Computation Fluid Dynamics Analysis of Roof-top Mounted Hospital Air Handler System

CFD Analysis of Roof-top Mounted Hospital Air Handler

Objective: Determine optimum air flow patterns and pressures in a large, roof-top mounted Hospital Air Handler

Modeling Assumptions and Details: A CFD finite element model was built based on drawing and geometry information provided by the client.

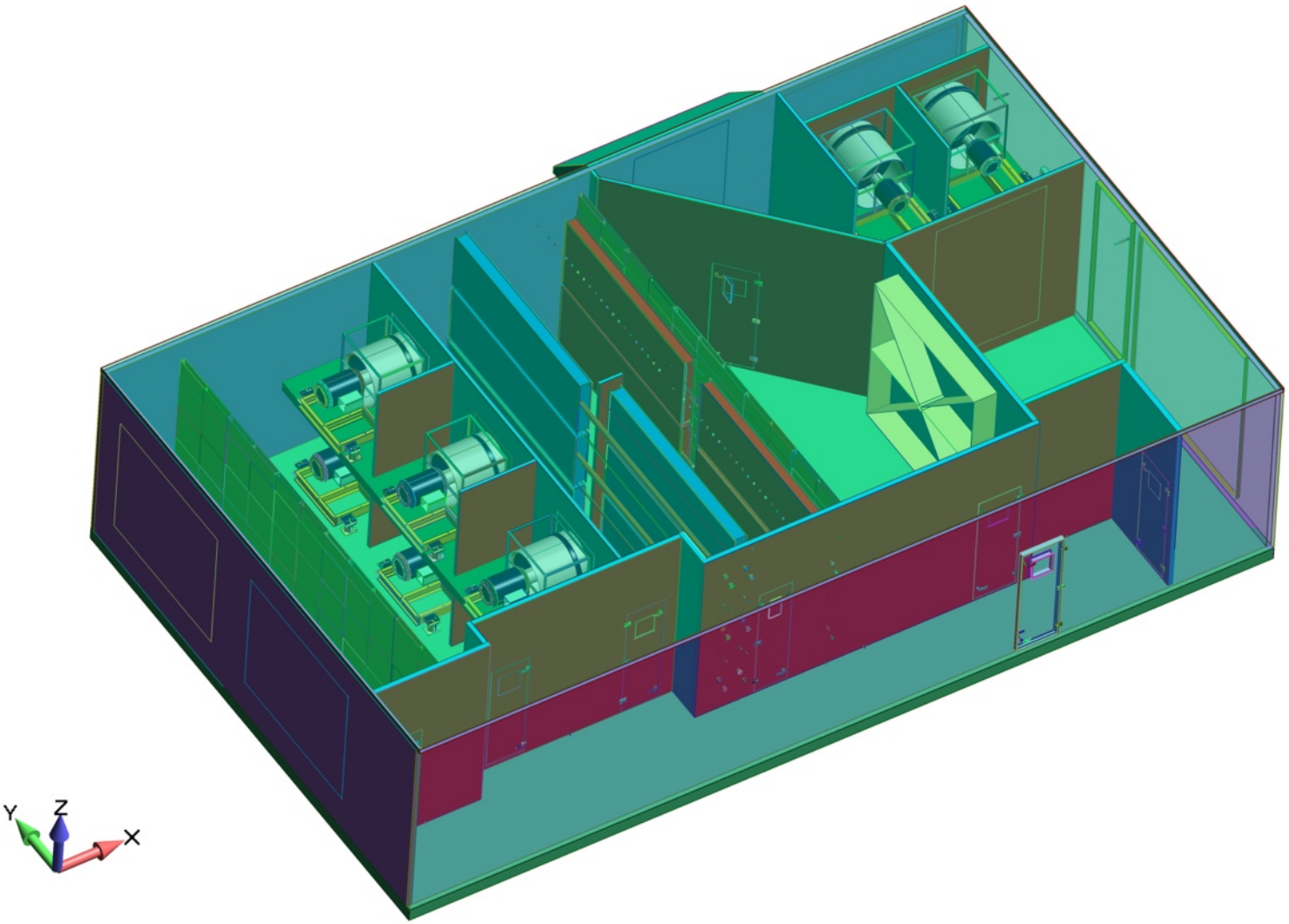
The engineering work presents CFD results for Winter conditions. This condition represented the most diverse operating conditions for the Air Handler (AH).

The CFD software used on this project was CFdesign v2011 and is manufactured by Blue Ridge Numerics of Charlottesville, VA.

