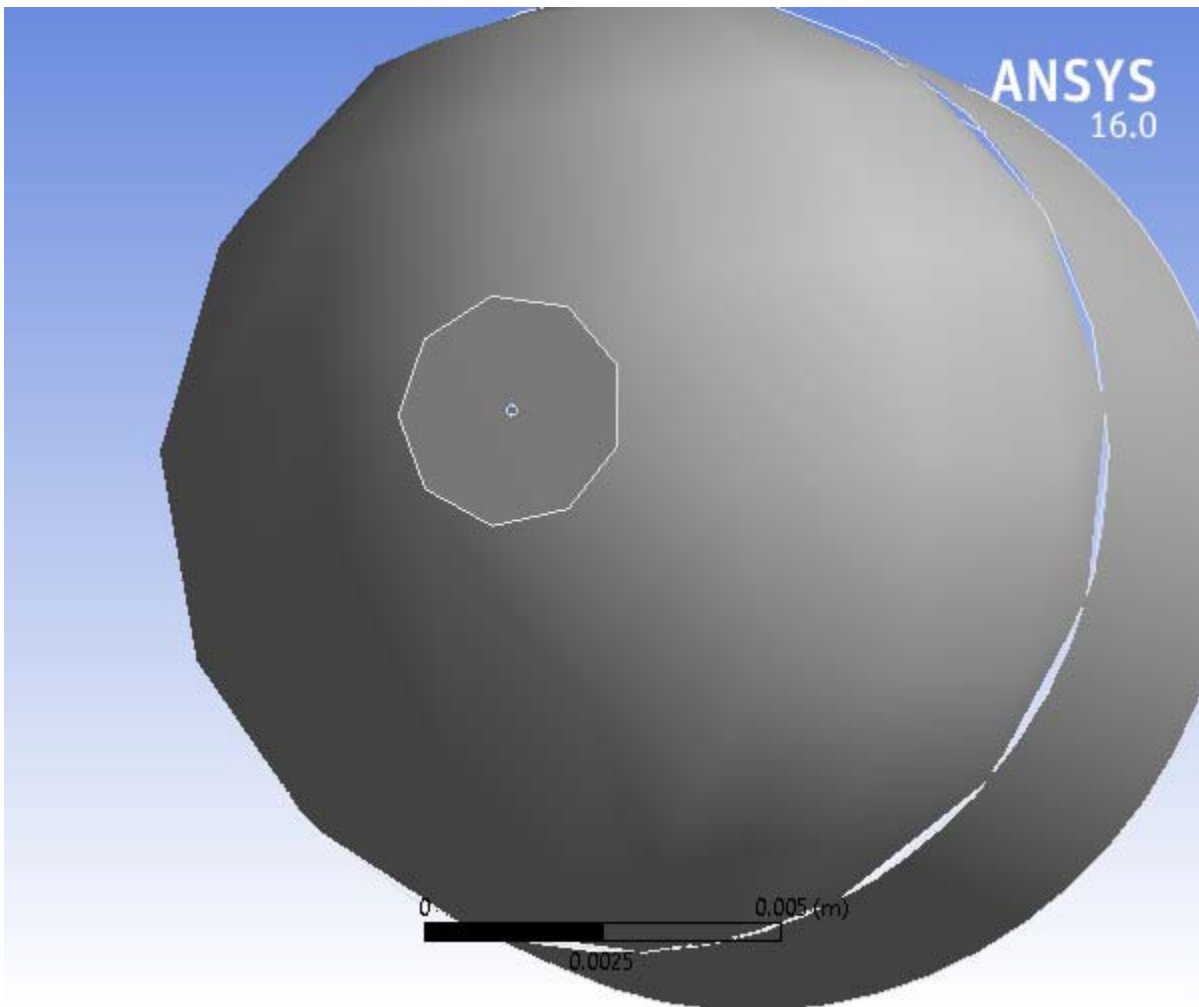




Exit window model with raster off

Author	Dave Meekins
Subject	TGT-CALC-103-015
Revision	0
Applicable Code	ASME B31.3 (2012)



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Units

TABLE 1

Unit System	Metric (m, kg, N, s, V, A) Degrees rad/s Kelvin
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Kelvin

Comment

TGT-CALC-103-015 Thermal analysis of exit window cap for no raster case

This is the worst case temperature rise on the cell body for a raster failure. Model assumes a conservative estimate for the beam spot size. Calculation is not required by Code.

Assumptions:

- beam current 20 microA
- beam raster off spot size square width = 0.150 mm
- material model from MPDB
- thermal load is 3.3W
- power density is 6.82E+11 W/m³

Model (H4)

Geometry

TABLE 2
Model (H4) > Geometry

Object Name	Geometry
State	Fully Defined
Definition	
Source	D:\Meekins\GoogleDrive\JLAB\Hall A\Trtium\Calculations\ANSYS\cell beam heating\Assembly2.iam
Type	Inventor
Length Unit	Centimeters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Length X	1.2954e-002 m
Length Y	1.3614e-002 m
Length Z	1.3614e-002 m
Properties	
Volume	2.435e-007 m ³
Mass	6.7063e-004 kg
Scale Factor Value	1.
Statistics	
Bodies	2
Active Bodies	2
Nodes	37225
Elements	18496
Mesh Metric	None
Basic Geometry Options	
Solid Bodies	Yes
Surface Bodies	Yes
Line Bodies	No
Parameters	Yes
Parameter Key	DS
Attributes	No
Named Selections	No
Material Properties	No
Advanced Geometry Options	
Use Associativity	Yes
Coordinate Systems	No
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	No
Compare Parts On Update	No
Attach File Via Temp File	Yes
Temporary Directory	C:\Users\David\AppData\Local\Temp

Analysis Type	3-D
Mixed Import Resolution	None
Decompose Disjoint Geometry	Yes
Enclosure and Symmetry Processing	Yes

TABLE 3
Model (H4) > Geometry > Parts

Object Name	<i>main body no raster:1</i> <i>exit beam no raster:1</i>	
State	Meshed	
Graphics Properties		
Visible	Yes	
Transparency	1	
Definition		
Suppressed	No	
Stiffness Behavior	Flexible	
Coordinate System	Default Coordinate System	
Reference Temperature	By Body	
Reference Temperature Value	40. K	
Material		
Assignment	7075 (UNS A97075)	
Nonlinear Effects	Yes	
Thermal Strain Effects	Yes	
Bounding Box		
Length X	1.2954e-002 m	2.5444e-004 m
Length Y	1.3614e-002 m	1.5001e-004 m
Length Z	1.3614e-002 m	1.5e-004 m
Properties		
Volume	2.4349e-007 m ³	4.4925e-012 m ³
Mass	6.7062e-004 kg	1.2373e-008 kg
Centroid X	-0.24622 m	-0.26415 m
Centroid Y	0.20961 m	0.20958 m
Centroid Z	3.1476e-004 m	2.0485e-014 m
Moment of Inertia Ip1	1.9907e-008 kg·m ²	3.4693e-017 kg·m ²
Moment of Inertia Ip2	1.3401e-006 kg·m ²	8.3814e-017 kg·m ²
Moment of Inertia Ip3	1.3379e-006 kg·m ²	8.3892e-017 kg·m ²
Statistics		
Nodes	35784	1441
Elements	17895	601
Mesh Metric	None	

Coordinate Systems

TABLE 4
Model (H4) > Coordinate Systems > Coordinate System

Object Name	<i>Global Coordinate System</i>
State	Fully Defined
Definition	

Type	Cartesian
Coordinate System ID	0.
Origin	
Origin X	0. m
Origin Y	0. m
Origin Z	0. m
Directional Vectors	
X Axis Data	[1. 0. 0.]
Y Axis Data	[0. 1. 0.]
Z Axis Data	[0. 0. 1.]

