	Cond j	
1	T	Q	Inner	L	5.000	800.00	0.000E+00	87.856	800.00	1.299	87.856	800.00	1.299	91.495	800.00	-10.199	93.068	800.00
2	T	Q	Space	R	-460.00	0.24935	-19.866	-460.00	0.24935	-38.199	-460.00	0.24935	-38.199	-460.00	0.24935	-39.216	-460.00	0.24935
3	T	Q	BotElec	R	5.000	0.02075	0.000E+00	86.660	0.02075	0.04276	86.660	0.02075	0.04276	89.100	0.02075	0.00716	90.887	0.02075
4	T	Q	Housing	R	5.000	0.00787	0.000E+00	89.266	0.00787	0.00357	89.266	0.00787	0.00357	90.617	0.00787	-0.01891	92.545	0.00787
6	T	Q	TopElec	R	5.000	0.02084	0.000E+00	93.804	0.02084	0.23035	93.804	0.02084	0.23035	99.703	0.02084	0.29147	101.16	0.02084
7	T	Q	Misc	R	Unknown	0.01935	0.000E+00	Unknown	0.01935	-1.226	Unknown	0.01935	-1.226	Unknown	0.01935	-1.306	Unknown	0.01935
8	T	Q	MidElec	R	5.000	0.07482	0.000E+00	71.781	0.07482	-0.75196	71.781	0.07482	-0.75196	75.950	0.07482	-0.75498	76.920	0.07482

The Heat Flow pane shows tabular connections to the selected node, submodel, or group. Connections are grouped by type (Linear, Radiative) first and then Heat Flow, Node, Temperature, or Conductance depending on what value is selected in the *Sort By* dropdown. Options include sorting by Heat, Temperature, Node, or Conductance. Each timestep displays the Temperature of the connection, the Conductance to the connection, and the Heat Flow to/from the connection. Check boxes may be used to toggle whether all three of these values are shown or some combination. A summary is shown at the top, including applied sources, linear heat into the node, submodel, or group as well as linear heat out, radiative heat in, and radiative heat out. Clicking the associated T or Q of a particular row will add that data to the Transient Results Plot and corresponding Plot Data Grid. Clicking on the node/group in the table will make it the new selected node/group and regenerate the data. Clicking the *Node i* cell will display heat flows for the same group at the next lower level of grouping if applicable. Depending on the setting for the Heat Flow Table Preference, all timesteps or only the selected timestep may be shown. Alternately, if a Matrix Option is selected, then the current heatflows or connections are shown as below.