Summary: Results indicate that air flow through all significant points of the air handler is extremely uniform and will provide optimum heating and cooling across the coils. Given the high-resistance HE Filter near the exit of the air handler, upstream flow, pressure and thermal results will be unaffected by the final exit configuration used on the air handler. Additionally, this final HE-Filter acts as an equalizer to ensure that the final exiting air quality (temperature and flow) will meet or exceed the air exit specification.

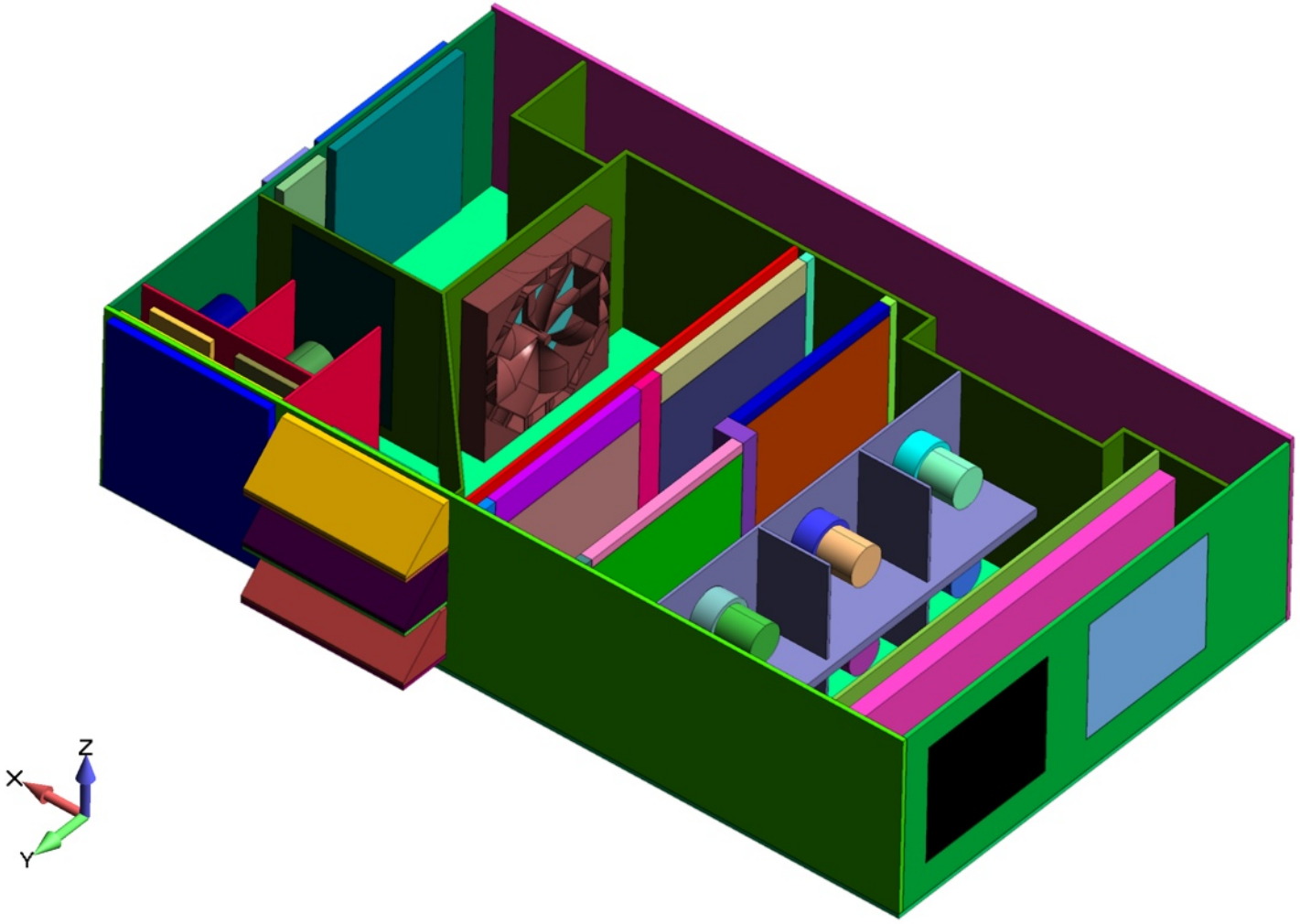
Modeling Details and Setup

Computation Fluid Dynamics Analysis of Roof-top Mounted Hospital Air Handler System



