

Oct 2003

ALSTOM

ESARAD v5.4

Bruno CASTELLI

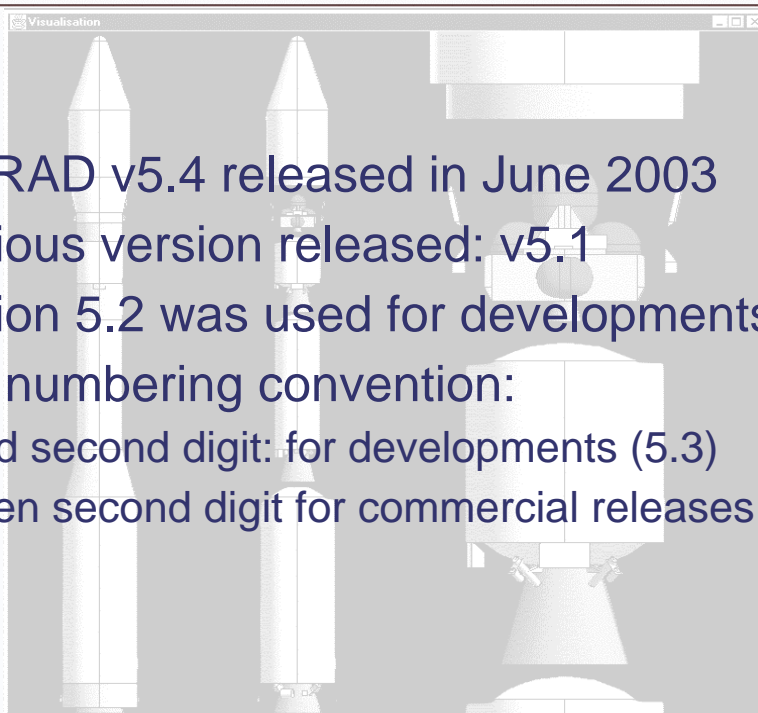
ALSTOM



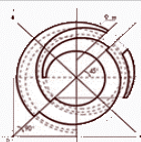
ESARAD v5.4

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- ESARAD v5.4 released in June 2003
- Previous version released: v5.1
- Version 5.2 was used for developments
- New numbering convention:
 - odd second digit: for developments (5.3)
 - even second digit for commercial releases (5.4)



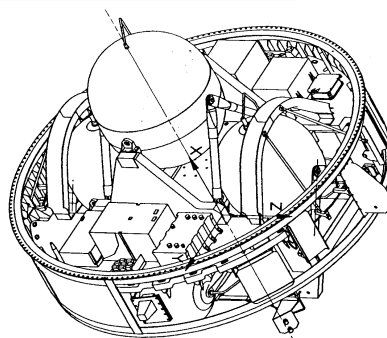
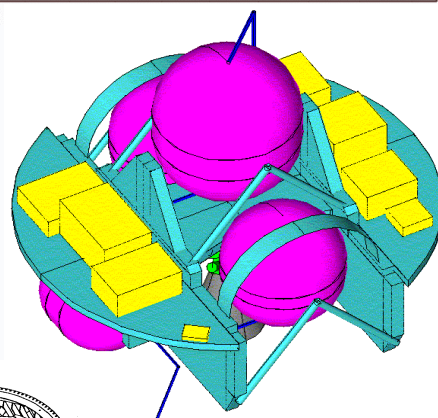
- Workshop 2003 -



ESARAD v5.4

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- List of new features
 - New Combine Shell
 - Recursive Attribute Editing
 - Spacecraft Orientation
 - Simplified Kernel Language
 - ACG
 - New Custom Menu
 - NASTRAN Converter
 - New HDF Data Format



- Short demo if time permitting

- Objectives -

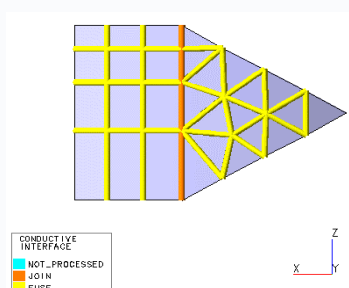
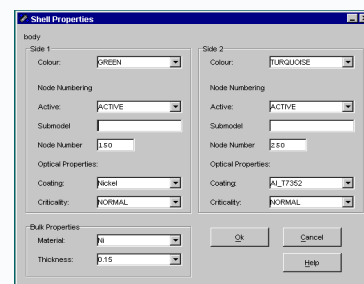
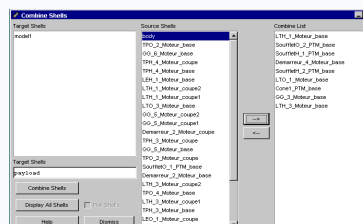


ESARAD v5.4

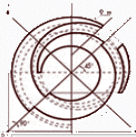
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Geometry - New features