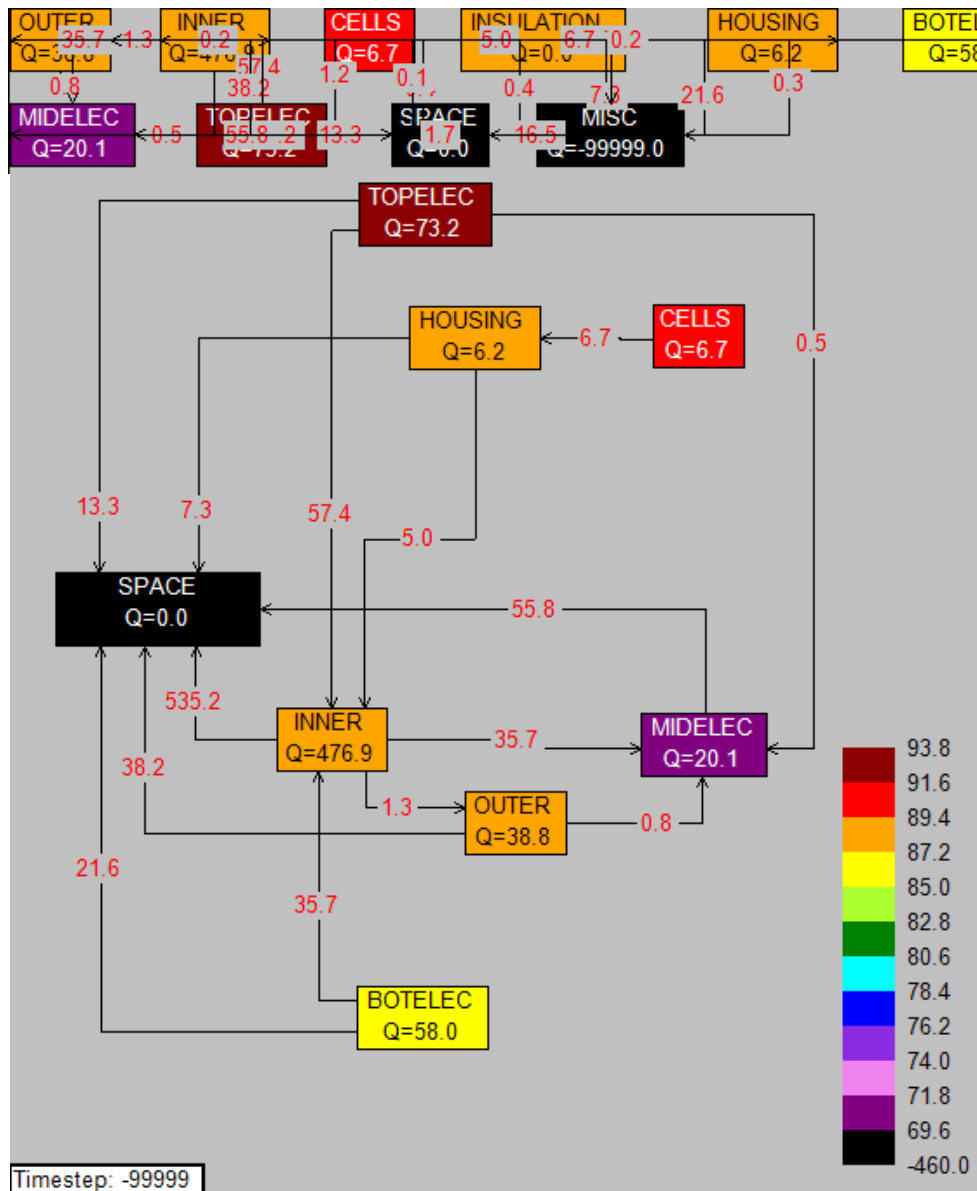


Source	38.155	0.613	0.000	475.570	1.367	0.000	6.653	0.000	6.180	57.954	20.107	73.177	0.000					
Lin Heat In	0.400	0.100	0.800	95.725	57.368	22.794			6.667		35.679							
Lin Heat Out				-36.078	-57.506	-21.234	-6.661	-0.005	-4.988	-35.690		-57.368						
Rad Heat In								0.005										
Rad Heat Out								-0.005										
Rdk Heat In	0.284	4.141E-04	0.001		2.700E-05				0.011	0.033	2.126		687.806	5.466				
Rdk Heat Out	-38.588	-0.733	-0.865	-532.927	-1.121	-1.245			-7.889	-22.413	-57.647	-15.838		-16.461				
Imbalance	0.251	-0.019	-0.064	2.290	0.108	0.314	-0.013	-2.649E-04	-0.019	-0.117	0.265	-0.029	687.806	-54.977				
Temp J	86.773	93.156	89.038	86.774	93.157	89.046	89.490	89.230	89.266	86.660	71.781	93.804	460.000					
Temp I	Group I \ J	OuterSides	OuterTop	OuterBot	InnerSides	InnerTop	InnerBot	Cells	Insulation	Housing	BotElec	MidElec	TopElec	Space	Misc			
86.773	OuterSides		0.005	0.001	0.400	1.062E-04				0.004	0.044	-0.713	0.229	-36.728	-1.148			
93.156	OuterTop	-0.005		-4.795E-05		0.100				-0.001	-0.001	-0.028	4.141E-04	-0.633	-0.065			
89.038	OuterBot	-0.001	4.795E-05			1.029E-06	0.800			3.131E-05	-1.188E-04	-0.011	0.001	-0.839	-0.014			
86.774	InnerSides	-0.400				57.406	20.434				17.884	-35.679		-532.927				
93.157	InnerTop	-1.062E-04	-0.100	-1.029E-06	-57.406					-1.360E-05	-3.080E-05	-0.001	57.368	-1.009	-0.111			
89.046	InnerBot			-0.800	-20.434					4.988	17.806			-1.245				
89.490	Cells								-0.005	-6.661								
89.230	Insulation							0.005		-0.005								
89.266	Housing	-0.004	0.001	-3.131E-05		1.360E-05	-4.988	6.661	0.005		-0.004	-0.390	0.010	-7.303	-0.187			
86.660	BotElec	-0.044	0.001	1.188E-04	-17.884	3.080E-05	-17.806			0.004		-0.448	0.027	-21.572	-0.349			
71.781	MidElec	0.713	0.028	0.011	35.679	0.001				0.390	0.448		0.535	-55.779	-1.868			
93.804	TopElec	-0.229	-4.141E-04	-0.001		-57.368				-0.010	-0.027	-0.535		-13.310	-1.725			
-460.000	Space	36.728	0.633	0.839	532.927	1.009	1.245			7.303	21.572	55.779	13.310		16.461			
	Misc	1.148	0.065	0.014		0.111				0.187	0.349	1.868	1.725	-16.461				

22.8 Graphical Heat Maps

Graphical Heatmaps display the HeatFlows between groups or submodels in a block diagram format. To add the groups at a given level to the display canvas, select “Show ___ Groups on Canvas” from the context menu accessed by a right click in the Navigation Pane or by using the Toolbar. Six canvases are reserved, one for each level of grouping available and one for submodels. Selecting a group in the Navigation Pane will automatically switch to the appropriate canvas for that group’s level.