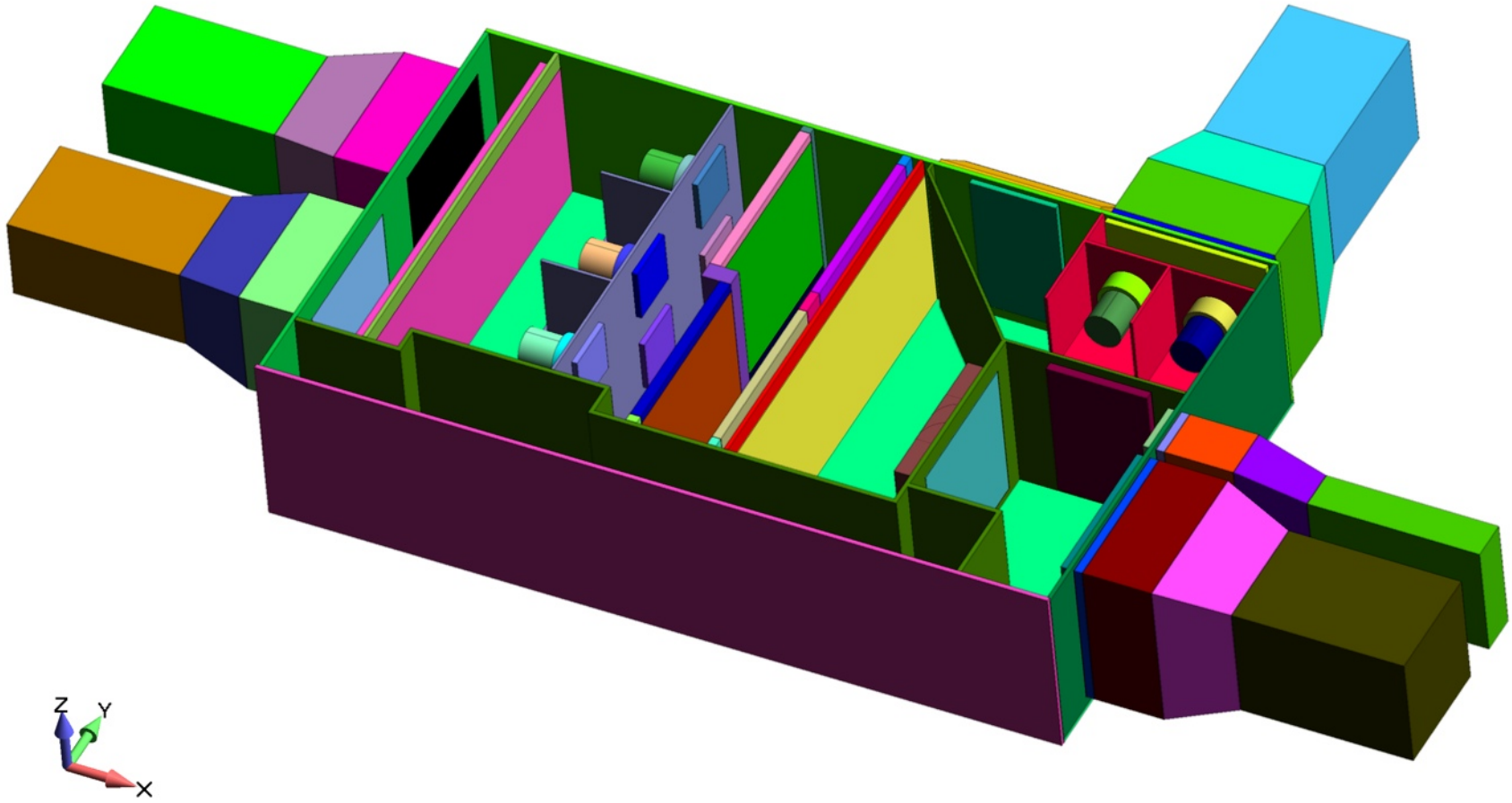
The 3-D geometry model of the Air Handler.

Computation Fluid Dynamics Analysis of Roof-top Mounted Hospital Air Handler System



