



Summary of Thermal Utility Programs Available at Goddard Space Flight Center

Presented by Hume Peabody <u>Hume.L.Peabody@nasa.gov</u> (301) 286-9141

2008 Thermal and Fluids Analysis Workshop San Jose State University in cooperation with NASA-AMES





- <u>Geometry Input</u>
 - Geo_Info: output various TSS surface properties (area, nodes, etc)
 - Ren_Optics: output TSS optics properties and make updates to both optics and geometry files
 - TSS_Conv: conversion between selected ASCII based geometry formats
- <u>Geometry Output</u>
 - Radk_Func: collection of Radk and HeatRate post processing functions
- <u>Thermal Model Input</u>
 - TMM_Conv: conversion between selected ASCII based thermal model formats
- <u>Thermal Model Output</u>
 - Backload: calculate backloads for selected nodes from temperature and radk output
 - ThermPlot: general post-processing program for thermal output
 - Generate_T-XYZ: find closest FEM node to geometry centroid and maps temperature for STOP analyses

Goddard Space Flight Center





- All programs developed to address specific need
 - Not developed to be robust and error free (i.e. not developed to be commercial software)
 - Have been developed and used successfully for years
- Tools may be provided as is
 - No support, expressed or implied, is included
 - Identified bugs will be corrected, but may not be considered high priority
 - No documentation exists (ThermPlot excepted)





Geo_Info output various TSS surface properties (area, nodes, etc)

		A	В	C	D	E	F	G	H	1	J	K
	1	Ent_name	Ent_type	Active	Optics (Out)	Alpha1	Eps1	Optics (In)	Alpha2	Eps2	Area	Nodes
	2	MLI.40010	polygon	out	MLI	0.92	. 0.81	MLI	0.92	0.81	1.050E-02 m*2	40011
	3	MLI.40011	polygon	out	Perfect_Black	1	1	Perfect_Black	1	1	4.950E-03 m ²	4999
	4	MLI.40020	polygon	out	MLI	0.92	. 0.81	MLI	0.92	0.81	1.050E-02 m ²	40011
	<u> </u>	MLI.40030	polygon	out	MLI	0.92	. 0.81	MLI	0.92	0.81	6.386E-03 m ²	40011
	6	MLI.40040	polygon	out	MLI	0.92	. 0.81	MLI	0.92	0.81	6.386E-03 m ²	40011
	7	MLI.40050	polygon	out	MLI	0.92	. 0.81	MLI	0.92	0.81	6.260E-03 m ²	40011
	8	MLI.40060	polygon	out	MLI	0.92	. 0.81	MLI	0.92	0.81	6.260E-03 m ²	40011
	9	MLI.40070	polygon	out	MLI	0.92	. 0.81	MLI	0.92	0.81	7.834E-03 m ²	40011
	1		nalugan	aut		0.92	. 0.81	MLI	0.92	0.81	7.834E-03 m ²	40011
🗧 Output Geometry	information				_	$\square \times 2$. 0.81	MLI	0.92	0.81	1.553E-02 m ²	40011
						2	. 0.81	MLI	0.92	0.81	1.553E-02 m ²	40011
Entitu Name	Geometry File:					2	. 0.81	MLI	0.92	0.81	2.075E-01 m ²	40111
Entitu Tune	010 WU 15001011				~		. 0.81	MLI	0.92	0.81	1.599E-01 m ²	40121
Active	U:\Spacecraft\WFU3\GM	MALA 122	\UB_int	.tssgm			. 0.81	MLI	0.92	0.81	3.372E-01 m ²	40131
Active							. 0.81	MLI	0.92	0.81	5.329E-01 m ²	40141
Uptics I	Ontical File:					4	0.81	MLI	0.92	0.81	3.3/2E-01 m ²	40161
Alpha 1	option The.						U.81	MLI	0.92	0.81	5.329E-01 m ²	40161
Eps1	C:\Spacecraft\WFC3\GM	MNTV TSS	NTV_Te	st_Cold_	14d.tsso 🛛 🦰	l 🐧 🗄	U.81	MLI	0.92	0.81	2.88/E-01 m ²	401/1
Spec Alpha 1							. 0.81	MLI	0.92	0.81	2.55/E-U1 m ²	40181
Spec Eps 1	Output File:					4	. 0.81	MLI	0.92	0.81	2.88/E-01 m ²	40191
Optics 2	output File.					4	. 0.81	MLI	0.92	0.81	2.557E-01 m ²	40201
Alaba 2	C:\Spacecraft\WFC3\GM	MNTV TSS	\Test.nf	o			0.89	al_irridite	0.29	0.08	6.161E-03 m ⁴ 2	30010
Alpha Z	,				<u>K</u> 2		0.89	al_irridite	0.29	0.08	3.791E-03 m ⁴ 2	30020
Eps 2		-					0.89	al_irridite	0.29	0.08	5.895E-03 m ²	30030
Spec Alpha 2	🛛 🔽 Convert Units to 📶 🗣	·					0.89	al_irridite	0.29	0.08	7.060E-03 m ⁴ 2	30040
Spec Eps 2		-					0.89	al_irridite	0.29	0.08	7.060E-03 m*2	30050
Area	Output sub-entity inform	ation					0.89	al_irridite	0.29	0.08	4.952E-03 m ⁴ 2	30060
Nodes												
	Open Output file in Exc	el			TSS	E vit						
Full List												