- Show Submodels on Canvas
- Show Major Groups on Canvas
- Show Minor Groups on Canvas
- Show Sub Groups on Canvas
- Show Sub2 Groups on Canvas
- Show Sub3 Groups on Canvas
- Add Selected Group to Canvas
- Clear All Canvases

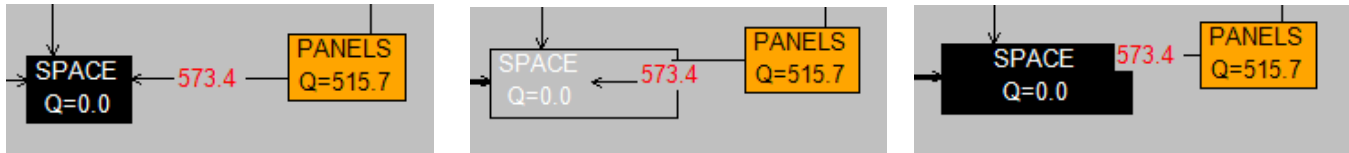


Once the Groups or Submodels are added, GroupBoxes are shown on the canvas for each Group or Submodel; the connections are displayed as Connectors which indicate the direction of the heat flow as well as the magnitude. The layout is defined by placing all the available GroupBoxes sequentially from left to right and top to bottom starting in the top left corner. However, this jumbled display is not particularly useful until the user drags each box and connector to its desired position to create the final layout. The location of each GroupBox, the path of all Connectors, and the location of the text along the connector can all be defined by the user. If the Plot View is currently displayed in the Graphics Window, then double-clicking will toggle the view back to the Graphical HeatMap View. One possible version of the layout shown previously is shown

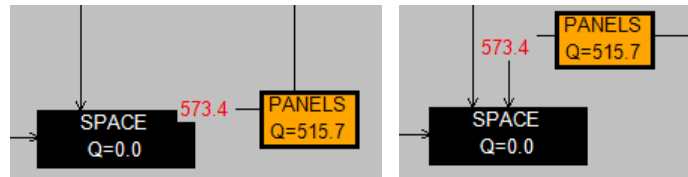
below the default layout. This version has the connectors displaying the total heatflow, with the GroupBoxes showing the applied heat in the text and the temperature per the color bar legend in the bottom right. The current timestep is displayed in the bottom left.

22.8.1 Laying out a Graphical Heat Map - GroupBoxes

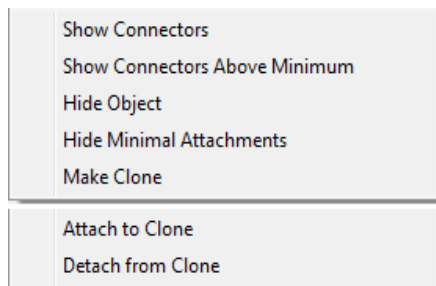
GroupBoxes are nominally sized based on the space needed for displaying the font. Selecting a corner of a GroupBox and dragging allows for the resizing; GroupBoxes may also be dragged into a new position in the layout by selecting the center of the GroupBox and dragging. If a GroupBox is selected, it is indicated with a thick line around the perimeter. GroupBoxes may also be removed from display by pressing the delete key.



Resizing a GroupBox



Moving a GroupBox



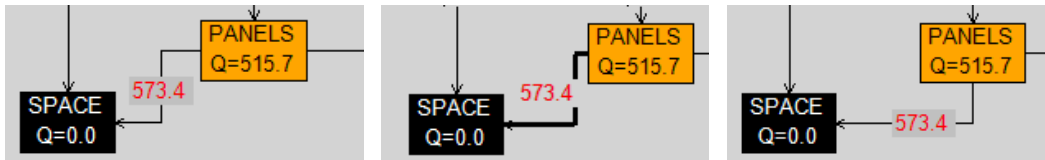
GroupBoxes can also be cloned to allow a second instance of a Group with many connections, such as a central structure or space. First, the GroupBox to be cloned should be selected and *Make Clone* selected from the right click, context menu. Then the Connector to be redirected should be selected and *Attach to Clone* selected from the right click context menu for the Connector. If Clones exist for both ends of the Connector, a prompt is given as to which connection to make. Detaching from the Clone follows a similar process through the *Detach from Clone* menu item.

22.8.2 Laying out a Graphical Heat Map - Connectors

Once GroupBoxes are positioned and sized as desired on the canvas, the next step is to lay out the Connectors, which always stay attached to their corresponding start and end GroupBoxes. If the value of a Connector is zero (when rounded to the specified precision) or if either GroupBox being connected is not visible, then the Connector will not be displayed. When a connector is first created it is set to *AutoDraw* mode, which bases the Connector shape on the angle between the GroupBoxes with the connector being drawn to the midpoint along the appropriate side of the GroupBoxes. If the angle is in the ranges (22.5° to -22.5°), (67.5° to 112.5°), (167.5° to 202.5°), or (247.5° to 292.5°), then the connector is S-shaped. If the angle is in the ranges (22.5° to 67.5°), (112.5° to 167.5°), (202.5° to 247.5°), or (292.5° to 337.5°), then the Connector is L-shaped. The value of the Connector is displayed at the middle point along the path. Occasionally, through manipulation of visibility and moving of boxes, one end of a Connector may appear to be orphaned (disconnected in space). If this occurs, select the Connector, right click for the context menu, and select *Reset to AutoDraw*.