Connections

TABLE 5
Model (H4) > Connections

Object Name	<i>Connections</i>
State	Fully Defined
Auto Detection	
Generate Automatic Connection On Refresh	Yes
Transparency	
Enabled	Yes

TABLE 6
Model (H4) > Connections > Contacts

Object Name	<i>Contacts</i>
State	Fully Defined
Definition	
Connection Type	Contact
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Auto Detection	
Tolerance Type	Slider
Tolerance Slider	0.
Tolerance Value	5.8014e-005 m
Use Range	No
Face/Face	Yes
Face/Edge	No
Edge/Edge	No
Priority	Include All
Group By	Bodies
Search Across	Bodies
Statistics	
Connections	1
Active Connections	1

TABLE 7
Model (H4) > Connections > Contacts > Contact Regions

Object Name	<i>Bonded - main body no raster:1 To exit beam no raster:1</i>
-------------	--

State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Contact	1 Face
Target	1 Face
Contact Bodies	main body no raster:1
Target Bodies	exit beam no raster:1
Definition	
Type	Bonded
Scope Mode	Manual
Behavior	Program Controlled
Trim Contact	Program Controlled
Suppressed	No
Advanced	
Formulation	Program Controlled
Detection Method	Program Controlled
Elastic Slip Tolerance	Program Controlled
Thermal Conductance	Program Controlled
Pinball Region	Program Controlled
Geometric Modification	
Contact Geometry Correction	None
Target Geometry Correction	None

Mesh

TABLE 8
Model (H4) > Mesh

Object Name	<i>Mesh</i>
State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	Mechanical
Relevance	0
Sizing	
Use Advanced Size Function	On: Fixed
Relevance Center	Medium
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Fast
Min Size	1.e-004 m
Max Face Size	Default (5.7833e-004 m)
Max Size	Default (1.1567e-003 m)
Growth Rate	Default (1.850)
Minimum Edge Length	4.7124e-004 m
Inflation	
Use Automatic Inflation	Program Controlled
Inflation Option	Smooth Transition

Transition Ratio	0.272
Maximum Layers	5
Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	Yes
Collision Avoidance	Stair Stepping
Gap Factor	0.5
Maximum Height over Base	1
Growth Rate Type	Geometric
Maximum Angle	140.0 °
Fillet Ratio	1
Use Post Smoothing	Yes
Smoothing Iterations	5
Patch Conforming Options	
Triangle Surface Mesher	Program Controlled
Patch Independent Options	
Topology Checking	No
Advanced	
Number of CPUs for Parallel Part Meshing	Program Controlled
Shape Checking	Standard Mechanical
Element Midside Nodes	Program Controlled
Straight Sided Elements	No
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Defeaturing	
Pinch Tolerance	Default (9.e-005 m)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (5.e-005 m)
Statistics	
Nodes	37225
Elements	18496
Mesh Metric	None

Named Selections

TABLE 9
Model (H4) > Named Selections > Named Selections

Object Name	<i>beam</i>
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Send to Solver	Yes
Visible	Yes

Program Controlled Inflation	Exclude
Statistics	
Type	Manual
Total Selection	1 Body
Suppressed	0
Used by Mesh Worksheet	No

Transient Thermal (H5)

TABLE 10
Model (H4) > Analysis

Object Name	<i>Transient Thermal (H5)</i>
State	Solved
Definition	
Physics Type	Thermal
Analysis Type	Transient
Solver Target	Mechanical APDL
Options	
Generate Input Only	No

TABLE 11
Model (H4) > Transient Thermal (H5) > Initial Condition

Object Name	<i>Initial Temperature</i>
State	Fully Defined
Definition	
Initial Temperature	Uniform Temperature
Initial Temperature Value	40. K

TABLE 12
Model (H4) > Transient Thermal (H5) > Analysis Settings

Object Name	<i>Analysis Settings</i>
State	Fully Defined
Step Controls	
Number Of Steps	10.
Current Step Number	1.
Step End Time	1. s
Auto Time Stepping	Off
Define By	Substeps
Number Of Substeps	4.
Time Integration	On
Solver Controls	
Solver Type	Program Controlled
Radiosity Controls	
Radiosity Solver	Program Controlled
Flux Convergence	1.e-004
Maximum Iteration	1000.
Solver Tolerance	0.1 W/m ²
Over Relaxation	0.1

Hemicube Resolution	10.
Nonlinear Controls	
Heat Convergence	Program Controlled
Temperature Convergence	Program Controlled
Line Search	Program Controlled
Nonlinear Formulation	Program Controlled
Output Controls	
Calculate Thermal Flux	Yes
General Miscellaneous	No
Store Results At	All Time Points
Analysis Data Management	
Solver Files Directory	D:\Meekins\GoogleDrive\JLAB\Hall A\Trtium\Calculations\ANSYS\cell beam heating\beam heating_files\dp0\SYS-4\MECH\
Future Analysis	None
Scratch Solver Files Directory	
Save MAPDL db	No
Delete Unneeded Files	Yes
Nonlinear Solution	Yes
Solver Units	Active System
Solver Unit System	mks

TABLE 13
Model (H4) > Transient Thermal (H5) > Analysis Settings
Step-Specific "Step Controls"

Step	Step End Time	Auto Time Stepping	Define By	Number Of Substeps	Initial Time Step	Minimum Time Step	Maximum Time Step
1	1. s	Off	Substeps	4.			
2	2. s	Program Controlled			1.e-002 s	1.e-003 s	0.1 s
3	3. s						
4	4. s						
5	5. s						
6	6. s						
7	7. s						
8	8. s						
9	9. s						
10	10. s						

TABLE 14
Model (H4) > Transient Thermal (H5) > Loads

Object Name	<i>Temperature</i>	<i>Internal Heat Generation</i>
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	Named Selection
Geometry	1 Face	
Named Selection	beam	

Definition		
Type	Temperature	Internal Heat Generation
Magnitude	100. K (step applied)	Tabular Data
Suppressed		No