- Area Unit Conversion
- Sub-entity output
 - Nodal sub areas, activity, properties



Ren_Optics





	A	B		С	;	D	E	F	G	Н	I	J
1	Property Name	EPS(B	BOL)	EPS(EOL)	ALP(BOL)	ALP(EOL)	SPEC EPS	SPEC EP\$	SPEC ALF	SPEC ALF	(EOL)
2	default_prop		1		1	1	1	0	0	0	0	
🐂 Rename TSS Optical Property Sets					0.77	0.08	0.08	0	0	0	0	
	Existing Property Sets:		~		0.77	0.08	0.08	0	0	0	0	
TCC Coometry Input File:	default prop	1	1		0.77	0.08	0.08	0	0	0	0	
		0.77	0.05		0.04	0.19	0.19	0	0	0	0	
		0.77	0.00		0.89	0.96	0.96	0	0	0	0	
TSS Optical Input File 1 (usually BOL):		0.77	0.00		0.86	0.96	0.96	0	0	0	0	
		0.77	0.00		0.1	0.5	0.5	0	0	0	0	
		0.04	0.13		0.85	0.84	0.84	0	0	0	0	
TSS Optical Input File 2 (usually EOL):	BRACKE I Block Doint	0.03	0.30		0.09	0.71	0.71	0	0	0	0	
C:\Spacecraft\WFC3\GMM\TV TSS\TV_		0.00	0.90	-	0.28	0.39	0.39	0	0	0	0	
		0.1	0.0		0.43	0.43	0.43	0	0	0	0	
OUTPUT FILES	CryoPanin	0.05	0.04		0.85	0.51	0.51	0	0	0	0	
TSS Geometru Output File:		0.09	0.71		0.85	0.51	0.51	0	0	0	0	
	ElectrolessiniPlate	0.28	0.35		0.81	0.92	0.92	0	0	0	0	
		0.43	0.43		0.05	0.98	0.98	0	0	0	0	
TSS Optical Output File 1 (usually BOL):	GerMLI	0.85	0.51		0.06	0.98	0.98	0	0	0	0	
C:\Spacecraft\WFC3\GMM\TVTSS\TV_	Ger_BikKapton	0.85	0.51		0.08	0.98	0.98	0	0	0	0	
TCC Ontinal Output Eile 2 (usually EOL)		0.81	0.92		0.7	0.98	0.98	0	0	0	0	
	UPTICS_98_05	0.05	0.98	<u>1</u>	0.8	0.98	0.98	0	0	0	0	
	IOPTICS_98_06	0.06	0.98	1 I I	0.85	0.98	0.98	0	0	0	0	
	New Property Name				0.9	0.01	0.01	0	0	0	0	
ACTIONS: Load Optics into Table			Rena	ame 📘	0.02	0.08	0.08	0	0	0	0	
Load Optics into Table					1	1	1	0	0	0	0	
Exit Check for unused Properties	Add instrument prefix to a	II			0.4	0.95	0.95	0	0	0	0	
Delete unused Properties								_	_	_	_	

- Rename specific properties
- Add prefix (to avoid duplicates)
- Check for, or remove, unused ______ Goddard Space Flight Center

Code 545 – Thermal Engineering Branch

- Make property tables
 - Optics (TSS, Desktop)
 - Materials (Desktop)