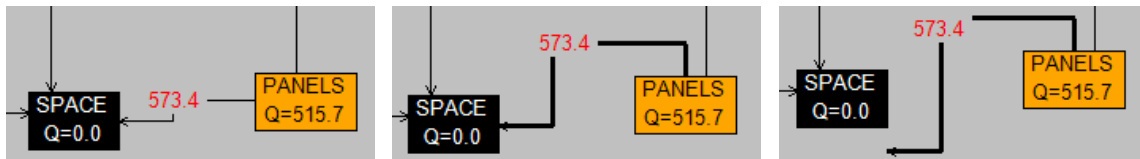
The Connector shape, connection points, and connector value location can all be modified by the user. In the three images below, the Connector starts out in *AutoDraw* mode. Clicking and dragging any segment of a Connector turns off the *AutoDraw*. Selecting the middle segment and dragging to the right maintains the S-shape until the segment connected to Panels falls inside the

Panels GroupBox, at which point the connection point shifts from the left side to the bottom and the connector changes from an S-Shape to an L-Shape. Similarly, an L-Shaped connector can be promoted to an S-Shaped (or even C-Shaped) connector. Connector segments may only move in a direction perpendicular to the segment (e.g. vertical segments move left or right; horizontal segments move up or down).



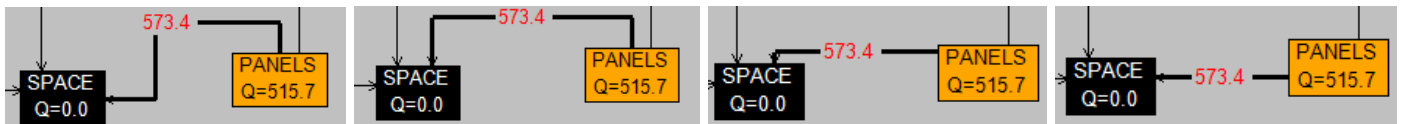
Collapsing a Connector from an S-Shape to an L-Shape

At this time, a Connector can be expanded to 4 segments or have as few as 1 (straight line). If during segment expansion, the last segment is unconnected, then the limit has been reached and the Connector should be modified or reset to AutoDraw.



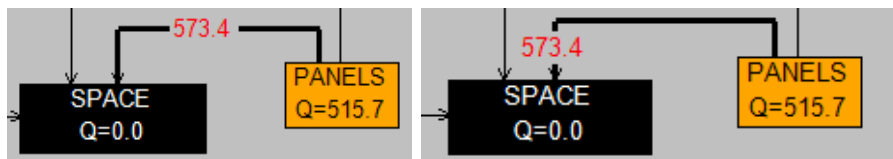
Expanding Connector too Far – Unconnected to End GroupBox

At times, it is easiest to create a straight line segment by expanding to a C-Shaped connector and then collapsing it to a straight line connector through dragging as shown below.



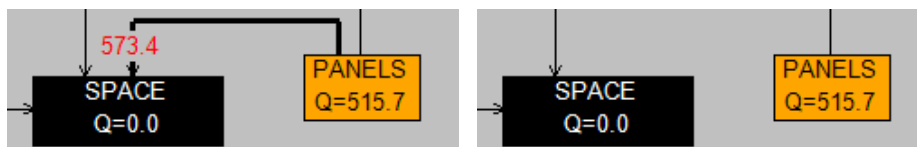
Making Straight Line Connector from C-Shape

The location of the Connector value can also be defined by the user. The value is stored as a percentage of the total path length from the start to the end GroupBox. Therefore, if the overall length and/or shape of the Connector changes, so does the position of the value. The Connector value position is adjusted by selecting the value and dragging it along the Connector path.



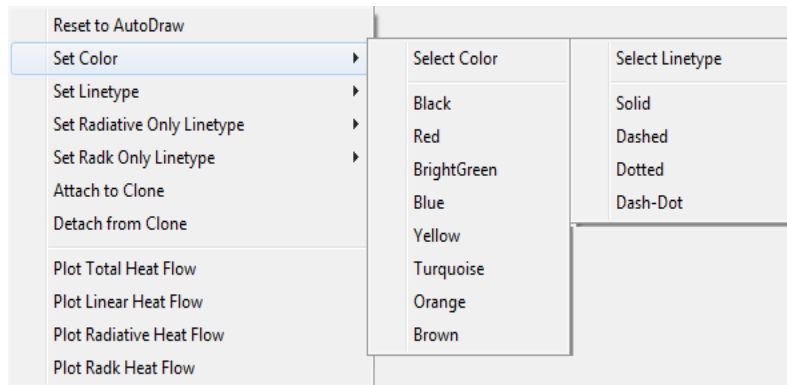
Setting the Connector Value Position

Connectors can be removed from view by selecting the connector and pressing the delete key. This only changes the visibility of the path and it can be redisplayed by various means.