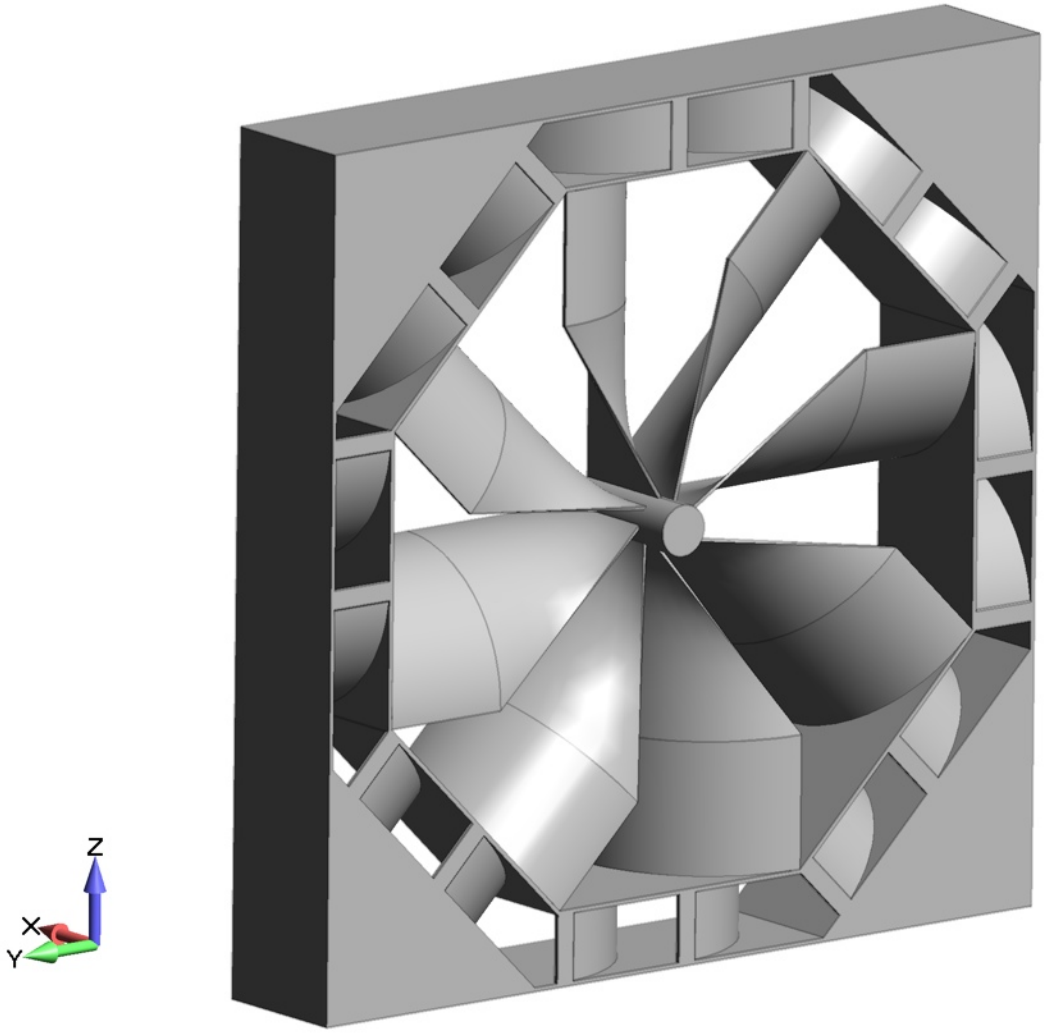
The CFD model was created from dimensions provided in the 3-D CAD design model. As can be noted, the original geometry was heavily idealized to be amiable to a CFD analysis.

Computation Fluid Dynamics Analysis of Roof-top Mounted Hospital Air Handler System