FIGURE 1
Model (H4) > Transient Thermal (H5) > Temperature

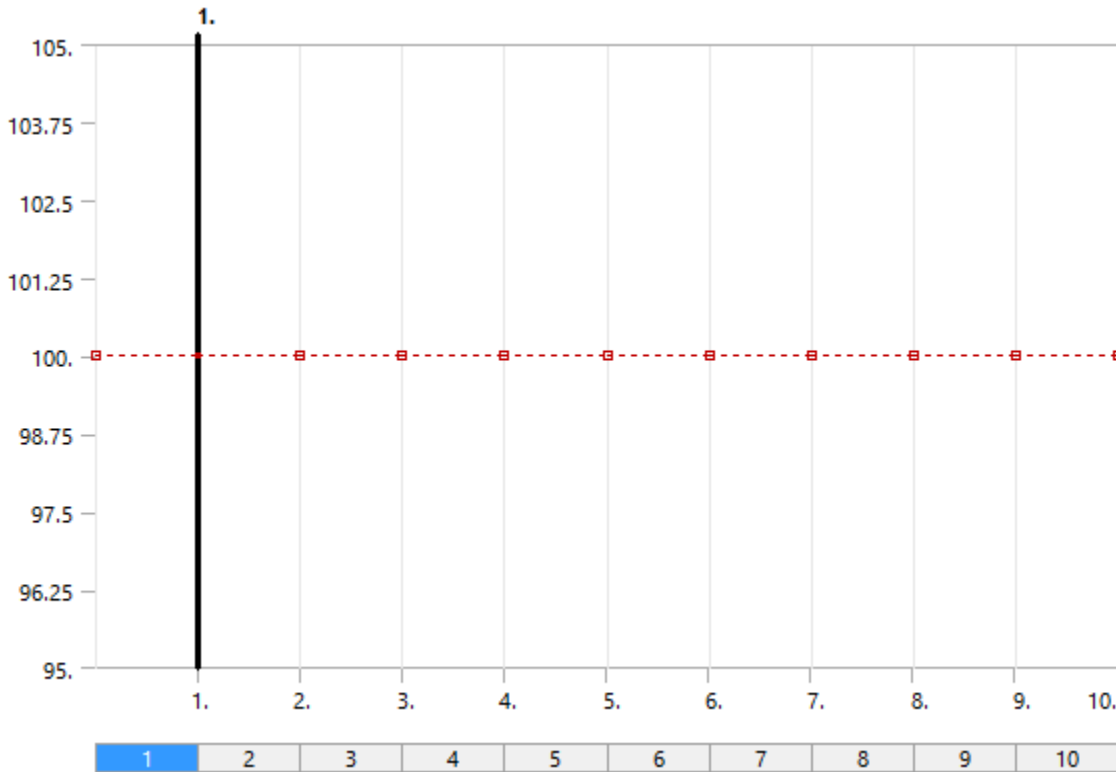


FIGURE 2
Model (H4) > Transient Thermal (H5) > Internal Heat Generation

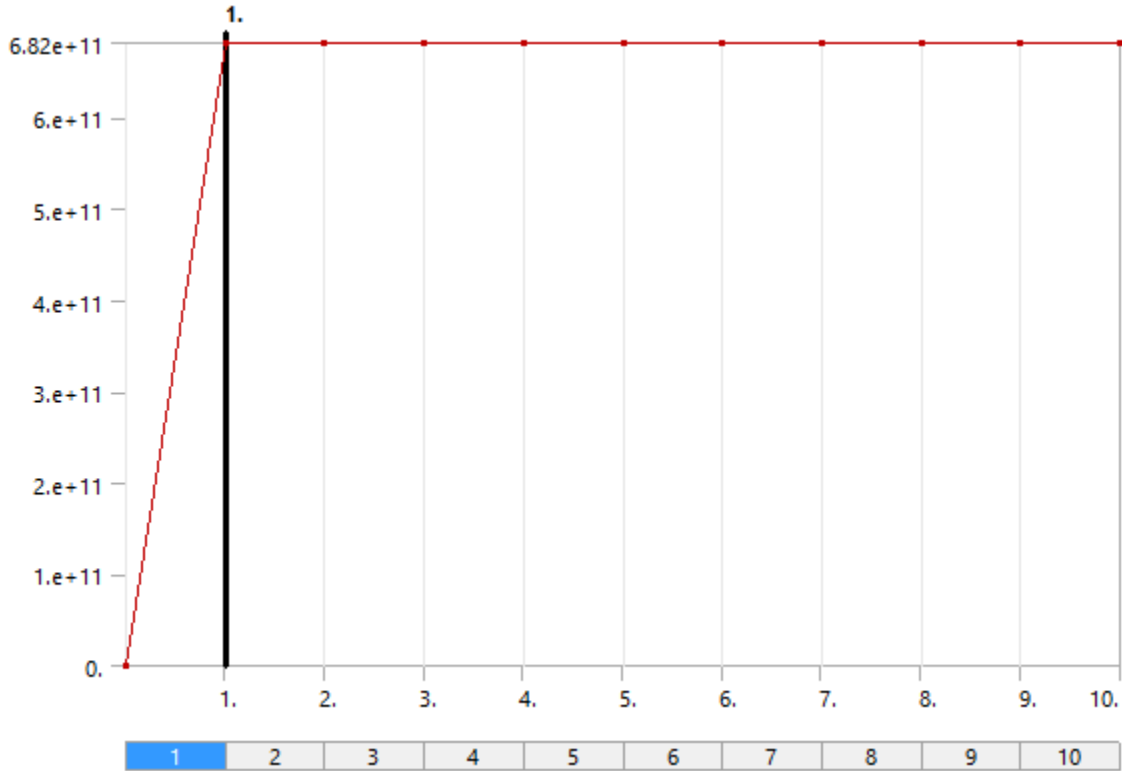


TABLE 15
Model (H4) > Transient Thermal (H5) > Internal Heat Generation

Steps	Time [s]	Internal Heat Generation [W/m³]
1	0.	0.
	1.	6.82e+011
2	2.	
3	3.	
4	4.	
5	5.	
6	6.	
7	7.	
8	8.	
9	9.	
10	10.	

Solution (H6)

TABLE 16
Model (H4) > Transient Thermal (H5) > Solution

Object Name	<i>Solution (H6)</i>
State	Solved
Adaptive Mesh Refinement	
Max Refinement Loops	1.
Refinement Depth	2.
Information	

Status	Done
Post Processing	
Calculate Beam Section Results	No

TABLE 17
Model (H4) > Transient Thermal (H5) > Solution (H6) > Solution Information

Object Name	<i>Solution Information</i>
State	Solved
Solution Information	
Solution Output	Solver Output
Update Interval	2.5 s
Display Points	All
FE Connection Visibility	
Activate Visibility	Yes
Display	All FE Connectors
Draw Connections Attached To	All Nodes
Line Color	Connection Type
Visible on Results	No
Line Thickness	Single
Display Type	Lines

TABLE 18
Model (H4) > Transient Thermal (H5) > Solution (H6) > Solution Information > Result Charts

Object Name	<i>Temperature - Global Maximum</i>	<i>Temperature - Global Minimum</i>
State	Solved	
Definition		
Type	Temperature	
Suppressed	No	
Scope		
Scoping Method	Global Maximum	Global Minimum
Results		
Minimum	100. K	44.041 K
Maximum	205.94 K	100. K

FIGURE 3
Model (H4) > Transient Thermal (H5) > Solution (H6) > Solution Information > Temperature - Global Maximum

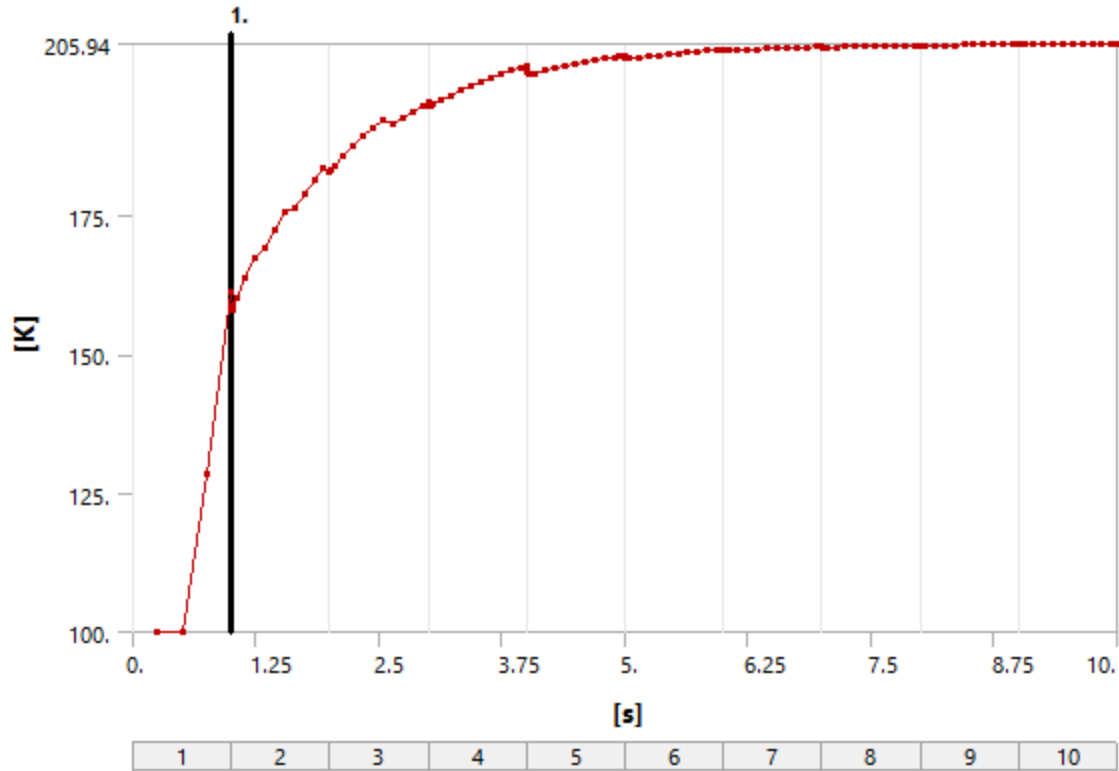


FIGURE 4
Model (H4) > Transient Thermal (H5) > Solution (H6) > Solution Information > Temperature - Global Minimum