Removing a Connector from Display

22.8.3 Laying out a Graphical Heat Map – Display Formatting

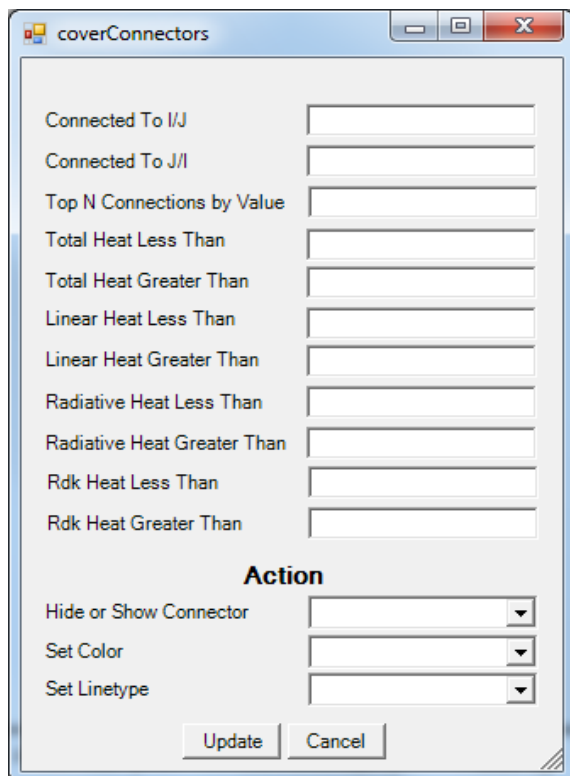


Connector Linetypes and Colors can be set by the user using the Context menu available through a right click. The available colors include Black, Red, BrightGreen, Blue, Yellow, Turquoise, Orange, and Brown. Linetype options include Solid, Dashed, Dotted, and Dash-Dot. The option to *Set Radiative Only Linetype* or *Set Radk Only Linetype* applies

the selected line style to all conductors that meet the criteria to identify primary radiative paths with no linear component.

Removing Connectors from view manually, however, is very time consuming. Generally it is best to use the options for visibility control based on the magnitude of the Connector and operating on all connectors. A variety of these options are available on the toolbar; the Show Object options for turning on visibility include showing all objects, showing all objects connected to the selected GroupBox, and showing all objects connected to the selected GroupBox whose value is above the user specified threshold.

Alternately, the Hide Objects options include hiding the selected GroupBox and all its Connectors, hiding all Connectors below the user specified threshold, and hiding Connectors below the user specified threshold connected to the selected GroupBox. Lastly, the GroupBoxes may be re-Auto positioned on the canvas based on the remaining visible GroupBoxes after some have been removed from view.



The Query mode for modifying Connectors is another way which provides the user greater control over which Connectors on which to act. A variety of fields are available including the start or end GroupBox and the magnitude of the HeatFlow. Connectors can be acted upon based on individual magnitudes of Total, Linear, Radiative, or External Radiative HeatFlow based on being above or below, or even in between, specified thresholds. The actions that can be applied to Connectors meeting the requirements include Show/Hide, setting of the Color, and/or setting of the Linetype. Multiple repetitions of this may be needed to achieve the desired final layout. For some users, this may be a preferred method for building a HeatMap. One method is to add everything to the canvas and then remove areas not of interest (a top down approach). An alternate method would be to add one Group to the Canvas and then display connections from the base Group outwards (a bottoms up approach).

Once a layout is complete for positioning of GroupBoxes, Connectors, and text positions, it can be saved to a file for later retrieval as new updates to the data are available. Since the layouts are based on the user's Group definitions, the entire nodal structure of the model can change, so long as the Groups are defined for the updated model.



The next buttons on the toolbar control the display of values on the Canvas. GroupBoxes may display the applied HeatLoad, Temperature, or the Heat Imbalance. Note that the Heat Imbalance is based on the Connectors shown and is meant to indicate if any major paths are not being displayed; it is not the imbalance as calculated by the total thermal network. Furthermore, the GroupBox may be colored by Temperature with a color legend in the bottom right. The default display is to show the Applied Heat as text in the GroupBox and to indicate the Temperature via the color bar and legend. If the ColorLegend option is not enabled, the GroupBoxes are drawn with a white background and red text.



Connectors may display the Total HeatFlow, the Linear HeatFlow (Lin), the Radiative HeatFlow (Rad), the External Radiative HeatFlow (Rdk), the Linear Conductance, the Radiative Conductance, or the External Radiative Conductance. Recall that if the value being displayed is zero, the Connector is not displayed. So, changing from Q-Tot to Q-Lin will not display Connectors with only a Radiative component.