- New Combine Shell Dialog
- Recursive Attribute Editing
- ACG

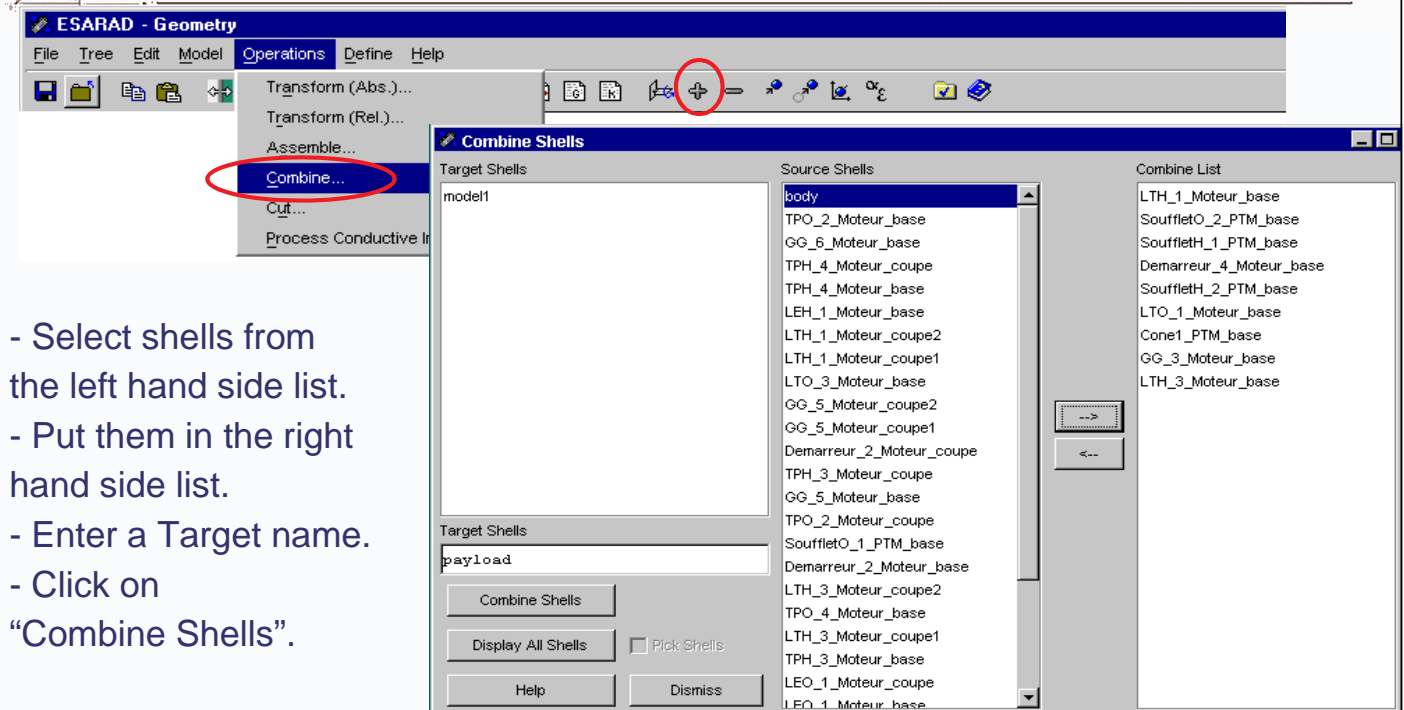


- Geometry Summary -



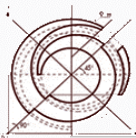
New Combine Shell Dialog

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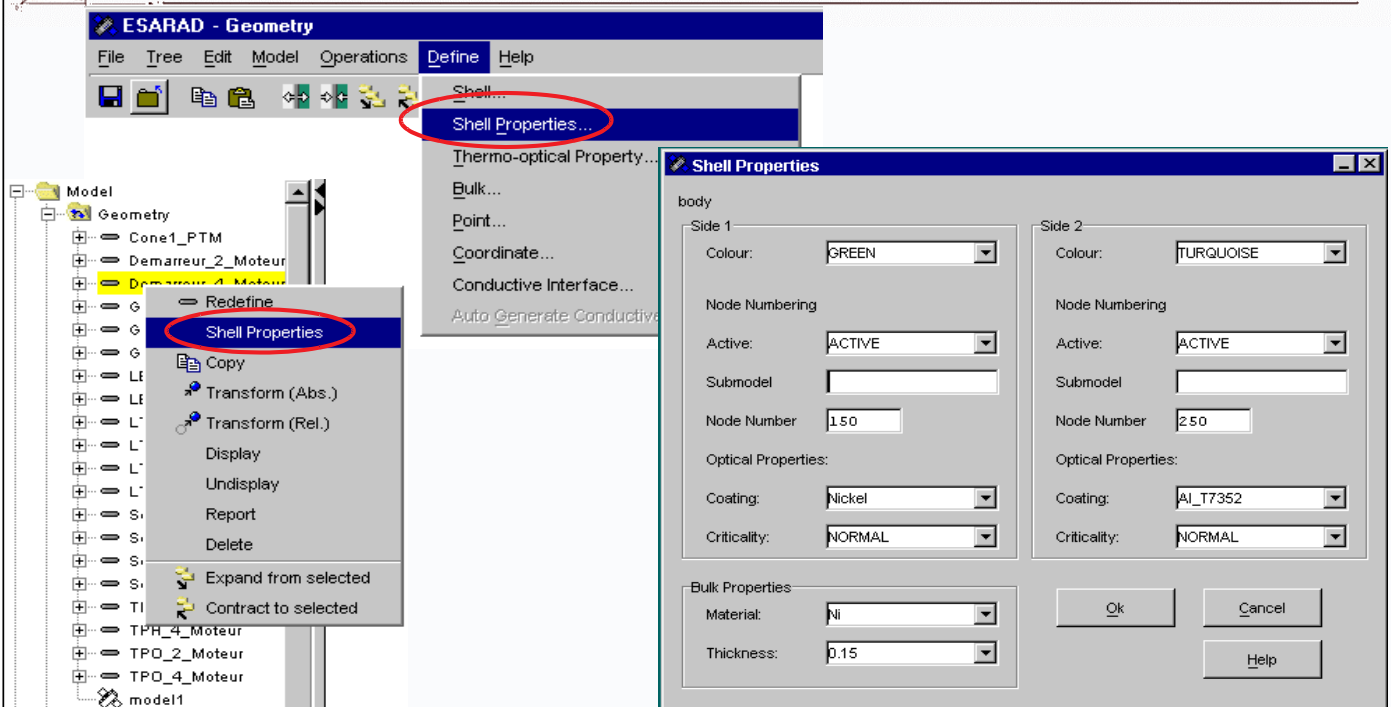
- Select shells from the left hand side list.
- Put them in the right hand side list.
- Enter a Target name.
- Click on "Combine Shells".