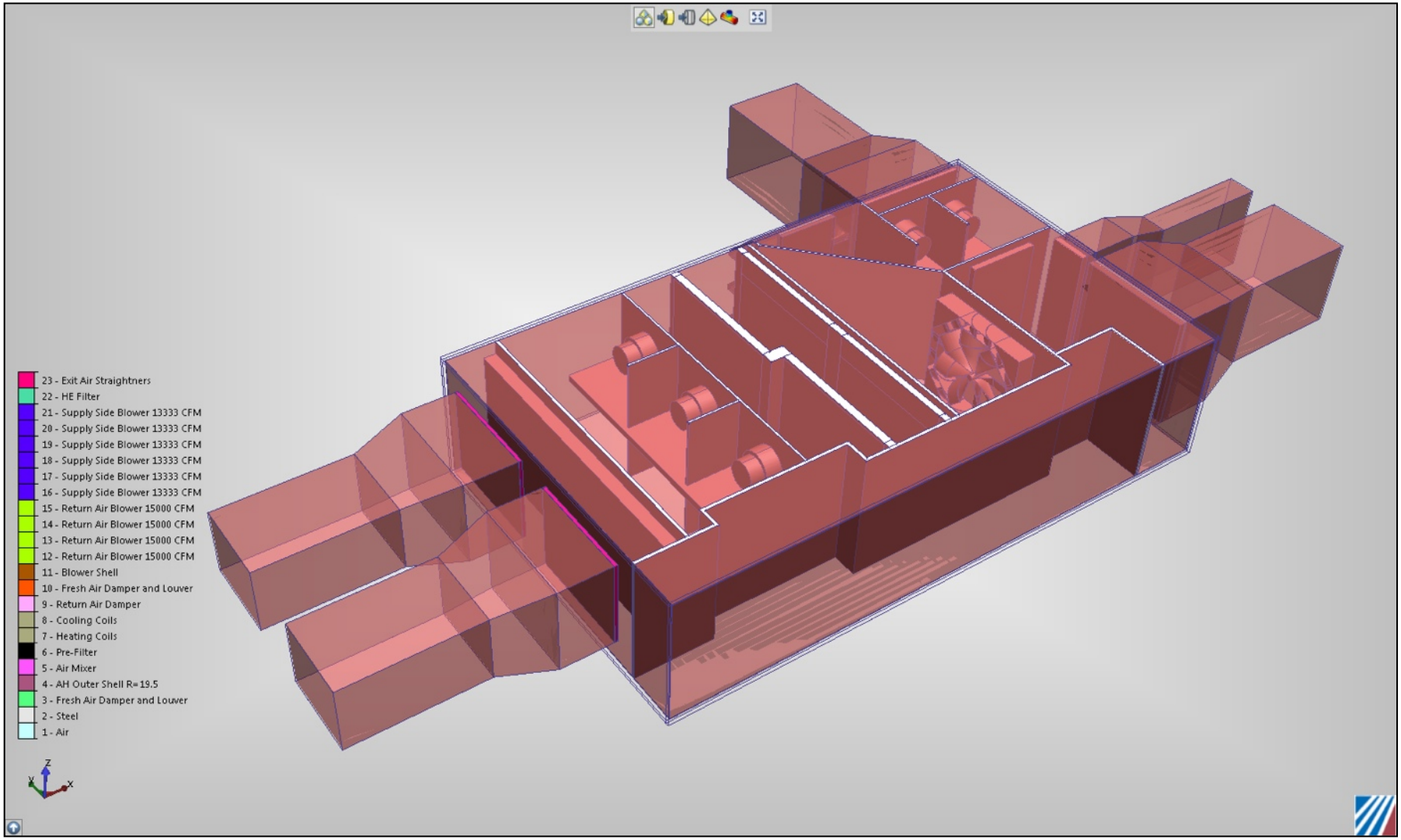
Inlet and exit extensions were added to the geometry to facilitate the computational process of handling the zero pressure far-field boundary conditions.

Computation Fluid Dynamics Analysis of Roof-top Mounted Hospital Air Handler System



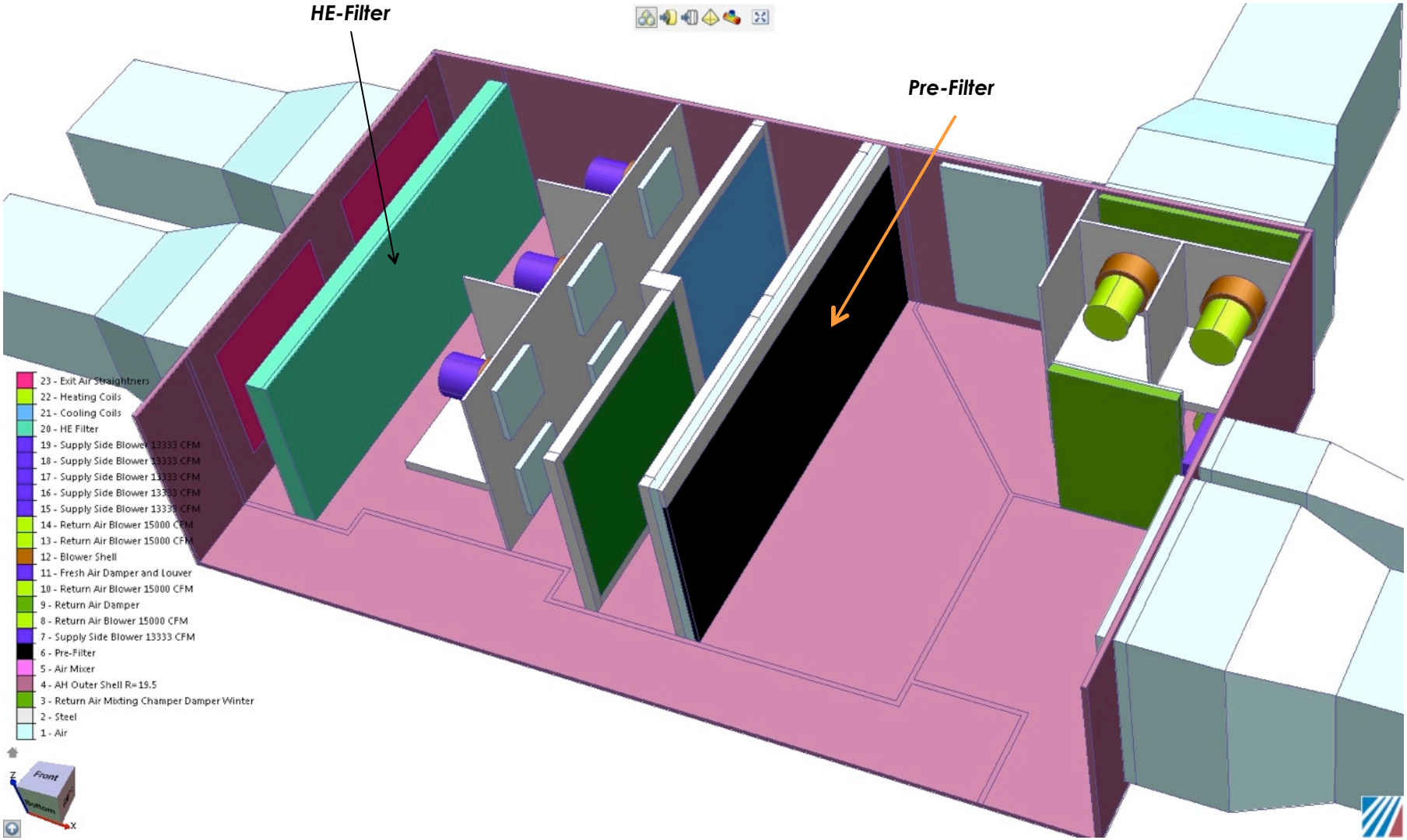
The air mixer component required a CFD friendly engineered piece of geometry due to its complexity. All surfaces were smoothed and short edges and small surfaces eliminated.

