Annexure - I

Technical Specifications of Thermal Analysis software for Electrical Machines including Permanent Magnet Machines

The Software should be capable of performing coupled and uncoupled flow and thermal analysis of Electrical machines and Permanent Magnet machines and simulate their performance under various operating conditions.

Technical specifications:

1. Basic Functionality:
    a) Flow Analysis – through control volume method. Both Laminar and turbulent flow regimes.
    b) Thermal Analysis - Forced, natural and mixed convection heat transfer modes; Conduction in solids; Surface to surface radiation heat transfer.
    c) Coupled analysis of the above two analysis

2. Modeling capabilities:
    a) The software should provide direct modeling capability through standard 3D modeling software like Solidworks.
    b) The Software should be capable of providing direct modeling capability through other 3D modeling softwares like CATIA, UG-NX & Pro –E
    c) The solid models imported should be editable in the modeling software. Should be able to import/export models in SAT and DXF file formats.
    d) It should support both automatic and user defined mesh generations and should have adaptation tools to automatically identify the areas where the mesh needs improvement or refinement.
    e) It should be possible to create user-defined materials (both editable and read-only) by inputting the following parameters: Thermal Conductivity, Specific Heat Capacity, Mass Density etc.
    f) The solver control for number of iterations, convergence tolerance etc. should be possible.

3. Boundary Conditions:

a) Pressure boundaries as a function of time
b) Electric currents as a function of time
c) Internal and external flow boundary conditions; Wall boundary conditions.
d) Periodic boundary conditions.
e) Surface boundaries with options for specifications of heat flux, temperature, convective heat transfer coefficients, radiation and symmetric conditions
f) Vents with options for specification of inlet/exit velocity, mass flow rate, inlet and exit pressure, inlet temperature and turbulence parameters
g) Time-dependent and temperature dependent sources
h) To capture the solid/fluid interface, through appropriate elements.

4. Analysis Capabilities:

a) Steady-state or transient analyses.
b) Input for full anisotropic conductivity in solids
c) Temperature dependent material properties
d) Non-linear fan curves for fan modeling.
e) Global and local rotating frame of reference.
f) Capable to do Design Variant Analysis and parametric study.

5. Post Processing Capabilities:

a) Dynamic mouse based view manipulation (Rotation, Translation, Zoom)
b) Visualization of velocity vectors, contours, particles traces on object faces, cut planes and iso-surfaces
c) Contours of velocity, speed, temperature, pressure or other solved quantities
d) Direct graphic output to printers, user-specified files like JPEG, PNG & BMP formats.
e) Transient animation is included. Create animation directly by writing out data into AVI formats.
f) The software should be able to determine the steady-state temperature distributions and time-varying temperature distributions for 2D models (Static &

Transient) and 3D models (Static & Transient) within the electrical machine components.

g) The results should provide following details after thermal analysis has taken place:

i) Temperature distribution: contour plots, shaded plots and animation

ii) Heat flow: arrow plot and animation.

6. Scope of supply and other details:

a) The scope of supply should cover the software, 2D (Static and Transient) & 3D (Static and Transient) in a CD/DVD and its license or hardware lock.

b) Operating Manuals and User Manuals for the Software are to be provided.

c) The Erection and Commissioning has be carried out in workstation available at BHEL, Corp. R&D, Hyderabad. The scope should also include 2 days training of Engineers at BHEL, Corp. R&D, Hyderabad.

d) One year Warranty, AMC and Upgradation to be provided.

e) The AMC charges for subsequent years to be specified.

f) The Technical offer should also have the necessary Brochures and Technical features of the software being offered.

7**.** Other Conditions:

a) The Supplier should either send trial version (free of cost) for checking above technical specification or they may send their representative to demonstrate the software at BHEL R&D, Hyderabad free of charge.

b) Software validation procedure is to be supplied along with the product.