- Geometry New Features -

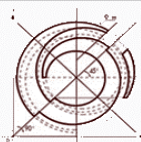


Recursive Attribute Editing

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- Geometry New Features -



ACG

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Automatic Conductance Generator

- Automate Calculations of Linear Conductances
- Recognise interface between two shells
- Output GL value to ESATAN file
- Works on uncut shell primitives
- Contact on common straight edge
- All intra GLs computed
- Inter GLs between Quads and Triangles only

- Geometry New Features -

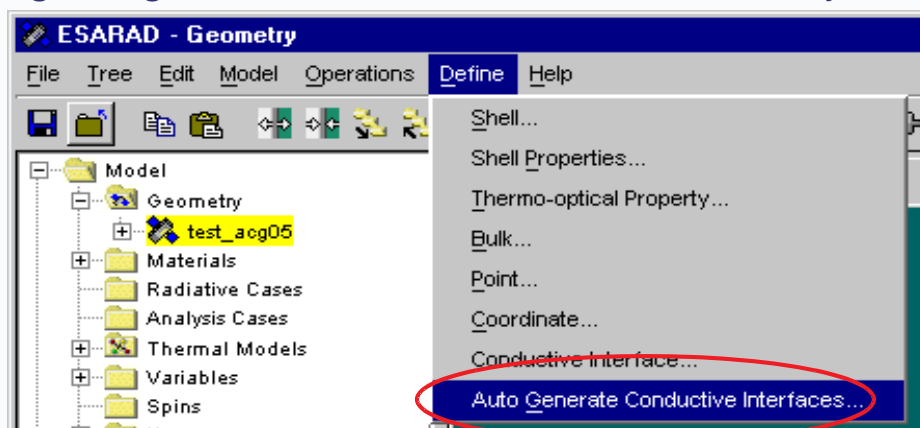


ACG

ALSTOM

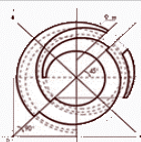
1st Option: Automatic

After having assigned the model, still in the Geometry workspace:



ESARAD will automatically detect the conductive interfaces, display them in the visualisation window and pop the dialog to process the interface type

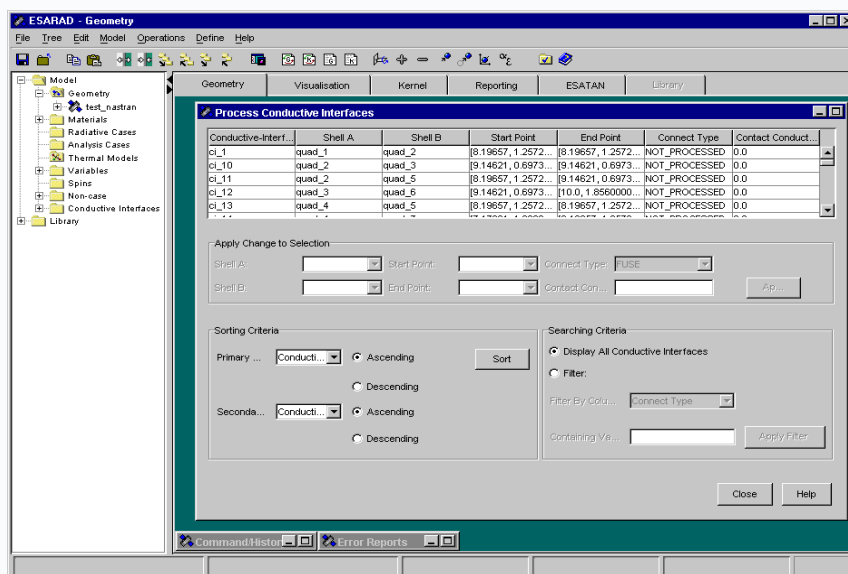
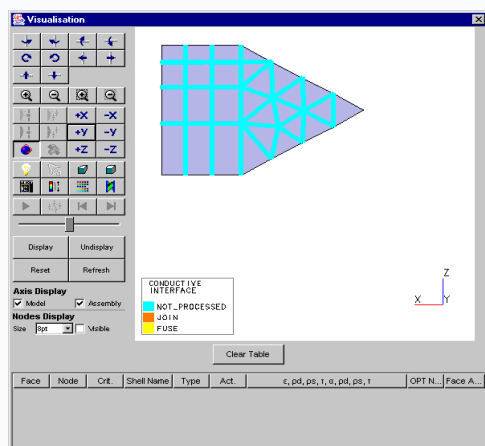
- Geometry New Features -



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1st Option: Automatic



The interfaces are default to NOT_PROCESSED

- Geometry New Features -



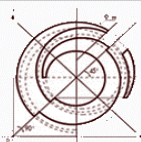
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1st Option: Automatic

- The Connection type can then be changed to one of the following:
 - FUSE: two shells form a single continuous surface
 - JOIN: two surfaces are linked by a contact conductance
 - NOT_PROCESSED: default
 - NOT_REQUIRED
- The Connection type can then be changed by either:
 - Clicking in the visualisation window on a conductive interface
 - Selecting the interface from the list in the dialog

- Geometry New Features -

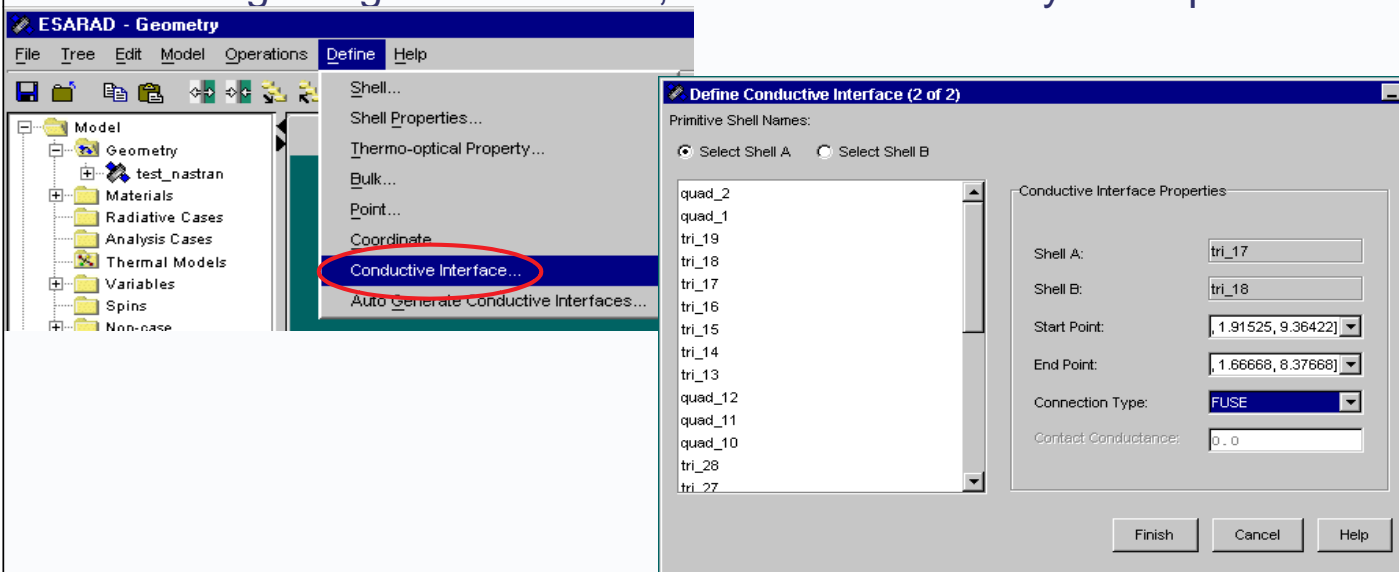


ACG

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2nd Option: Manual

After having assigned the model, still in the Geometry workspace:



- Geometry New Features -

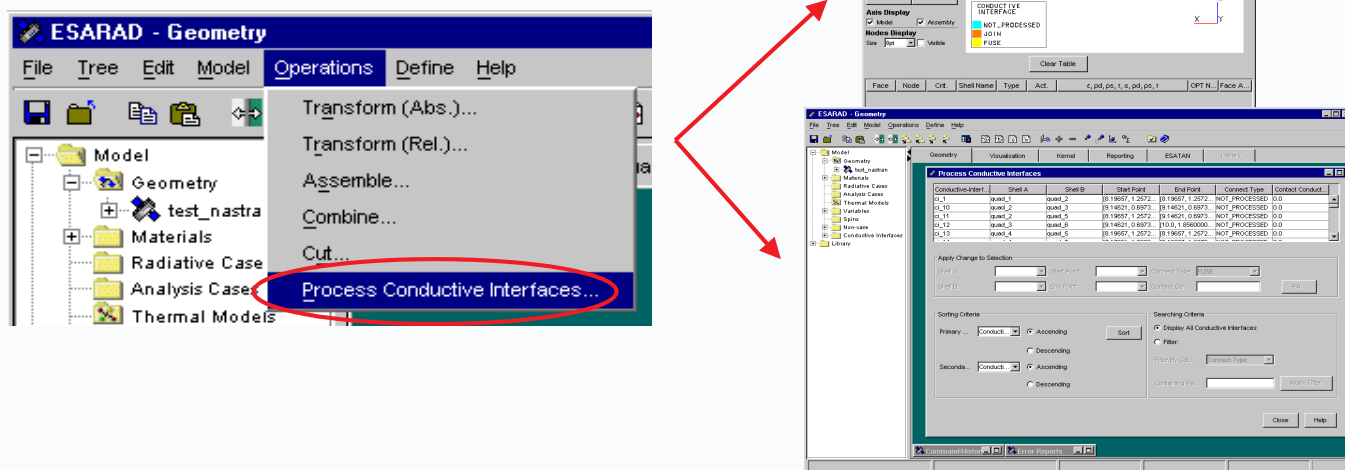


ACG

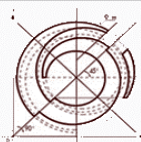
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2nd Option: Manual

To visualise the Conductive Interfaces and their parameter:



- Geometry New Features -

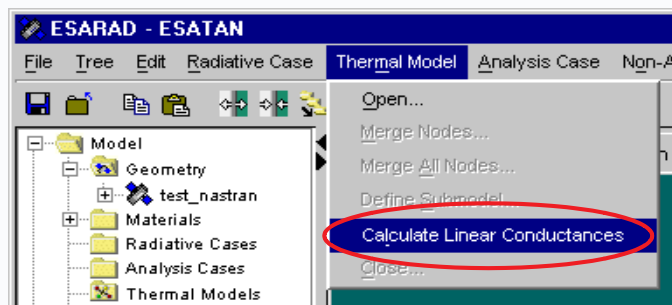


ACG

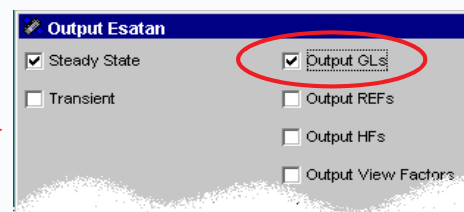
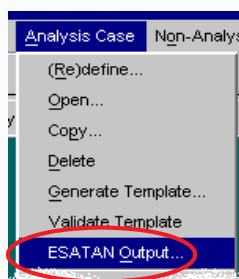
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Outputting GLs to ESATAN

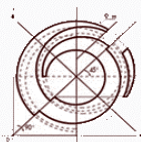
1. Calculate Linear Conductance in the Thermal Model Menu:



2. Click Output GL in the Analysis Case:



- Geometry New Features -

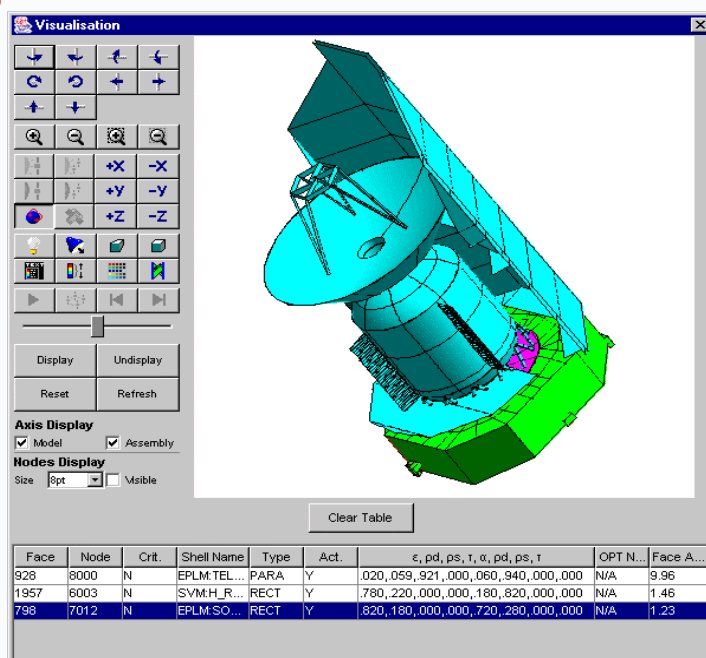


ESARAD v5.4

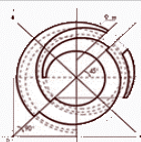
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Visualisation - New features