Save Materials to File



TSS_Conv conversion between selected ASCII based geometry formats



🖣 TSS	Conversions								_ 🗆 ×
Input	Geometry File:	P:\Projects\Therma	I\EOS\PM Mo	dels\Spacecra	aft\Geometry\F	Rev 🖻 📐	Conversion Format	-	Exit
Input	Optical File:					- 🖻 🖪	Entity Conversion	Options	Help
Outpu	ut Geometry File:	c:\temp\test.tssgm				- 🖻 🗳	Input Units	m. 🔻	No. of Entities
Outpu Clear	ut Optics File:	c:\temp\test.tssop				🖻 🖾	Output Units	No Change 🔻	
	Entity	Туре	Rotation 1	Rotation 2	Rotation 3	Translations (x,y,	z) Optics 1,2	Parameters	_
				TSS Entity C	onversion				
				Polygon to	Triangles				
-				5+ Sided P	olygon to Triar	ngles			
				Ellipse to P	olygon/Triangl	e			×
				Torus to Co	ones				
			I	Brick to Pri	mitives				
			I	Solid Cyline	ler to Primitive:	;			
			I	Wedge to f	Primitives				
			I	Tetrahedro	n to Primitives				
			J	Non-Ortho	Brick to Primiti	ves			
			I	Remove Bo	oolean Cylinde	rs			
			I	Box to Prim	itives				
			I	Multi-Node	Box to Primitiv	es			
			Sł	iorten entity na	ames to 0	characters			

Note: presented at 2002 TFAWS as "Use of TSS as a Neutral Format for Geometry Model Conversions: An Alternative to STEP-TAS"

- Available conversions
 - TSS to ESARAD
 - TSS to Thermica
 - Esarad to TSS
 - Thermica to TSS
 - Esarad to Thermica
 - TSS to NEVADA
 - TMG to TSS
- Unit conversion
- Special cases
 - Solids to primitives
 - Torus breakdown
 - Polygons to triangles
 - Shorten entity names

TFAWS 2008



Radk_Func

collection of Radk and HeatRate post processing functions



💐 Queries ar	d Actions.				_ [
Input File 1				•	B
Input File 2				•	
Output File				•	
	□ Multiple	Cases		_	
	R	adks H	leatLoads	Evaluation]
	Action	Comment out			
	For	Remove Submo Renumber starti Increment By Comment out Delete Scale by List to File List to Screen	del Name ng with	▲ 	
		List of Actions	Load From File	Save To File	
		Add Remove	Clear Options	Go	Abo

- Collection of utilities to post process RADK output
 - Renumber
 - Comment
 - Delete
 - Scale
 - Sum
- Can act on
 - All conductors
 - Conductors connected to
 - Conductor between
- *Multiple sequential actions may be defined*
- Some support for heatloads but not as mature



TMM_Conv





📮 Thermal Model Conversion				<u>_ </u>	
Unit Conversion					
	From	То	Multiplier	Offset	
Capacitance	J/K 💌	J/K 💌	1	0	
Temperature	C 💌	C 💌	1	0	
Linear Conductor	W/K 💌	W/K 💌	1	0	
Radiative Conductor	m^2 💌	m^2 💌	1	0	
Heat Load	w 💌	W 💌	1	0	
- Ronumboring	💐, Te	mperature Mode	el Conversion		
Nedec: Increment	Inpu	t Temperature Fi	ile:		
From File	Outp	out Temperature	File:		
Lin Conds: Increment					🖻 🗋
From File			real Loose	21	-
Rad Conds: Increment		<u> </u>		ieg	Exit
🗖 From File	ES/	A -> S85S85 ->	> S85 Repl F	Reg	Options
Arrays: Increment	0				
🗌 From File					
Variable Conversion					
	1 1 6				
 Do not change variat O Bename Variables a 	ole definition according to	ns user snecifie	d file		
 Substitute Variable v 	alues in pla	ce of Variable	e names		
C Substitute Variable v	alues and E	Evaluation Exp	pressions		

- Thermal Model
 Conversion
 - TAK2000 to SINDA
 - SINDA to ESATAN
 - -ESATAN to SINDA
- Unit conversion – C, T, GL, GR, Q
- Renumbering – Nodes
 - Lin,Rad Conds
 - Arrays
- Variables

×

- Convert names (shorten)
- Replace with values
- Replace with values and evaluate