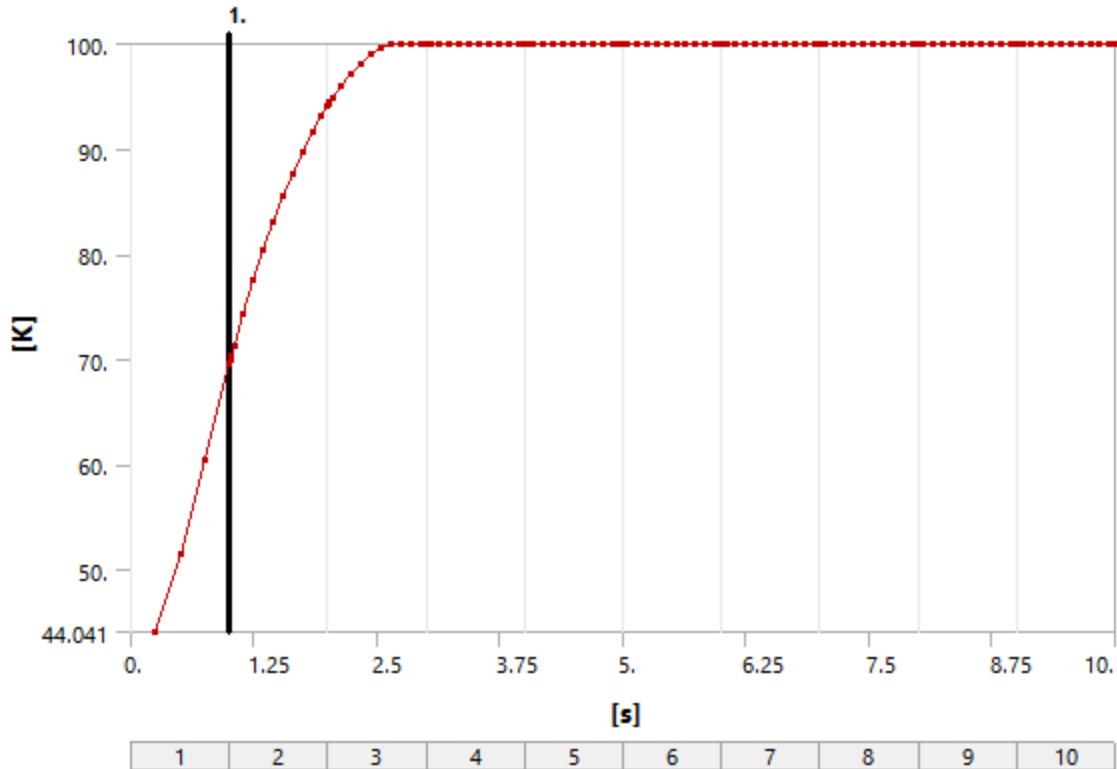


TABLE 19
Model (H4) > Transient Thermal (H5) > Solution (H6) > Results

Object Name	Temperature
State	Solved
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Temperature
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Results	
Minimum	100. K
Maximum	205.94 K
Minimum Occurs On	main body no raster:1
Maximum Occurs On	exit beam no raster:1
Minimum Value Over Time	
Minimum	44.041 K
Maximum	100. K
Maximum Value Over Time	
Minimum	100. K
Maximum	205.94 K

Information	
Time	10. s
Load Step	10
Substep	14
Iteration Number	127

FIGURE 5
 Model (H4) > Transient Thermal (H5) > Solution (H6) > Temperature

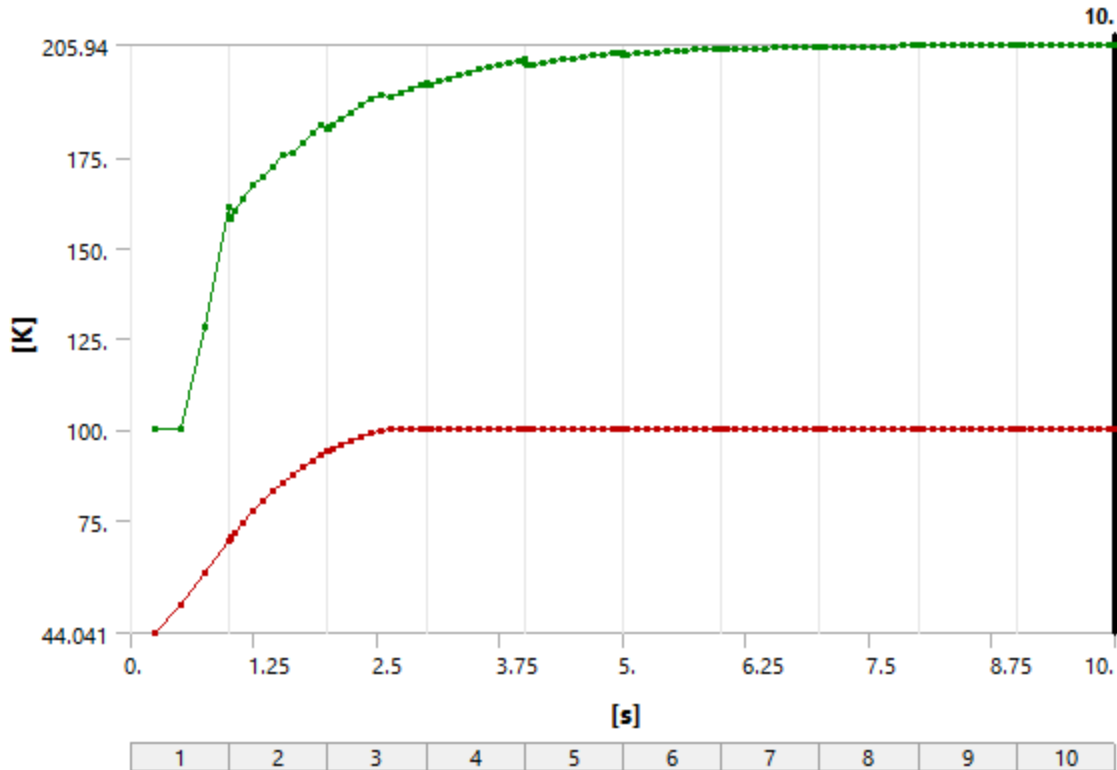


TABLE 20
 Model (H4) > Transient Thermal (H5) > Solution (H6) > Temperature

Time [s]	Minimum [K]	Maximum [K]
0.25	44.041	100.
0.5	51.504	
0.75	60.504	128.33
1.	69.585	161.21
1.01	69.941	158.13
1.02	70.296	158.6
1.05	71.353	160.03
1.14	74.372	163.77
1.24	77.492	167.54
1.34	80.374	169.33
1.44	83.025	172.54
1.54	85.456	175.54
1.64	87.677	176.46
1.74	89.7	179.05

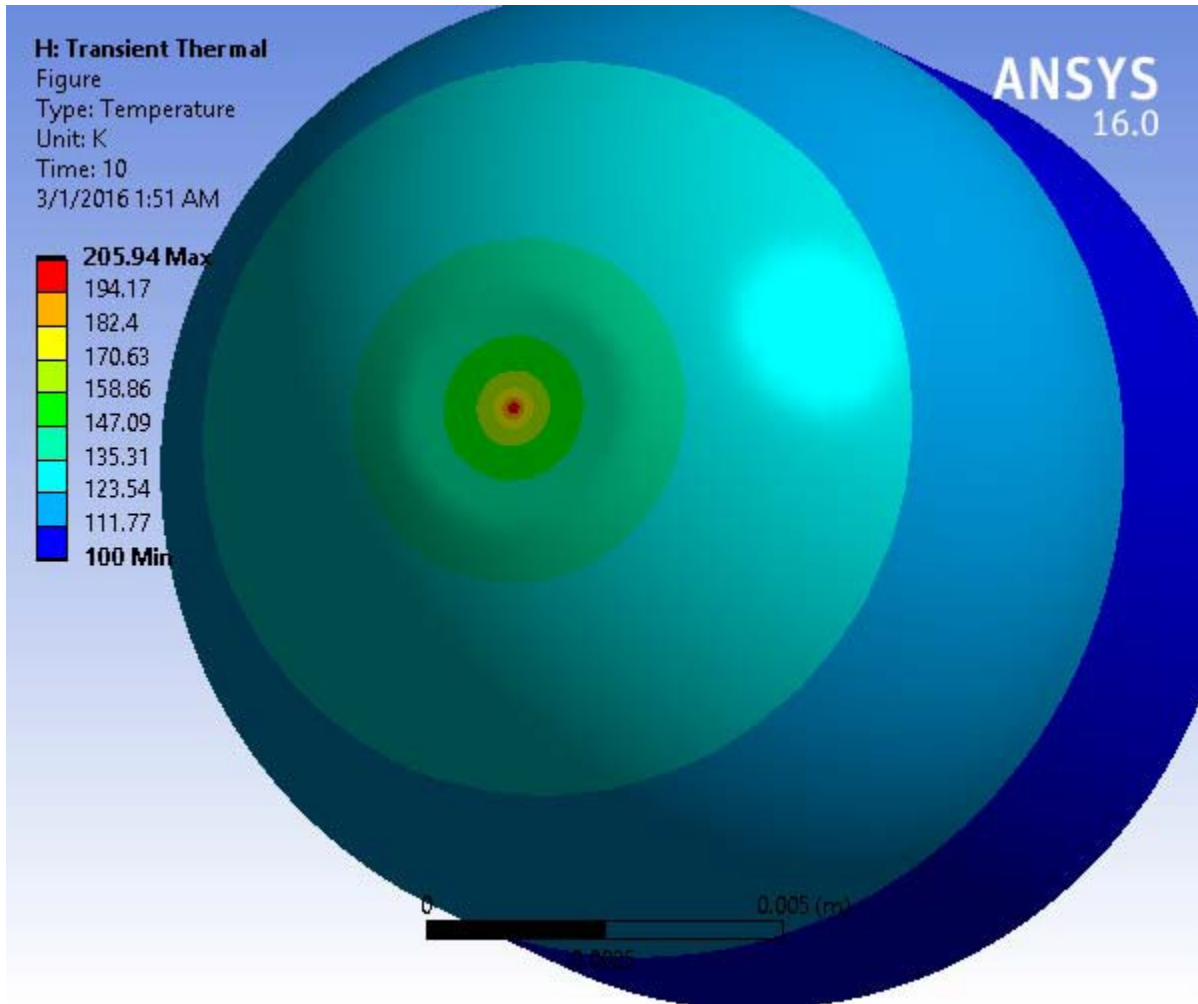
1.84	91.535	181.49
1.94	93.19	183.77
2.	94.112	182.97
2.01	94.262	183.09
2.02	94.41	183.26
2.05	94.842	183.86
2.14	96.019	185.63
2.24	97.166	187.48
2.34	98.147	189.21
2.44	98.955	190.82
2.54	99.577	192.33
2.64	99.963	191.41
2.74		192.61
2.84		193.82
2.94		194.95
3.		195.61
3.01		194.91
3.02		194.84
3.05		195.02
3.14		195.82
3.24		196.71
3.34		197.56
3.44		198.36
3.54		199.11
3.64		199.82
3.74		200.47
3.84		201.09
3.94		201.66
4.		201.99
4.01		200.85
4.0156	100.	200.7
4.0212		200.63
4.0381		200.59
4.0887		200.71
4.1887		201.08
4.2887		201.48
4.3887		201.87
4.4887		202.25
4.5887		202.6
4.6887		202.93
4.7887		203.25
4.8887		203.54
4.9444		203.7
5.		203.85
5.01		203.46
5.02		203.39
5.05		203.37
5.14		203.51