PANELS

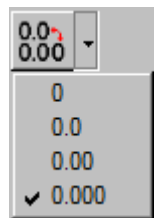
Heat Applied:515.7
 Lin Heat In: 62.4
 Lin Heat Out: 0.0
 Rad Heat In: 0.0
 Rad Heat Out: 0.0
 Radk Heat In: 0.0036
 Radk Heat Out: 575.2
 Imbalance:2.9

Elec to Panels
 Linear Heat:57.4
 Radk Heat:-0.5

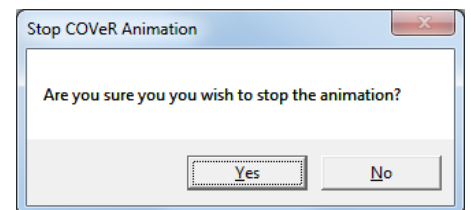
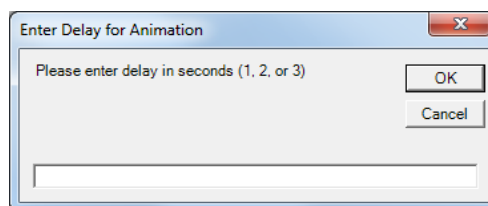
A Summary for the selected Group displays the Applied Heat Load and the Linear, Radiative (Rad) and External Radiative (Rdk) heats in and out, and the Imbalance. The Summary for a Connector shows the Linear, Radiative (Rad) and External Radiative (Rdk) of the Connector between the two Groups. This summary may be turned off or shown in the top right corner of the Canvas. A future option is reserved for displaying the Summary as a ToolTip when the cursor hovers over a GroupBox or Connector indicated by the ToolTip with the Unlock.



Connectors whose value results in 0 when rounding is applied based on the numeric format are not displayed. To change the format, select the numeric format from the drop down button to apply. Options include 0, 0.0, 0.00, and 0.000. For Radiation couplings in units of meters, this may be a problem if 0.0005 m² couplings are important or if the Radiation Coupling already includes the Sigma term.

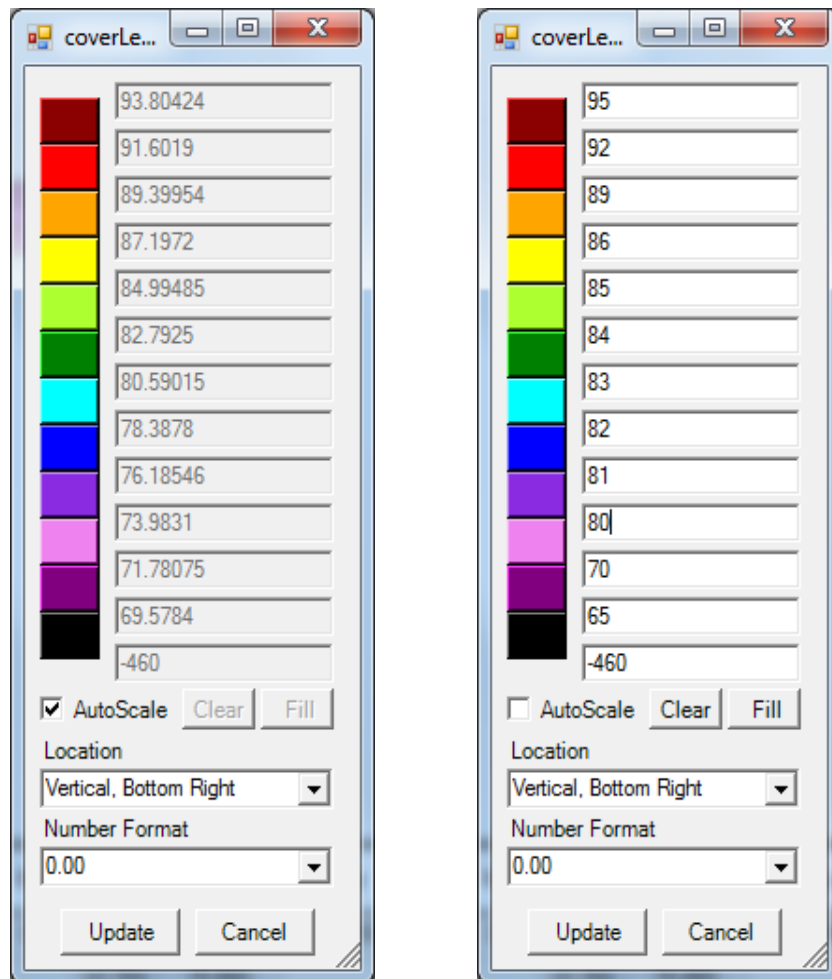


The last option on the Toolbar is an animation to cycle through all timesteps. When selected, the user is prompted for a delay of 1, 2, or 3 seconds between frames. The color bar is sized based on the maximum and minimum temperatures for all timesteps. To end the animation, press ESC and confirm when the MessageBox is displayed.