Background defaults
to White



- Visualisation New Features -



Kernel - New features

- New Spacecraft orientation

- Simplified Kernel Language

```
FOR (orbit_index = 1;  
    orbit_index <= rcase.NUM_ORBIT_POSITIONS;  
    orbit_index = orbit_index + 1)  
  
    CALCULATE (  
        radiative_case = rcase,  
        calc_types = "REF, SDF, SAF",  
        pos_index = orbit_index,  
        eclipse_check = TRUE);  
END_FOR
```

- Kernel Summary -



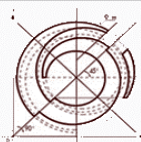
New Spacecraft orientation

- Primary and Secondary vectors make it easier to define the spacecraft orientation within the orbit

- Select vectors from the GUI

- Old LOCS Orientation method still working

- Kernel New Features -

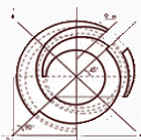


All the previous calculate functions have been replaced with one new calculate method

CALCULATE_ORBIT_POSITION
CALCULATE_ORBIT_POSITION_WITH_SPIN
CALCULATE_PLANET_ABSORBED_FLUX_MATRIX
CALCULATE_PLANET_ABSORBED_FLUX_RAYTRACING
CALCULATE_PLANET_DIRECT_FLUX
CALCULATE_SOLAR_ABSORBED_FLUX_MATRIX
CALCULATE_SOLAR_ABSORBED_FLUX_RAYTRACING
CALCULATE_SOLAR_DIRECT_FLUX
CALCULATE_VIEW_FACTORS
CALCULATE_RADIATIVE_EXCHANGE_FACROTRS_MATRIX
CALCULATE_RADIATIVE_EXCHANGE_FACROTRS_RAYTRACING

CALCULATE (.....)

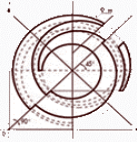
- Kernel New Features -



Example of a new CALCULTE method for a moving geometry:

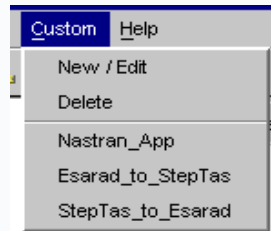
```
FOR (orbit_index = 1;  
    orbit_index <= rcase.NUM_ORBIT_POSITIONS;  
    orbit_index = orbit_index + 1)  
  
    CALCULATE (  
        radiative_case = rcase,  
        calc_types = "REF, SDF, SAF",  
        pos_index = orbit_index,  
        eclipse_check = TRUE);  
END_FOR
```

- Kernel New Features -

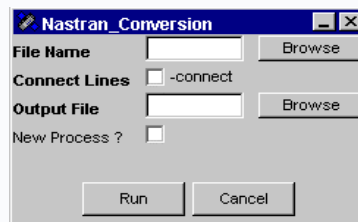


Library - New features

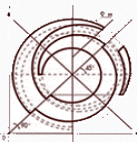
- New Custom Menu



- NASTAN Converter

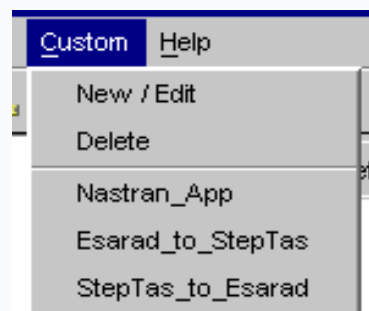


- Library Summary -

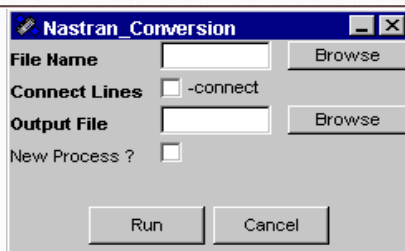


New Custom Menu

- Allows external process to be called from within ESARAD
- Can integrate user's application to work with ESARAD
- Can launch program or access system functions without needing to leave ESARAD
- Call NASTRAN converter
- Call STEP-TAS converter
- In the Library workspace



- Library New Features -

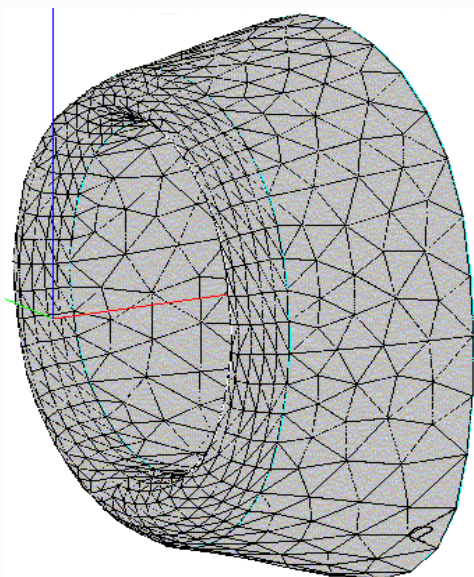


- Converts MSc/NASTRAN input files into ESARAD
- Only supports thin shells and elements (TRIA and QUAD)
- Maps GRID points \Rightarrow ESARAD Points Variables
- Maps FE elements \Rightarrow ESARAD shells
- Does not translate Material data yet
- Can be used with Combine Shells & Recursive Attribute

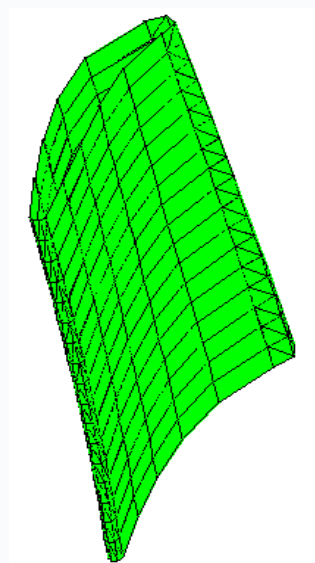
- Library New Features -



Examples



Nacelle Air-Inlet



Turbine Blade

- Library New Features -



Data Format - New features

- New Data Store HDF (Hierarchical Data Format)
- Neutral Binary
- Platform Independent
 - same model can be opened from any platform
 - can transfer a complete model (with all data) to another site
- Only compatible with ESARAD v5.4 onwards

- Data Format New Features -



Conclusion

Chris KIRTLEY will present future
developments after the break.