5.24	203.69
5.34	203.89
5.44	204.07
5.54	204.25
5.64	204.42
5.74	204.58
5.84	204.73
5.94	204.87
6.	204.95
6.01	204.75
6.0195	204.71
6.0291	204.7
6.0577	204.71
6.1435	204.77
6.2435	204.87
6.3435	204.96
6.4435	205.05
6.5435	205.14
6.6435	205.22
6.7435	205.3
6.8435	205.37
6.9435	205.44
7.	205.48
7.01	205.38
7.0197	205.37
7.0294	205.36
7.0584	205.36
7.1456	205.4
7.2456	205.44
7.3456	205.49
7.4456	205.54
7.5456	205.58
7.6456	205.62
7.7456	205.66
7.8456	205.69
7.9456	205.73
8.	205.75
8.01	205.7
8.0197	205.69
8.0295	205.69
8.0587	205.69
8.1463	205.71
8.2463	205.73
8.3463	205.75
8.4463	205.77
8.5463	205.8
8.6463	205.82
8.7463	205.83

8.8463		205.85
8.9463		205.87
9.		205.88
9.01		
9.0198		205.85
9.0295		
9.0588		
9.1466		205.86
9.2466		205.87
9.3466		205.88
9.4466		205.89
9.5466		205.9
9.6466		205.91
9.7466		205.92
9.8466		205.93
9.9466		
10.		205.94

FIGURE 6

**Model (H4) > Transient Thermal (H5) > Solution (H6) > Temperature > Figure
Temp on exit window**



Material Data

7075 (UNS A97075)

TABLE 21
7075 (UNS A97075) > Density

Density kg m ⁻³	Temperature C
2754.3	-273.15
2754.3	-266.08
2754.2	-259.01
2754.2	-251.94
2754.3	-244.87
2754.2	-237.8
2754.1	-230.73
2753.9	-223.66
2753.6	-216.58
2753.2	-209.51
2752.7	-202.44

2752.2	-195.37
2751.7	-188.3
2751	-181.23
2750.4	-174.16
2749.6	-167.09
2748.8	-160.02
2748	-152.95
2747.2	-145.88
2746.2	-138.81
2745.3	-131.74
2744.3	-124.67
2743.3	-117.59
2742.3	-110.52
2741.2	-103.45
2740.1	-96.382
2739	-89.312
2737.9	-82.241
2736.7	-75.17
2735.6	-68.099
2734.4	-61.029
2733.2	-53.958
2732	-46.887
2730.7	-39.817
2729.5	-32.746
2728.2	-25.675
2727	-18.605
2725.7	-11.534
2724.4	-4.4631
2723.2	2.6076
2721.9	9.6783
2720.6	16.749
2719.3	23.82
2718	30.89
2716.6	37.961
2715.3	45.032
2714	52.103
2712.7	59.173
2711.3	66.244
2710	73.315
2708.7	80.385
2707.3	87.456
2706	94.527
2704.6	101.6
2703.3	108.67
2701.9	115.74
2700.5	122.81
2699.2	129.88
2697.8	136.95

2696.4	144.02
2695	151.09
2693.6	158.16
2692.2	165.23
2690.8	172.3
2689.4	179.38
2688	186.45
2686.5	193.52
2685.1	200.59
2683.6	207.66
2682.2	214.73
2680.7	221.8
2679.3	228.87
2677.8	235.94
2676.3	243.01
2674.8	250.08
2673.3	257.15
2671.7	264.22
2670.2	271.29
2668.7	278.37
2667.1	285.44
2665.6	292.51
2664	299.58
2662.4	306.65
2660.8	313.72
2659.2	320.79
2657.6	327.86
2656	334.93
2654.4	342
2652.8	349.07
2651.1	356.14
2649.5	363.21
2647.8	370.28
2646.2	377.36
2644.5	384.43
2642.9	391.5
2641.2	398.57
2639.6	405.64
2637.9	412.71
2636.3	419.78
2634.6	426.85

TABLE 22
7075 (UNS A97075) > Tensile Yield Strength

Tensile Yield Strength Pa	Temperature C
6.56e+008	-269.15
6.3812e+008	-260.98
6.2069e+008	-252.81
6.1153e+008	-244.63

6.029e+008	-236.46
5.9478e+008	-228.29
5.8716e+008	-220.12
5.8e+008	-211.95
5.7329e+008	-203.78
5.67e+008	-195.6
5.6111e+008	-187.43
5.5559e+008	-179.26
5.5041e+008	-171.09
5.4557e+008	-162.92
5.4103e+008	-154.75
5.3676e+008	-146.57
5.3275e+008	-138.4
5.2898e+008	-130.23
5.2541e+008	-122.06
5.2202e+008	-113.89
5.188e+008	-105.72
5.1571e+008	-97.544
5.1274e+008	-89.372
5.0986e+008	-81.201
5.0704e+008	-73.029
5.0427e+008	-64.857
5.0151e+008	-56.685
4.9876e+008	-48.514
4.9597e+008	-40.342
4.9313e+008	-32.17
4.9022e+008	-23.998
4.8721e+008	-15.827
4.8407e+008	-7.6551
4.8079e+008	0.51667
4.7735e+008	8.6884
4.737e+008	16.86
4.6985e+008	25.032
4.6575e+008	33.204
4.6138e+008	41.375
4.5673e+008	49.547
4.5177e+008	57.719
4.4648e+008	65.89
4.4082e+008	74.062
4.3479e+008	82.234
4.2835e+008	90.406
4.2148e+008	98.577
3.8152e+008	106.75
3.3689e+008	114.92
2.9467e+008	123.09
2.5601e+008	131.26
2.2171e+008	139.44
1.9223e+008	147.61