Computation Fluid Dynamics Analysis of Roof-top Mounted Hospital Air Handler System



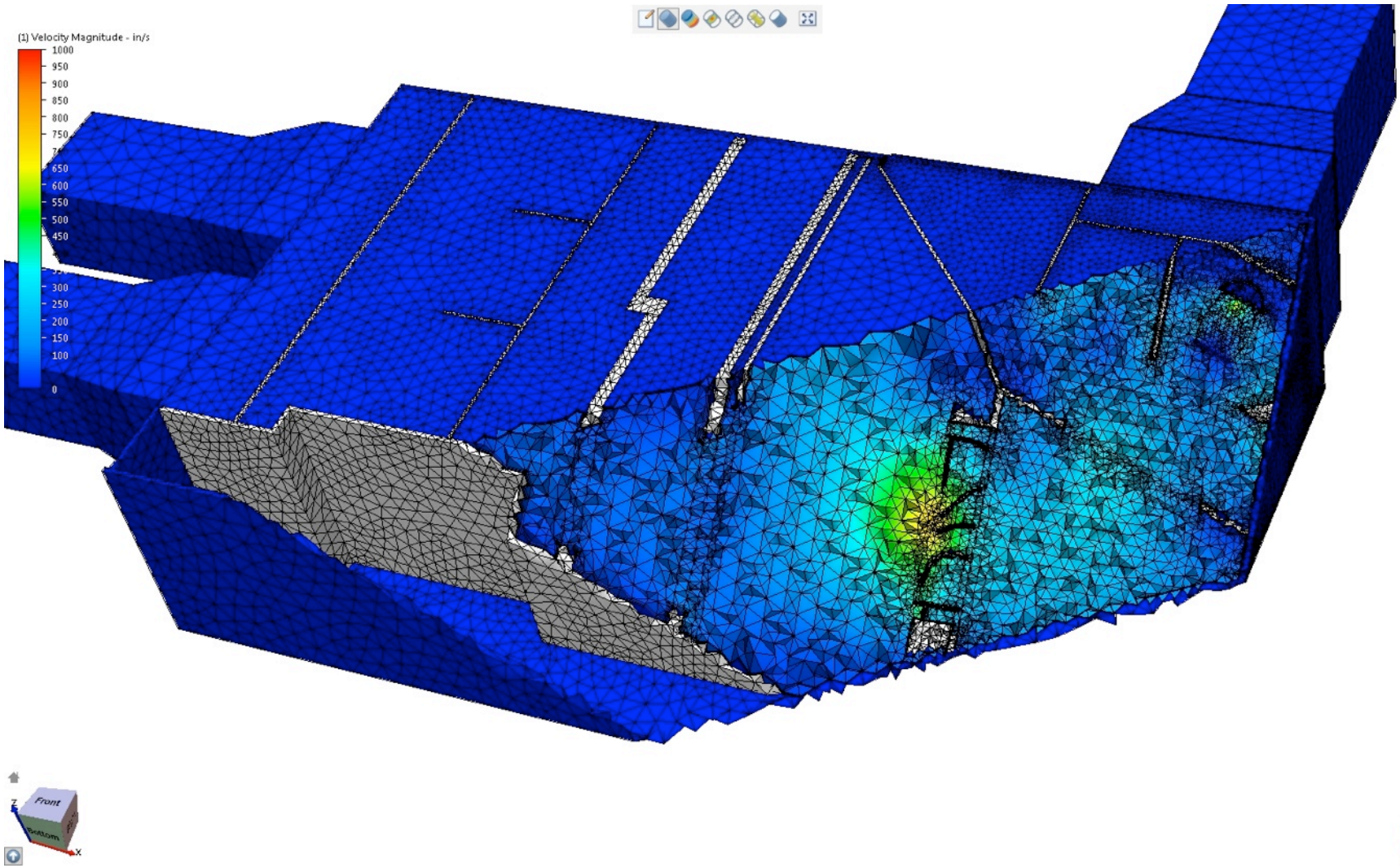
The CFD model layout is shown above with the material definitions given on the legend on the far left. The air material is set to be translucent in this view.