- Conclusion -

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ESARAD Demo

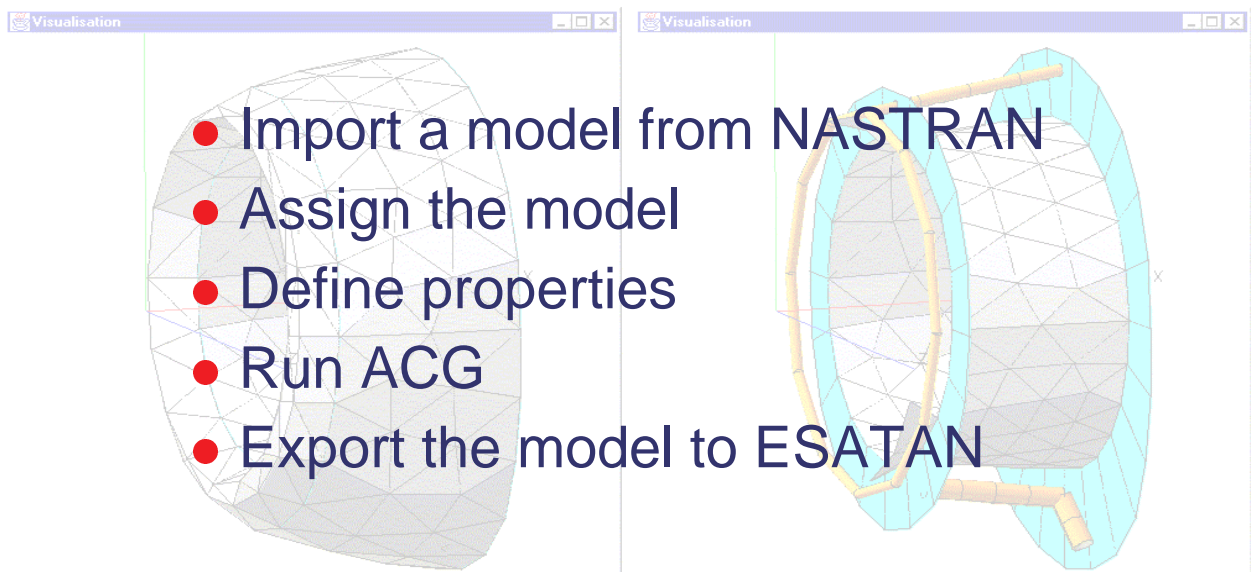
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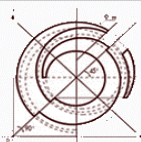
ESARAD v5.4 Demo

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- Import a model from NASTRAN
- Assign the model
- Define properties
- Run ACG
- Export the model to ESATAN

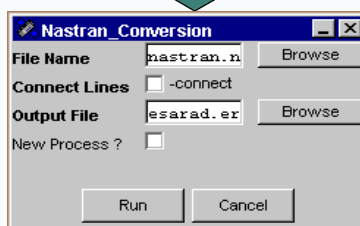
- Demo Objectives -



Import from NASTRAN

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```
1 $ Nacelle Model
2 $ Nodes of the Entire Model
3 GRID 1 84.392 747553 284.677
4 GRID 2 84.4176 230045 286.886
5 GRID 3 84.4584 691363 289.099
6 GRID 4 84.5148 131917 291.317
7 GRID 5 84.5866 551467 293.538
8 GRID 6 84.6738 949566 295.763
9 GRID 7 84.7758 325148 297.992
10 GRID 8 84.8929 676673 300.222
11 GRID 9 85.0255 004253 302.455
12 GRID 10 85.173 307992 304.692
13 GRID 11 85.3344 587392 306.928
14 (...)
15 CTRIA3 1 1 55 37 56
16 CTRIA3 2 1 38 56 37
17 CTRIA3 3 1 37 19 38
18 CTRIA3 4 1 20 38 19
19 CTRIA3 5 1 19 1 20
20 CTRIA3 6 1 2 20 1
21 CTRIA3 7 1 56 38 57
22 CTRIA3 8 1 39 57 38
23 CTRIA3 9 1 38 20 39
24 CTRIA3 10 1 21 39 20
25 CTRIA3 11 1 20 2 21
26 (...)
27 COUAD4 103 1 163 145 146 164
28 COUAD4 104 1 145 127 128 146
29 COUAD4 105 1 127 109 110 128
30 COUAD4 106 1 109 91 92 110
31 COUAD4 107 1 91 73 74 92
32 COUAD4 108 1 164 146 147 165
33 COUAD4 109 1 146 128 129 147
34 COUAD4 110 1 128 110 111 129
35 COUAD4 111 1 110 92 93 111
36 COUAD4 112 1 92 74 75 93
37 COUAD4 113 1 165 147 148 166
38 COUAD4 114 1 147 129 130 148
39 COUAD4 115 1 129 111 112 130
40 COUAD4 116 1 111 93 94 112
41 $ Referenced Coordinate Frames
42 ENDDATA a594743b
```