1.6771e+008	155.78
1.4794e+008	163.95
1.324e+008	172.12
1.2022e+008	180.29
1.1018e+008	188.47
1.0141e+008	196.64
9.3918e+007	204.81
8.7157e+007	212.98
8.1071e+007	221.15
7.5603e+007	229.32
7.07e+007	237.5
6.631e+007	245.67
6.2384e+007	253.84
5.8876e+007	262.01
5.574e+007	270.18
5.2935e+007	278.36
5.042e+007	286.53
4.8157e+007	294.7
4.611e+007	302.87
4.4247e+007	311.04
4.2537e+007	319.21
4.095e+007	327.39
3.946e+007	335.56
3.8043e+007	343.73
3.6676e+007	351.9
3.5341e+007	360.07
3.4019e+007	368.24
3.2695e+007	376.42
3.1357e+007	384.59
2.9994e+007	392.76
2.8597e+007	400.93
2.716e+007	409.1
2.568e+007	417.27
2.4154e+007	425.45
2.2584e+007	433.62
2.0972e+007	441.79
1.9324e+007	449.96
1.7646e+007	458.13
1.595e+007	466.3
1.4245e+007	474.48
1.2548e+007	482.65
1.0874e+007	490.82
9.2425e+006	498.99
7.674e+006	507.16
6.192e+006	515.33
4.8221e+006	523.51
3.5922e+006	531.68
2.5322e+006	539.85

TABLE 23
7075 (UNS A97075) > Tensile Ultimate Strength

Tensile Ultimate Strength Pa	Temperature C
7.65e+008	-269.15
7.6245e+008	-260.98
7.5936e+008	-252.81
7.4368e+008	-244.63
7.29e+008	-236.46
7.1529e+008	-228.29
7.0251e+008	-220.12
6.906e+008	-211.95
6.7953e+008	-203.78
6.6925e+008	-195.6
6.5973e+008	-187.43
6.5093e+008	-179.26
6.4279e+008	-171.09
6.3528e+008	-162.92
6.2836e+008	-154.75
6.2198e+008	-146.57
6.1611e+008	-138.4
6.107e+008	-130.23
6.057e+008	-122.06
6.0109e+008	-113.89
5.9681e+008	-105.72
5.9283e+008	-97.544
5.8909e+008	-89.372
5.8557e+008	-81.201
5.8221e+008	-73.029
5.7899e+008	-64.857
5.7584e+008	-56.685
5.7274e+008	-48.514
5.6964e+008	-40.342
5.665e+008	-32.17
5.6328e+008	-23.998
5.5993e+008	-15.827
5.5642e+008	-7.6551
5.527e+008	0.51667
5.4873e+008	8.6884
5.4446e+008	16.86
5.3986e+008	25.032
5.3489e+008	33.204
5.295e+008	41.375
5.2365e+008	49.547
5.173e+008	57.719
5.104e+008	65.89
5.0293e+008	74.062
4.9482e+008	82.234
4.8605e+008	90.406
4.7656e+008	98.577

4.3469e+008	106.75
3.871e+008	114.92
3.4111e+008	123.09
2.9795e+008	131.26
2.5859e+008	139.44
2.2374e+008	147.61
1.9383e+008	155.78
1.6904e+008	163.95
1.4931e+008	172.12
1.3428e+008	180.29
1.2335e+008	188.47
1.1565e+008	196.64
1.0933e+008	204.81
1.03e+008	212.98
9.7132e+007	221.15
9.1691e+007	229.32
8.6652e+007	237.5
8.1988e+007	245.67
7.7674e+007	253.84
7.3684e+007	262.01
6.9995e+007	270.18
6.6583e+007	278.36
6.3426e+007	286.53
6.0502e+007	294.7
5.779e+007	302.87
5.527e+007	311.04
5.2923e+007	319.21
5.073e+007	327.39
4.8674e+007	335.56
4.6738e+007	343.73
4.4905e+007	351.9
4.3161e+007	360.07
4.149e+007	368.24
3.9879e+007	376.42
3.8316e+007	384.59
3.6787e+007	392.76
3.5282e+007	400.93
3.3791e+007	409.1
3.2302e+007	417.27
3.0808e+007	425.45
2.9301e+007	433.62
2.7772e+007	441.79
2.6215e+007	449.96
2.4625e+007	458.13
2.2997e+007	466.3
2.1326e+007	474.48
1.961e+007	482.65
1.7845e+007	490.82

1.6029e+007	498.99
1.4162e+007	507.16
1.2244e+007	515.33
1.0275e+007	523.51
8.2565e+006	531.68
6.1907e+006	539.85

TABLE 24
7075 (UNS A97075) > Isotropic Secant Coefficient of Thermal Expansion

Coefficient of Thermal Expansion C ⁻¹	Temperature C
1.4225e-005	-273.15
1.4583e-005	-266.08
1.494e-005	-259.01
1.5309e-005	-251.94
1.5736e-005	-244.87
1.6143e-005	-237.8
1.6531e-005	-230.73
1.6902e-005	-223.66
1.7254e-005	-216.58
1.759e-005	-209.51
1.7909e-005	-202.44
1.8213e-005	-195.37
1.8501e-005	-188.3
1.8775e-005	-181.23
1.9035e-005	-174.16
1.9281e-005	-167.09
1.9514e-005	-160.02
1.9735e-005	-152.95
1.9944e-005	-145.88
2.0142e-005	-138.81
2.0329e-005	-131.74
2.0506e-005	-124.67
2.0673e-005	-117.59
2.083e-005	-110.52
2.0978e-005	-103.45
2.1118e-005	-96.382
2.125e-005	-89.312
2.1375e-005	-82.241
2.1492e-005	-75.17
2.1603e-005	-68.099
2.1707e-005	-61.029
2.1805e-005	-53.958
2.1898e-005	-46.887
2.1985e-005	-39.817
2.2068e-005	-32.746
2.2146e-005	-25.675
2.222e-005	-18.605
2.229e-005	-11.534
2.2357e-005	-4.4631

2.2421e-005	2.6076
2.2482e-005	9.6783
2.254e-005	16.749
2.2596e-005	23.82
2.265e-005	30.89
2.2702e-005	37.961
2.2753e-005	45.032
2.2803e-005	52.103
2.2851e-005	59.173
2.2899e-005	66.244
2.2946e-005	73.315
2.2993e-005	80.385
2.304e-005	87.456
2.3086e-005	94.527
2.3133e-005	101.6
2.318e-005	108.67
2.3227e-005	115.74
2.3276e-005	122.81
2.3325e-005	129.88
2.3374e-005	136.95
2.3425e-005	144.02
2.3477e-005	151.09
2.353e-005	158.16
2.3584e-005	165.23
2.364e-005	172.3
2.3697e-005	179.38
2.3755e-005	186.45
2.3815e-005	193.52
2.3876e-005	200.59
2.3939e-005	207.66
2.4003e-005	214.73
2.4069e-005	221.8
2.4136e-005	228.87
2.4205e-005	235.94
2.4275e-005	243.01
2.4347e-005	250.08
2.442e-005	257.15
2.4494e-005	264.22
2.4569e-005	271.29
2.4646e-005	278.37
2.4724e-005	285.44
2.4802e-005	292.51
2.4882e-005	299.58
2.4962e-005	306.65
2.5042e-005	313.72
2.5124e-005	320.79
2.5205e-005	327.86
2.5286e-005	334.93

2.5368e-005	342
2.5449e-005	349.07
2.5529e-005	356.14
2.5609e-005	363.21
2.5688e-005	370.28
2.5766e-005	377.36
2.5843e-005	384.43
2.5918e-005	391.5
2.5991e-005	398.57
2.6062e-005	405.64
2.6131e-005	412.71
2.6197e-005	419.78
2.626e-005	426.85
Reference Temperature C	
19.85	

TABLE 25
7075 (UNS A97075) > Specific Heat

Specific Heat J kg ⁻¹ C ⁻¹	Temperature C
572.12	-157.15
586.75	-151.25
600.86	-145.35
614.47	-139.45
627.58	-133.55
640.21	-127.66
652.39	-121.76
664.12	-115.86
675.41	-109.96
686.29	-104.06
696.77	-98.16
706.86	-92.261
716.57	-86.362
725.92	-80.463
734.93	-74.564
743.6	-68.665
751.94	-62.766
759.98	-56.867
767.73	-50.968
775.18	-45.069
782.37	-39.17
789.3	-33.271
795.98	-27.372
802.42	-21.473
808.64	-15.574
814.64	-9.6753
820.44	-3.7763
826.05	2.1227
831.48	8.0217
836.74	13.921