Backloads



calculate backloads for selected nodes from temperature and radk output

🚴 Generate Backloads v1.38	
Backload Files	
Rad Coupling File (TSS)	🛏 🖂
Temperature File (SINDA/G)	
BL Node Range	
Backload Output File (SINDA/G)	🔎 🗋
Environmental Heatrate Files	
IR Heatrate File (TSS)	🔎 🖾
UV Heatrate File (TSS)	🗾 🔁
 UV and IR Seperat 	e C UV and IR combined
Backload Calculation Options	
Options and Parameters	Input File Formats
1 Initial Array No	SINDA/G Temperature TSS HeatRate
C Temperature Units	TSS RadK SINDA/G Backload
5.67e-08 (W/m ² K ⁴) Stefan Boltzmann Constant	Output Type
Additional Comments	IR Backloads C Equivalent Sinks BL Entries/Bow 5 Only Environment
	Dutput Uptions Spacecraft Node Temps
	and Transient Steady-State ore Output Temperatures
Include Self View Rean When Dane	C Only Steady-State C Use Value Specified
Self View range same Make component	C Only Transient
as BL Range File	Environment Output
Post Process Output	Include Environment Spacecrait Hodes
	C Environment

- Backloads present a method for representing complex thermal environment for a surface/node as a simple heat load
- Requires Radk and Temperature
 Output
- May include env fluxes – Recommend separate IR & UV
- Numerous formats supported
- Output SS, TR or both
- Define conduction interfaces
- Include or exclude effects of other nodes in BL range (self view)
- Component file for validation

Note: application of backload usage presented at 2004 TFAWS as "Use of the Interface-Backload Method for Solving LISA and other Large, Divided Thermal Problems"



ThermPlot

general post-processing program for thermal output



File Make Excel! Options Plots Tables Groups Help	Generalized Post
Input File	Processing Program
File 1: Filename T Format SINDA85-T XL Sheet Data1	- Data - Data - Tables - Plots
No Data Files: 1 Node Filter (e.g.)	- Groups - HeatMaps
Group List Current Table: 1 APERTURE FABRY MAIN OPTICS Node List APERTURE.1 APERTURE.2 APERTURE.3 APERTURE.4 APERTURE.5 APERTURE.5 APERTURE.6 APERTURE.6 APERTURE.7 APERTURE.7 APERTURE.8 APERTURE.8 APERTURE.9 APERTURE.10 FABRY.502 FAB	 Current Plot: 1 Data1:APERTURE (Pri) Data1:FABRY (Pri) Data1:OPTICS (Pri) ANO further updates planned Note: presented at 2001 TFAWS as
Make Excel Get Nodes	"Use of ThermPlot Software for Quick Evaluation of Thermal Model Results"

TFAWS 2008



Generate_TXYZ



find closest FEM node to geometry centroid and maps temperature for STOP analyses

🐂 Generate	K,Y,Z locatio	ns for GMM			
Input Geome	try File:				
					الم 🔁
Input Tempe	rature File:				
I Input FEM Fi	ile:				
					- 🔁 🗳
Output T-XY	Z File:				
GMM	ТММ	Ignore	FEM	Output	Status
Add	itional Cent	roids	Double Sid	led Surfaces	·
			 Average 	Front/Reverse	Side Temp
			O Use From	it Side Temp	
			🔿 Use Rev	erse Side Tem	p
			C Generate	e two points sej hickness	parated by
			C Generate	two points sep cified thickness	parated by
			Subdivide Rev	volves into 15	* increments
Add	Delete	Load			
	Points File for	visualization			
				Mak	e T-XYZ File

- Finds closest FEM node to TMM node for STOP mapping
- GMM
 - Revolves subdivided into segments to locate "centroid" near to surface
 - Options for double sided surfaces
 - Additional (non-geometric) centroids may be added
- *TMM*
 - Timestep selection
 - Dereference GMM node to TMM node (MLI mapping)
- FEM
 - Units and Coordinate System offsets
 - TMM node to FEM node override
- Output
 - Sorting
 - Multiple associations (>1 GMM nodes map to 1 FEM node)





The described tools have not been developed to commercial levels

But they do expand the capabilities of existing tools

- Some of the features may be outdated, or have been reproduced or improved with later releases of various thermal codes
 - However, some of the capabilities remain unique (particularly the model conversion capabilities)
- The utilities are available to interested parties, but the source code remains under GSFC control