```
BEGIN_MODEL Nacelle ESARAD_NODE_NUMBERING ESARAD_GENERATED
POINT POINT_20 = [ 7.756000e-001, 6.174700e-001, -2.798000e-001];
POINT POINT_21 = [ 7.756000e-001, 5.199400e-001, -4.438000e-001];
POINT POINT_22 = [ 7.756000e-001, 3.691100e-001, -5.603000e-001];
POINT POINT_23 = [ 7.756000e-001, 1.904300e-001, -6.276000e-001];
POINT POINT_24 = [ 5.406600e-001, 0.000000e+000, 6.219500e-001];
POINT POINT_25 = [ 4.807400e-001, 1.548600e-001, -6.002000e-001];
POINT POINT_26 = [ 4.748900e-001, 4.778000e-001, -4.199000e-001];
POINT POINT_27 = [ 6.381200e-001, 1.237600e-001, -6.272000e-001];
POINT POINT_28 = [ 6.023300e-001, 1.513800e-001, 6.185200e-001];
POINT POINT_29 = [ 6.219700e-001, 3.094500e-001, 5.714600e-001];
POINT POINT_30 = [ 4.446300e-001, 1.248900e-001, 5.994100e-001];
(...)
SHELL quad_1:
quad_1 = SHELL_QUADRILATERAL (
    point1 = POINT_144,
    point2 = POINT_1,
    point3 = POINT_3,
    point4 = POINT_145,
    colour1 = "CYAN",
    colour2 = "CYAN",
    label = "Fwd Bulkhead",
    nbasel = 109,
    nbase2 = 119,
    opt1 = AMS4911_coat,
    opt2 = AMS4901_coat,
    bulk = AMS4901_mat,
    thick = T132_thick);
(...)
SHELL tri_43:
tri_43 = SHELL_TRIANGLE (
    point1 = POINT_3,
    point2 = POINT_1,
    point3 = POINT_25,
    colour1 = "WHITE",
    colour2 = "WHITE",
    nbasel = 209,
    nbase2 = 209,
    side2 = "INACTIVE",
    opt1 = A12219_coat,
    bulk = A12219_mat,
    thick = A163_thick);
PURGE_MODEL ();
END_MODEL
```

NASTRAN .ns file

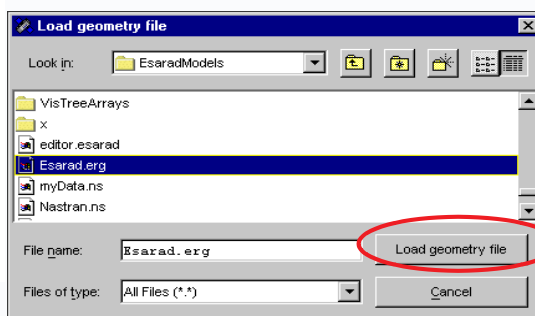
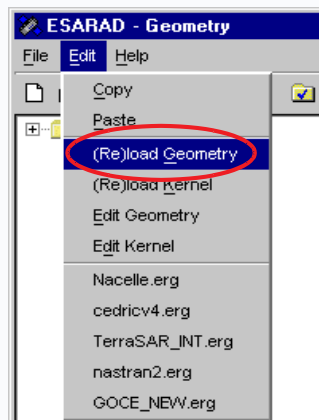
ESARAD .erg file

- Demo -

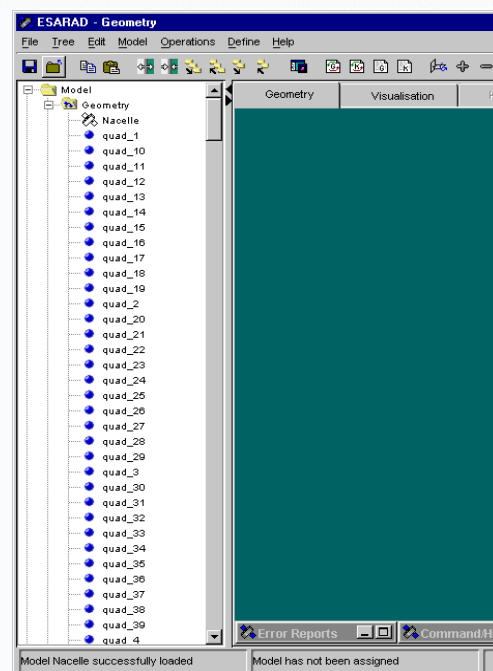


Import .erg file

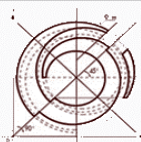
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Create et open the model in ESARAD



- Demo -



Assign the model

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1. Define Optical Properties

Define Thermo-Optical (2 of 2)

Infrared

Emissivity: 0.36 Diffuse Reflectivity: 0.64

Transmissivity: 0.0 Specular Reflectivity: 0.0

Solar

Absorptivity: 0.4 Diffuse Reflectivity: 0.6

Transmissivity: 0.0 Specular Reflectivity: 0.0

OK Cancel Help

2. Define bulks

Define Bulk Material (2 of 2)

Density: 2768.037

Specific Heat: 1187.0

Conductivity: 913.0

OK Cancel Help

3. Assign properties

Shell Properties

Intbkld Assy

Side 1: Colour: WHITE, Node Numbering: ACTIVE, Submodel: , Node Number: , Optical Properties: Coating: AMS4911_coat, Criticality: NORMAL

Side 2: Colour: LIGHT_GREY, Node Numbering: INACTIVE, Submodel: , Node Number: , Optical Properties: Coating: AMS4911_coat, Criticality: NORMAL

Bulk Properties: Material: AMS4911_mat, Thickness: T02_thick

OK Cancel Help

- Demo -



Run ACG

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ESARAD - Geometry

File Tree Edit Model Operations Define Help

Model Tree: Geometry, Nacelle, Intbkld Assy, Skin, TAI_Out, Tee_Pipe, piccolo, Materials, Opticals, Bulks, AMS4901_m, AMS4911_m, AI2219_mat, Radiative Cases, Analysis Cases, Thermal Models, Variables, Spins, Non-case, Conductive Interfaces, Library

Process Conductive Interfaces

Conductive-Interf...	Shell A	Shell B	Start P
cl_95	quad_32	tri_155	[0.7756,-0
cl_96	quad_32	tri_388	[0.7756,-0
cl_97	quad_33	quad_34	[0.7756,-0
cl_98	quad_33	tri_159	[0.7756,-0