841.83	19.82
846.78	25.719
851.58	31.618
856.25	37.517
860.8	43.416
865.23	49.315
869.56	55.214
873.8	61.113
877.95	67.012
882.01	72.911
886.01	78.81
889.94	84.709
893.82	90.608
897.65	96.507
901.44	102.41
905.2	108.3
908.92	114.2
912.63	120.1
916.33	126
920.01	131.9
923.7	137.8
927.39	143.7
931.09	149.6
934.8	155.5
938.53	161.4
942.29	167.29
946.08	173.19
949.91	179.09
953.77	184.99
957.68	190.89
961.64	196.79
965.64	202.69
969.7	208.59
973.82	214.49
978	220.39
982.25	226.28
986.56	232.18
990.94	238.08
995.39	243.98
999.91	249.88
1004.5	255.78
1009.2	261.68
1014	267.58
1018.8	273.48
1023.7	279.38
1028.7	285.27
1033.8	291.17
1039	297.07

1044.2	302.97
1049.5	308.87
1055	314.77
1060.5	320.67
1066	326.57
1071.7	332.47
1077.5	338.37
1083.3	344.26
1089.2	350.16
1095.2	356.06
1101.2	361.96
1107.4	367.86
1113.6	373.76
1119.8	379.66
1126.2	385.56
1132.5	391.46
1139	397.36
1145.5	403.25
1152.1	409.15
1158.7	415.05
1165.4	420.95
1172.1	426.85

TABLE 26
7075 (UNS A97075) > Isotropic Thermal Conductivity

Thermal Conductivity W m ⁻¹ C ⁻¹	Temperature C
77.555	-157.15
79.962	-151.25
82.281	-145.35
84.514	-139.45
86.664	-133.55
88.735	-127.66
90.73	-121.76
92.651	-115.86
94.501	-109.96
96.284	-104.06
98.002	-98.16
99.659	-92.261
101.26	-86.362
102.8	-80.463
104.29	-74.564
105.73	-68.665
107.13	-62.766
108.48	-56.867
109.79	-50.968
111.06	-45.069
112.3	-39.17
113.51	-33.271
114.69	-27.372

115.84	-21.473
116.97	-15.574
118.08	-9.6753
119.18	-3.7763
120.26	2.1227
121.33	8.0217
122.4	13.921
123.46	19.82
124.51	25.719
125.57	31.618
126.64	37.517
127.71	43.416
128.79	49.315
129.89	55.214
131	61.113
132.14	67.012
133.29	72.911
134.47	78.81
135.68	84.709
136.93	90.608
138.2	96.507
139.52	102.41
140.87	108.3
142.27	114.2
143.72	120.1
145.21	126
146.76	131.9
148.36	137.8
150.03	143.7
151.75	149.6
153.54	155.5
155.39	161.4
157.32	167.29
159.32	173.19
161.4	179.09
163.56	184.99
165.8	190.89
168.13	196.79
170.54	202.69
171.5	208.59
172.09	214.49
172.65	220.39
173.17	226.28
173.64	232.18
174.08	238.08
174.48	243.98
174.84	249.88
175.17	255.78

175.45	261.68
175.69	267.58
175.9	273.48
176.06	279.38
176.19	285.27
176.28	291.17
176.33	297.07
176.34	302.97
176.31	308.87
176.24	314.77
176.13	320.67
175.99	326.57
175.8	332.47
175.58	338.37
175.32	344.26
175.01	350.16
174.67	356.06
174.29	361.96
173.87	367.86
173.41	373.76
172.92	379.66
172.38	385.56
171.8	391.46
171.19	397.36
170.54	403.25
169.84	409.15
169.11	415.05
168.34	420.95
167.53	426.85

TABLE 27
7075 (UNS A97075) > Isotropic Resistivity

Resistivity ohm m	Temperature C
2.76e-008	-269.15
2.7632e-008	-264.08
2.7665e-008	-259.01
2.7697e-008	-253.94
2.7775e-008	-248.87
2.7892e-008	-243.8
2.8042e-008	-238.73
2.8226e-008	-233.66
2.8441e-008	-228.59
2.8687e-008	-223.52
2.8963e-008	-218.45
2.9267e-008	-213.38
2.9599e-008	-208.31
2.9957e-008	-203.24
3.034e-008	-198.17
3.0747e-008	-193.1

3.1177e-008	-188.03
3.1629e-008	-182.96
3.2101e-008	-177.89
3.2593e-008	-172.82
3.3103e-008	-167.75
3.3631e-008	-162.68
3.4174e-008	-157.61
3.4733e-008	-152.54
3.5306e-008	-147.47
3.5891e-008	-142.4
3.6488e-008	-137.33
3.7095e-008	-132.26
3.7712e-008	-127.19
3.8337e-008	-122.11
3.8969e-008	-117.04
3.9607e-008	-111.97
4.025e-008	-106.9
4.0896e-008	-101.83
4.1545e-008	-96.764
4.2196e-008	-91.694
4.2847e-008	-86.624
4.3497e-008	-81.554
4.4145e-008	-76.483
4.4791e-008	-71.413
4.5432e-008	-66.343
4.6068e-008	-61.273
4.6697e-008	-56.203
4.7319e-008	-51.132
4.7932e-008	-46.062
4.8535e-008	-40.992
4.9128e-008	-35.922
4.9708e-008	-30.852
5.0275e-008	-25.782
5.0828e-008	-20.711
5.1365e-008	-15.641
5.1886e-008	-10.571
5.2389e-008	-5.5009
5.2874e-008	-0.4307
5.3338e-008	4.6395
5.3781e-008	9.7096
5.4203e-008	14.78
5.46e-008	19.85

TABLE 28
7075 (UNS A97075) > Isotropic Elasticity

Temperature C	Young's Modulus Pa	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa
-273.15	7.8813e+010	0.32387	7.4577e+010	2.9766e+010
-265.34	7.8818e+010	0.32391	7.46e+010	2.9767e+010
-257.53	7.88e+010	0.32398	7.4612e+010	2.9759e+010

-249.73	7.8762e+010	0.32407	7.4614e+010	2.9742e+010
-241.92	7.8704e+010	0.32418	7.4606e+010	2.9718e+010
-234.11	7.8626e+010	0.32431	7.4589e+010	2.9686e+010
-226.3	7.8532e+010	0.32446	7.4563e+010	2.9647e+010
-218.49	7.842e+010	0.32463	7.4528e+010	2.9601e+010
-210.69	7.8293e+010	0.32481	7.4485e+010	2.9549e+010
-202.88	7.8152e+010	0.32501	7.4433e+010	2.9491e+010
-195.07	7.7997e+010	0.32521	7.4374e+010	2.9428e+010
-187.26	7.7829e+010	0.32543	7.4306e+010	2.936e+010
-179.45	7.765e+010	0.32566	7.4231e+010	2.9287e+010
-171.64	7.7459e+010	0.32589	7.4148e+010	2.921e+010
-163.84	7.7259e+010	0.32613	7.4058e+010	2.9129e+010
-156.03	7.7049e+010	0.32637	7.3961e+010	2.9045e+010
-148.22	7.683e+010	0.32662	7.3857e+010	2.8957e+010
-140.41	7.6604e+010	0.32687	7.3746e+010	2.8866e+010
-132.6	7.6371e+010	0.32713	7.3629e+010	2.8773e+010
-124.8	7.6131e+010	0.32738	7.3505e+010	2.8677e+010
-116.99	7.5886e+010	0.32763	7.3376e+010	2.8579e+010
-109.18	7.5635e+010	0.32788	7.324e+010	2.848e+010
-101.37	7.538e+010	0.32813	7.3098e+010	2.8378e+010
-93.564	7.5121e+010	0.32838	7.2951e+010	2.8275e+010
-85.756	7.4858e+010	0.32862	7.2798e+010	2.8171e+010
-77.948	7.4592e+010	0.32885	7.2639e+010	2.8066e+010
-70.14	7.4324e+010	0.32908	7.2476e+010	2.796e+010
-62.332	7.4053e+010	0.32931	7.2307e+010	2.7854e+010
-54.524	7.378e+010	0.32953	7.2134e+010	2.7747e+010
-46.716	7.3506e+010	0.32974	7.1956e+010	2.7639e+010
-38.908	7.3231e+010	0.32995	7.1773e+010	2.7532e+010
-31.099	7.2955e+010	0.33014	7.1586e+010	2.7424e+010
-23.291	7.2679e+010	0.33033	7.1394e+010	2.7316e+010
-15.483	7.2402e+010	0.33052	7.1199e+010	2.7208e+010
-7.6753	7.2124e+010	0.33069	7.0999e+010	2.71e+010
0.13283	7.1847e+010	0.33086	7.0796e+010	2.6993e+010
7.9409	7.157e+010	0.33102	7.0589e+010	2.6885e+010
15.749	7.1293e+010	0.33117	7.0379e+010	2.6778e+010
23.557	7.1016e+010	0.33131	7.0166e+010	2.6671e+010
31.365	7.0739e+010	0.33145	6.995e+010	2.6565e+010
39.173	7.0463e+010	0.33158	6.973e+010	2.6458e+010
46.981	7.0187e+010	0.33171	6.9509e+010	2.6352e+010
54.789	6.9911e+010	0.33183	6.9284e+010	2.6246e+010
62.597	6.9635e+010	0.33194	6.9058e+010	2.614e+010
70.406	6.9359e+010	0.33205	6.8829e+010	2.6035e+010
78.214	6.9083e+010	0.33216	6.8598e+010	2.5929e+010
86.022	6.8806e+010	0.33226	6.8366e+010	2.5823e+010
93.83	6.8529e+010	0.33236	6.8132e+010	2.5717e+010
101.64	6.8251e+010	0.33246	6.7896e+010	2.5611e+010
109.45	6.7971e+010	0.33257	6.766e+010	2.5504e+010
117.25	6.769e+010	0.33267	6.7422e+010	2.5397e+010

