Simulating the Thermal Effects of an Orbit

Use *Orbit/Attitude Modeling* to request solar, albedo, and planet view factor calculations for selected elements within a defined orbit.

Heat loads resulting from direct solar flux, albedo and planet IR are automatically modeled, using a radiosity approach to determine the reflection and absorption of the incident flux throughout the model. Ray-tracing is used for specular or transmissive surfaces. Eclipses are detected and modeled accurately. The spacecraft orientation can be anchored to the sun, the planet or a star; spinning spacecraft can also be modeled. Orbit definitions may be of complete or partial orbit segments, and may be concatenated to model orbital maneuvers. You can also define orbits or orbital maneuvers by specifying time-varying sun and planet vectors.

Preview a defined orbit prior to solving the model by picking the *Orbit Display* icon on the *Orbit / Attitude Modeling* form. Orbital view factors and heat fluxes may be recovered for post-processing and visualization.

Locate the icon.

Setting up an Orbiting Thermal Simulation

The steps shown here guide you through the process of preparing your model for an orbital heating analysis. Details about the different orbits and options of *Orbit/Attitude Modeling* follow.

1. Build a complete enclosure model (see *Understanding Radiation Requests*).

   Use the *Space Enclosure* option on the *Radiation Control* form to create a non-geometric element modeling the ambient environment for radiation simulation.

Locate the icon.

   Be sure that there are no inactive element faces in the enclosure (see *Front and Reverse Element Sides*).

Locate the icon.

2. In the *Meshing* task, define solar and IR surface properties for all elements in the enclosure

   use *Fluid/Thermal - Thermal Solid* material or *Simulation - Isotropic* or *Orthotropic*

   TMG will exclude from the solar heating process all elements selected with the option *Ignore Elements for all Solar/Orbital/Radiative Heating* or *Ignore Elements for all View Factor Calculations* of the *Element Radiation Switches* or those with solar absorptivity values less than 0.

3. Create *Radiation Requests* to compute a complete set of black body view factors for the enclosure.

Locate the icon.

4. Use *Orbit/Attitude Modeling* to setup spacecraft orbit and orientation. View the orbit to

visualize spacecraft attitude, orbit parameters, calculations points and other parameters. During the solution, TMG will compute appropriate view factors for selected elements.

Locate the icon.

5. On the *Transient Analysis Parameters* form set the *End Time* to control the maximum number of orbits. You can use the *Periodic Convergence* option to avoid calculation of repetitious temperature cycles. Access these options by picking the *Transient Parameters* button on the *Solver Control* form.

Locate the icon.

6. Toggle on *View Factor Sums*, *Radiative Flux* and *Solar, Earth VF's* on the *Solution Data* form for post processing.

Locate the icon.

7. To obtain better transient results near the beginning of the analysis, first perform a steady-state analysis with transient boundary conditions set to *Time Average.* Then rename or move the *TEMPF* file and use it to specify *Initial Conditions.* (Use restart to avoid recalculating view factors) (see *Setting Restart Control*).

Locate the icon.

Defining the Orbital Calculation

Orbit/Attitude Modeling offers a wide range of options to define any orbit or orbital maneuver around any planet of the solar system or the moon.

To simplify the orbit definition, many choices are available only for specific orbit types or planet. The early choices you make while defining the case at hand will restrain the options that are available to you. Basically, when defining a new orbit, you should enter data in the main form by following these steps:

1. select the illuminated elements
2. select the planet
3. select the orbit type
4. select the shadowing options

You can select from four basic orbit types for any planet:

- Beta Angle
- Geostationary
- Classical
- Sun & Planet Vectors

Three additional orbit types based on the classical definition are added for Earth only:

- Sun-synchronous

- Shuttle
- Molniya

See *Orbit Definition* for complete information about each type of orbit.

Once you have selected the planet and the orbit type, you must specify additional data by picking each icon situated on the right of the form, proceeding from top to bottom. Your choice of planet, orbit type and other options selected via the icons, will determine the subsequent choices available.

Supported Elements Types

The following element types are supported as Illuminated Elements.

Front of:

- 2-D thin shell elements
- Beam elements with cross section defined
- Lumped mass elements
- Free faces of 3-D solid elements

Reverse of:

- 2-D thin shell elements

Notes on Orbital Heating

The *Error Criterion* defines shadowing granularity by specifying a view factor error tolerance with respect to shadowing checks. When you specify an error criterion, the software will estimate a subdivision level for each view factor, using the lowest subdivision level that should satisfy the error criterion you specified. (See the article on *Shadowing Checks* for more information).

- Use *Orbit Display* to preview your orbit before you solve the model. This is particularly useful for verifying spacecraft orientation.
- Use the *Spinning* option on the *Spacecraft Attitude* form to model spacecraft which spin rapidly about an axis.
- The calculation time for orbital view factors and heat loads can be substantial. If you wish to change surface properties for a model, you can define *Initial Conditions and Restart Control* to reload previously-calculated orbital view factors.