cl_99	quad_33	tri_370	[0.7756,-0

Apply Change to Selection: Shell A: Start Point: Shell B: End Point:

Sorting Criteria: Primary: Conducti... Ascending, Second: Conducti... Ascending

Axis Display: Model, Assembly, Nodes Display: Size Opt, Visible

CONDUCTIVE INTERFACE: NOT_PROCESSED (cyan), JOIN (orange), FUSE (yellow)

Clear Table

Face	Node	Crit.	Shell Name	Type	Act.	$\epsilon, \rho_d, \rho_s, t, \alpha, \rho_d, \rho_s, t$	OPT N...	Face A...
------	------	-------	------------	------	------	--	----------	-----------

Command/History Error Reports

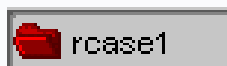
- Demo -



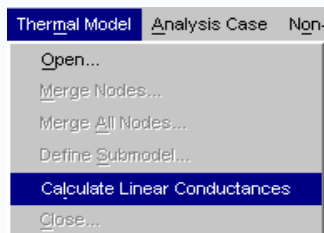
Export model to ESATAN

ALSTOM

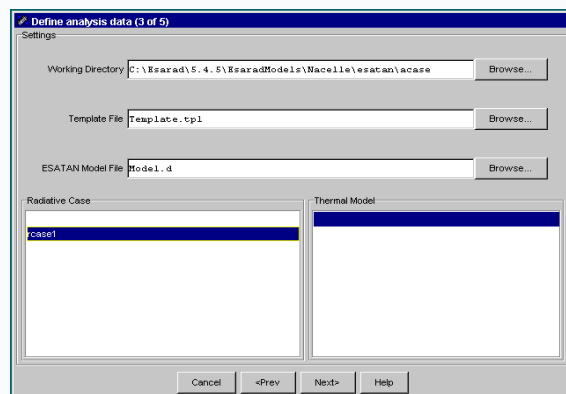
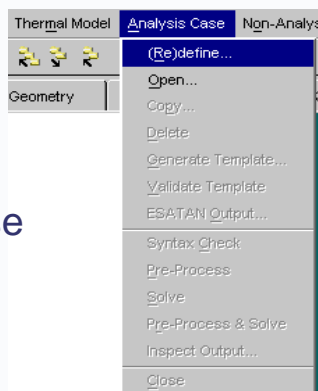
1. Run a kernel



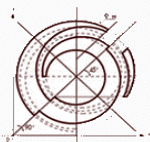
2. Calculate Linear Conductances



3. Open an Analysis Case



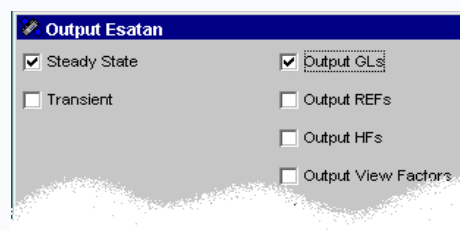
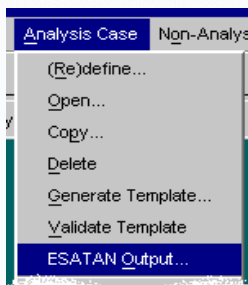
- Demo -



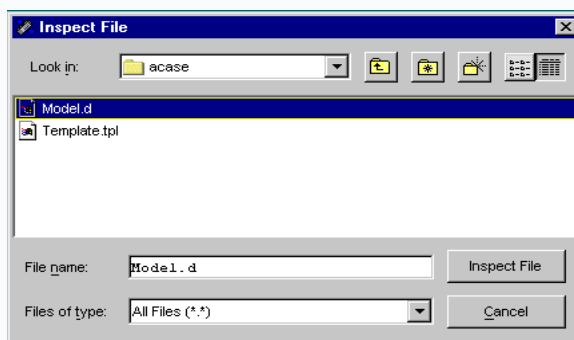
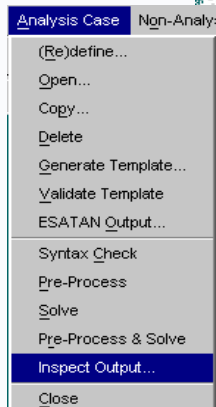
Export model to ESATAN

ALSTOM

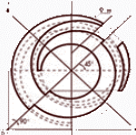
4. Output to ESATAN



5. Inspect Output



- Demo -



Inspect ESATAN Input File

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```
1 # Esarad version 5.4.5, run date 11:40 Mon 20 Oct 2003
2 # Model name: Nacelle           Analysis case: acase
3 $MODEL Nacelle_acase
4 $LOCALS
5 $NODES
6   D1 = 'Piccolo', T = 0.000000,
7   A = 0.021944, ALP = 0.400000, EPS = 0.360000;
8   D2 = 'Piccolo', T = 0.000000,
9   A = 0.021944, ALP = 0.400000, EPS = 0.360000;
10 (...)
11
12 $CONDUCTORS
13   GR(204, 205) = 0.000447918;
14   GR(204, 206) = 0.000167911;
15   GR(204, 207) = 0.000107477;
16 (...)
17
18   GL(203,204) = k_Al2219_mat * 0.00744496;
19   GL(267,287) = k_Al2219_mat * 0.00426211;
20   GL(281,290) = k_Al2219_mat * 0.00555827;
21 (...)
22
23 $CONSTANTS
24 $REAL
25   # Material data for 'AMS4901_mat'
26   Cp_AMS4901_mat = 0.000000;
27   Dens_AMS4901_mat = 4511.900000;
28 #
29   # Material data for 'AMS4911_mat'
30   Cp_AMS4911_mat = 0.000000;
31   Dens_AMS4911_mat = 4428.859000;
32 #
33   # Material data for 'Al2219_mat'
34   Cp_Al2219_mat = 0.000000;
35   Dens_Al2219_mat = 2768.037000;
36 #
37   # Conductivity from bulk 'Al2219_mat'
38   k_Al2219_mat = 120.000;
39
40 $ARRAYS
41
42 $SUBROUTINES
43   SUBROUTINE QCYCIC LANG = MORTRAN
44   RETURN
45 END
46   SUBROUTINE QAVERG LANG = MORTRAN
47   RETURN
48 END
49   SUBROUTINE RCYCIC LANG = MORTRAN
50   RETURN
51 END
52
53 $INITIAL
54   C101 = 0.000019 * Cp_AMS4901_mat * Dens_AMS4901_mat
55   C102 = 0.000038 * Cp_AMS4901_mat * Dens_AMS4901_mat
56   C103 = 0.000037 * Cp_AMS4901_mat * Dens_AMS4901_mat
57 (...)
58
59 $VARIABLES1
60   IF (SOLVER(:2) .EQ. 'SS') THEN
61     CALL QAVERG
62   ELSE
63     CALL QCYCIC
64     CALL RCYCIC
65   END IF
66
67 $VARIABLES2
68 $EXECUTION
69 # Steady State Solution
70   RELXCA=0.001
71   NLOOP=1000
72   CALL SOLVIT
73 # Transient Solution
74   TIMEND=PERIOD
75   DTIMEI=TIMEND/100.0
76   OUTINT=TIMEND/10.0
77   CALL SLFWBK
78
79 $OUTPUTS
80   CALL PRNDTB(' ','I,T,QS,QE,QA,C',CURRENT)
81   CALL DMPCFF(' ',CURRENT)
82 $ENDMODEL #Nacelle_acase
```

- Demo -

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