Computation Fluid Dynamics Analysis of Roof-top Mounted Hospital Air Handler System



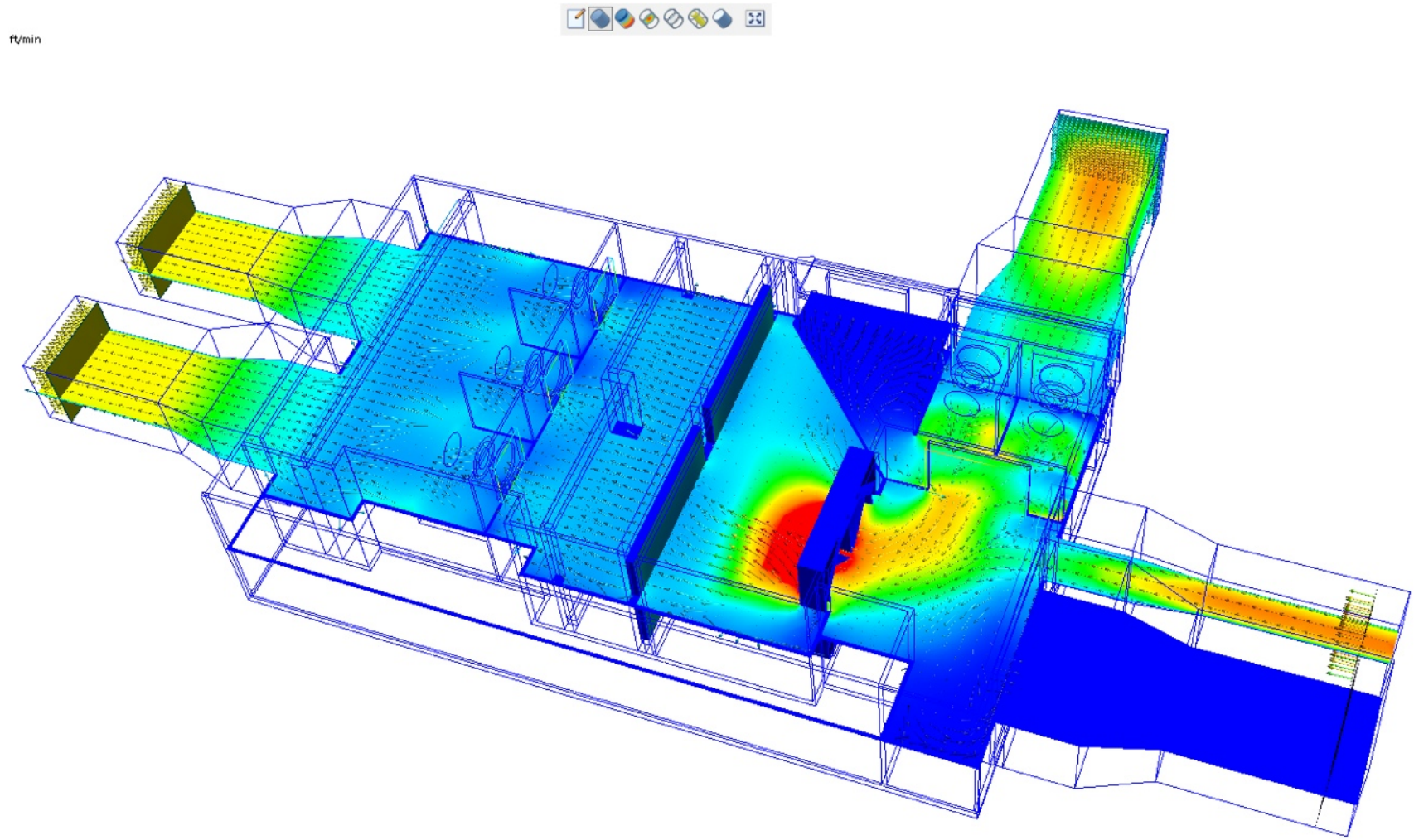
The above view shows the placement of the two key air filters in the air handler. At the front of the heating coils is the pre-filter and toward the exit is the large HE filter section. Their resistance factors (head loss characteristics) were calculated using the procedure shown in the Appendix. The calculation procedure was verified using small test CFD models.