22.8.4 Laying out a Graphical Heat Map – ColorBar Legend

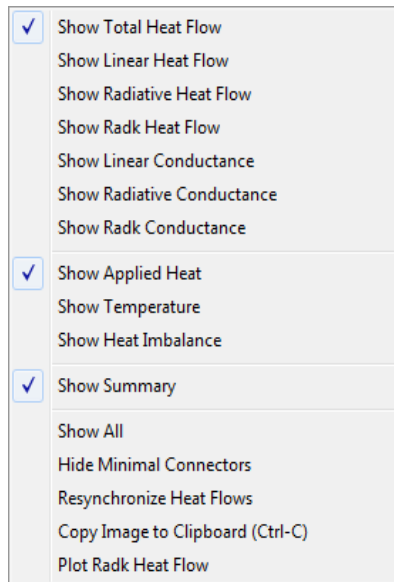
The ColorBar legend can be controlled by the user by clicking the legend on the Canvas. The color bar includes a maximum value and two minimum values. The rationale for two minimums is that the temperature representation of deep space is often well below the minimum temperature of components. Therefore, to prevent the usage of color levels between the minimum component temperature and the minimum space temperature, two minimum values are calculated for the *AutoScale*. If the *AutoScale* is not used, the user is free to set the levels and the *Clear* and *Fill* buttons are enabled. The *Clear* button will set all the level textboxes blank. The *Fill* button will evenly populate all the blank values between user entered values, allowing for uneven spacing if desired. The *Location* drop down is reserved for future use to specify the placement of the legend. The *Number Format* is an alternate place to set the precision displayed on Graphical HeatMaps



22.8.5 Laying out a Graphical Heat Map – ToolBar Summary

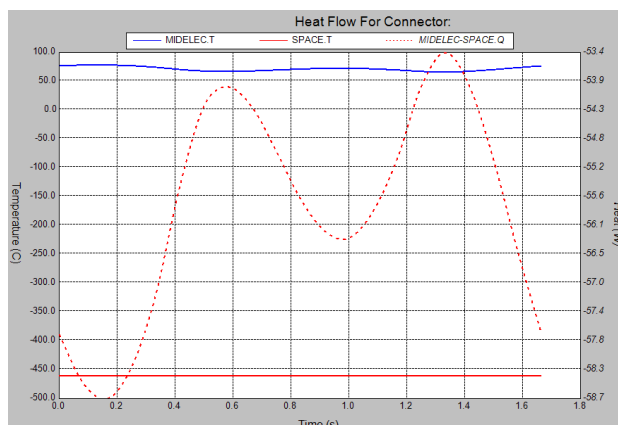
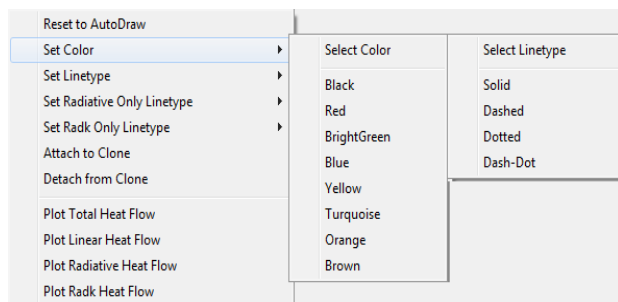
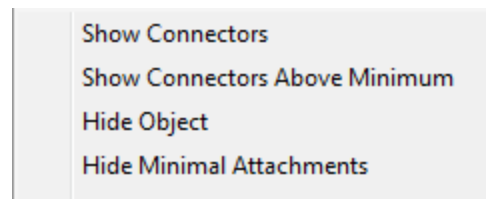
<i>Load/Save Layout Options</i>			
	Save Layout to File		Load Layout from File
<i>Show Object Options</i>			
	Show All Objects		Show Objects Connected to Selected GroupBox
	Show Objects Connected to Selected GroupBox above Specified Heat Threshold		Query Mode for Connector Display
<i>Hide Object Options</i>			
	Hide Selected GroupBox and Associated Connectors		Hide All Connectors below Specified Heat Threshold
	Hide Connectors Attached to Selected Group below Specified Heat Threshold		Realign remaining Groups that are Displayed
<i>GroupBox Display Options</i>			
	Show Applied Heat Loads in text For GroupBoxes		Show Temperatures in text for GroupBoxes
	Show Heat Imbalance in text for GroupBoxes		
<i>Connector Display Options</i>			
	Show Total Heat Flow in Text For Connector		
	Show Linear Heat Flow in Text For Connector		Show Linear Conductance in Text For Connector
	Show Radiative Heat Flow in Text For Connector		Show Radiative Conductance in Text For Connector
	Show External Radiative Heat Flow in Text For Connector		Show External Radiative Conductance In Text for Connector
<i>ToolTip Display Options</i>			
	Hide ToolTip		
	Show ToolTip with GroupBox/ Connector Summary locked in Upper Right		Show ToolTip with GroupBox/ Connector Summary floating by Selected GroupBox (future)
<i>General Display Options</i>			
	Set Background color based on Temperature and ColorBar legend		Increase/Decrease Number of Decimal Places in Display Text
	Cycle Through all Timesteps		Display Help
<i>Entire Heatmap Shift</i>			
	Move entire HeatMap to Left		Move entire HeatMap Up
	Move entire HeatMap to Right		Move entire HeatMap Down