125.06	6.7407e+010	0.33278	6.7183e+010	2.5288e+010
132.87	6.7122e+010	0.33289	6.6944e+010	2.5179e+010
140.68	6.6834e+010	0.33301	6.6704e+010	2.5069e+010
148.49	6.6543e+010	0.33313	6.6464e+010	2.4958e+010
156.29	6.6249e+010	0.33327	6.6223e+010	2.4844e+010
164.1	6.595e+010	0.33342	6.5982e+010	2.473e+010
171.91	6.5646e+010	0.33358	6.5742e+010	2.4613e+010
179.72	6.5338e+010	0.33375	6.5502e+010	2.4494e+010
187.53	6.5023e+010	0.33394	6.5262e+010	2.4372e+010
195.33	6.4702e+010	0.33416	6.5022e+010	2.4248e+010
203.14	6.4373e+010	0.33439	6.4784e+010	2.4121e+010
210.95	6.4037e+010	0.33465	6.4546e+010	2.399e+010
218.76	6.3692e+010	0.33493	6.4309e+010	2.3856e+010
226.57	6.3337e+010	0.33525	6.4073e+010	2.3717e+010
234.38	6.2972e+010	0.33559	6.3839e+010	2.3575e+010
242.18	6.2596e+010	0.33598	6.3605e+010	2.3427e+010
249.99	6.2209e+010	0.3364	6.3374e+010	2.3275e+010
257.8	6.1808e+010	0.33686	6.3143e+010	2.3117e+010
265.61	6.1394e+010	0.33736	6.2915e+010	2.2953e+010
273.42	6.0964e+010	0.33792	6.2688e+010	2.2783e+010
281.22	6.0519e+010	0.33852	6.2463e+010	2.2607e+010
289.03	6.0058e+010	0.33918	6.224e+010	2.2423e+010
296.84	5.9578e+010	0.33989	6.202e+010	2.2232e+010
304.65	5.908e+010	0.34067	6.1801e+010	2.2034e+010
312.46	5.8561e+010	0.34152	6.1585e+010	2.1826e+010
320.26	5.8021e+010	0.34243	6.1371e+010	2.161e+010
328.07	5.7459e+010	0.34342	6.1159e+010	2.1385e+010
335.88	5.6873e+010	0.34448	6.095e+010	2.1151e+010
343.69	5.6262e+010	0.34563	6.0744e+010	2.0906e+010
351.5	5.5625e+010	0.34687	6.0541e+010	2.065e+010
359.3	5.4961e+010	0.34819	6.034e+010	2.0383e+010
367.11	5.4268e+010	0.34961	6.0143e+010	2.0105e+010
374.92	5.3544e+010	0.35114	5.9948e+010	1.9815e+010
382.73	5.2789e+010	0.35277	5.9757e+010	1.9512e+010
390.54	5.2001e+010	0.35451	5.9569e+010	1.9196e+010
398.34	5.1178e+010	0.35636	5.9384e+010	1.8866e+010
406.15	5.0319e+010	0.35834	5.9203e+010	1.8522e+010
413.96	4.9423e+010	0.36045	5.9026e+010	1.8164e+010
421.77	4.8487e+010	0.36269	5.8853e+010	1.7791e+010
429.58	4.7511e+010	0.36507	5.8684e+010	1.7402e+010
437.39	4.6492e+010	0.36759	5.8519e+010	1.6998e+010
445.19	4.5429e+010	0.37026	5.8359e+010	1.6577e+010
453	4.432e+010	0.37309	5.8204e+010	1.6139e+010
460.81	4.3164e+010	0.37608	5.8054e+010	1.5683e+010
468.62	4.1958e+010	0.37925	5.7911e+010	1.521e+010
476.43	4.0701e+010	0.38258	5.7773e+010	1.4719e+010
484.23	3.9391e+010	0.38611	5.7643e+010	1.4209e+010
492.04	3.8027e+010	0.38982	5.7521e+010	1.368e+010

499.85	3.6605e+010	0.39373	5.7407e+010	1.3132e+010
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TABLE 29
7075 (UNS A97075) > Multilinear Isotropic Hardening

Stress Pa	Plastic Strain m m ⁻¹	Temperature C
4.9711e+008	0	19.85
5.1103e+008	5.7895e-003	19.85
5.233e+008	1.1579e-002	19.85
5.3415e+008	1.7368e-002	19.85
5.4377e+008	2.3158e-002	19.85
5.5236e+008	2.8947e-002	19.85
5.6009e+008	3.4737e-002	19.85
5.6711e+008	4.0526e-002	19.85
5.7356e+008	4.6316e-002	19.85
5.7956e+008	5.2105e-002	19.85
5.8521e+008	5.7895e-002	19.85
5.9061e+008	6.3684e-002	19.85
5.9582e+008	6.9474e-002	19.85
6.009e+008	7.5263e-002	19.85
6.0589e+008	8.1053e-002	19.85
6.1081e+008	8.6842e-002	19.85
6.1566e+008	9.2632e-002	19.85
6.2043e+008	9.8421e-002	19.85
6.2509e+008	0.10421	19.85
6.296e+008	0.11	19.85

TABLE 30
7075 (UNS A97075) > Alternating Stress R-Ratio

Alternating Stress Pa	Cycles	R-Ratio
3.4779e+008	4000	-1
3.4027e+008	4677.6	-1
3.3275e+008	5469.9	-1
3.252e+008	6396.4	-1
3.1762e+008	7479.9	-1
3.1e+008	8746.9	-1
3.0236e+008	10229	-1
2.9467e+008	11961	-1
2.8696e+008	13987	-1
2.7923e+008	16356	-1
2.7148e+008	19127	-1
2.6373e+008	22367	-1
2.5599e+008	26156	-1
2.4828e+008	30586	-1
2.406e+008	35767	-1
2.3297e+008	41826	-1
2.2542e+008	48910	-1
2.1796e+008	57195	-1
2.1061e+008	66883	-1
2.0338e+008	78213	-1

1.963e+008	91461	-1
1.8939e+008	1.0695e+005	-1
1.8266e+008	1.2507e+005	-1
1.7614e+008	1.4626e+005	-1
1.6983e+008	1.7103e+005	-1
1.6377e+008	2.e+005	-1
1.5796e+008	2.3388e+005	-1
1.5243e+008	2.7349e+005	-1
1.4717e+008	3.1982e+005	-1
1.4222e+008	3.7399e+005	-1
1.3757e+008	4.3734e+005	-1
1.3324e+008	5.1143e+005	-1
1.2923e+008	5.9806e+005	-1
1.2555e+008	6.9936e+005	-1
1.222e+008	8.1782e+005	-1
1.1918e+008	9.5635e+005	-1
1.1648e+008	1.1183e+006	-1
1.141e+008	1.3078e+006	-1
1.1202e+008	1.5293e+006	-1
1.1024e+008	1.7884e+006	-1
1.0874e+008	2.0913e+006	-1
1.0749e+008	2.4455e+006	-1
1.0647e+008	2.8598e+006	-1
1.0566e+008	3.3442e+006	-1
1.0501e+008	3.9106e+006	-1
1.0449e+008	4.5731e+006	-1
1.0406e+008	5.3477e+006	-1
1.0366e+008	6.2535e+006	-1
1.0325e+008	7.3128e+006	-1
1.0215e+008	1.e+007	-1