22.8.6 Laying out a Graphical Heat Map – Context Menus



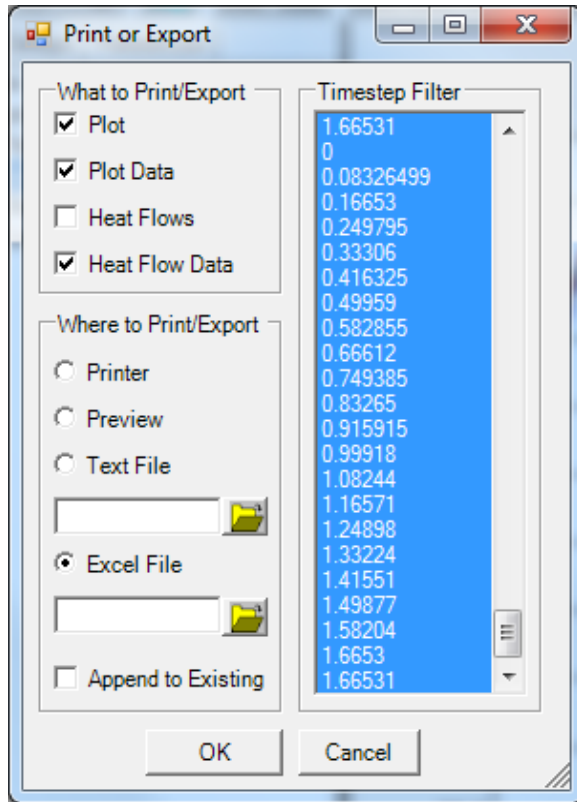
Most all of the toolbar options can be accessed through the context menus, by right clicking in the Graphics Windows area. Additional capabilities beyond the toolbar options are also offered in the context menu. Three context menus may be displayed depending on the type of object selected. If no object is selected, context menu to the left is shown. Options here include display of Connector values (Conductance or heat flow by type) and GroupBox value (Temperature, Heat or Imbalance). A toggle exists for the display of the summary. The *Show All* and *Hide Minimal Connectors* options operate on the entire set of objects. The *Resynchronize Heat Flows* will ensure that the data displayed on the canvas will match the last selected timestep. This should be automatically done when a timestep is selected, but clicking this option ensures it by refreshing the data. Lastly, The Copy Image to Clipboard allows the current image to be stored and pasted into external applications as a bitmap.

The second context menu is shown when the selected object is a GroupBox. These options include the Display of all Connectors connected to the selected GroupBox or only Connectors above the user specified threshold. The selected GroupBox can be hidden (including any Connectors tied to it). Minimal Connectors attached to the selected GroupBox can also be hidden based on the user specified criteria. Lastly, a GroupBox may be clone to exist in two places on the Canvas for GroupBoxes with many Connectors.



The last context menu is shown when the selected object is a Connector. Selecting *Reset to AutoDraw* for these connectors will redraw the connector as a simple L-shape or S-Shape depending on the angle between the start and end GroupBox. Color and Linetype can both be set for the selected Connector using *Set Color* and *Set Linetype* options. Colors include: Black, Red, Green, Blue, Yellow, Turquoise, Orange, and Brown. Linetype styles include: Solid, Dashed, Dotted, and Dash-Dot. *Set Radiative Only Linetype* or *Set Radk Only Linetype* will change the linetype of all Connectors that have only the specified component, helping to identify the connectivity of the model. *Attach to Clone* and *Detach from Clone* were discussed previously. Lastly, *Plot ___ Heat Flow* makes a special case of the Plot Window with the temperatures of the two groups on the primary axis and the heat flow between them on the secondary axis.

22.9 Outputting Results



Four sets of data may be output from COVeR to various applicable formats: Plot Image, Plot Data, Graphical HeatMap Image, and Heat Flow Data. The results are based on the last selected Group, Node, or Submodel. If exporting to the Printer or a Print Preview, all options are available. However, if exporting to a Text File or an Excel File, then only Plot Data or Heat Flow Data may be exported. Options exist to allow the user to select the timesteps for output if only a subset of the data is desired. If it is desired to continuously append output to the same file, the *Append to Existing* Checkbox may be selected. All of the output functionality can be replicated by simple cut and paste operations between COVeR and other external applications.

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