Computation Fluid Dynamics Analysis of Roof-top Mounted Hospital Air Handler System



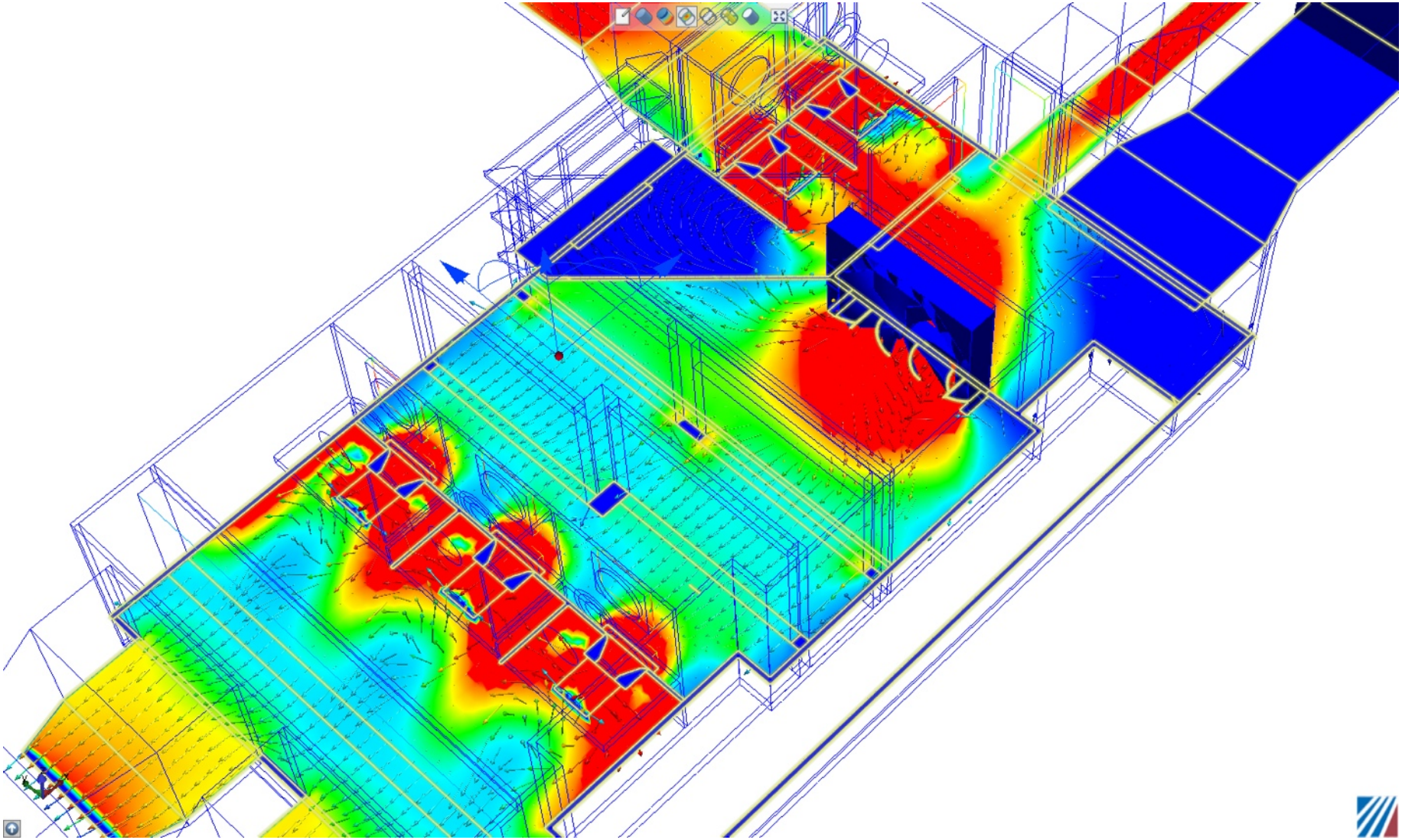
The element type used in the CFD study is a 4-node tetrahedral. The mesh type and sizing was validated against a higher-density mesh and shown to provide nearly identical results (within 1.4%).

Computation Fluid Dynamics Analysis of Roof-top Mounted Hospital Air Handler System



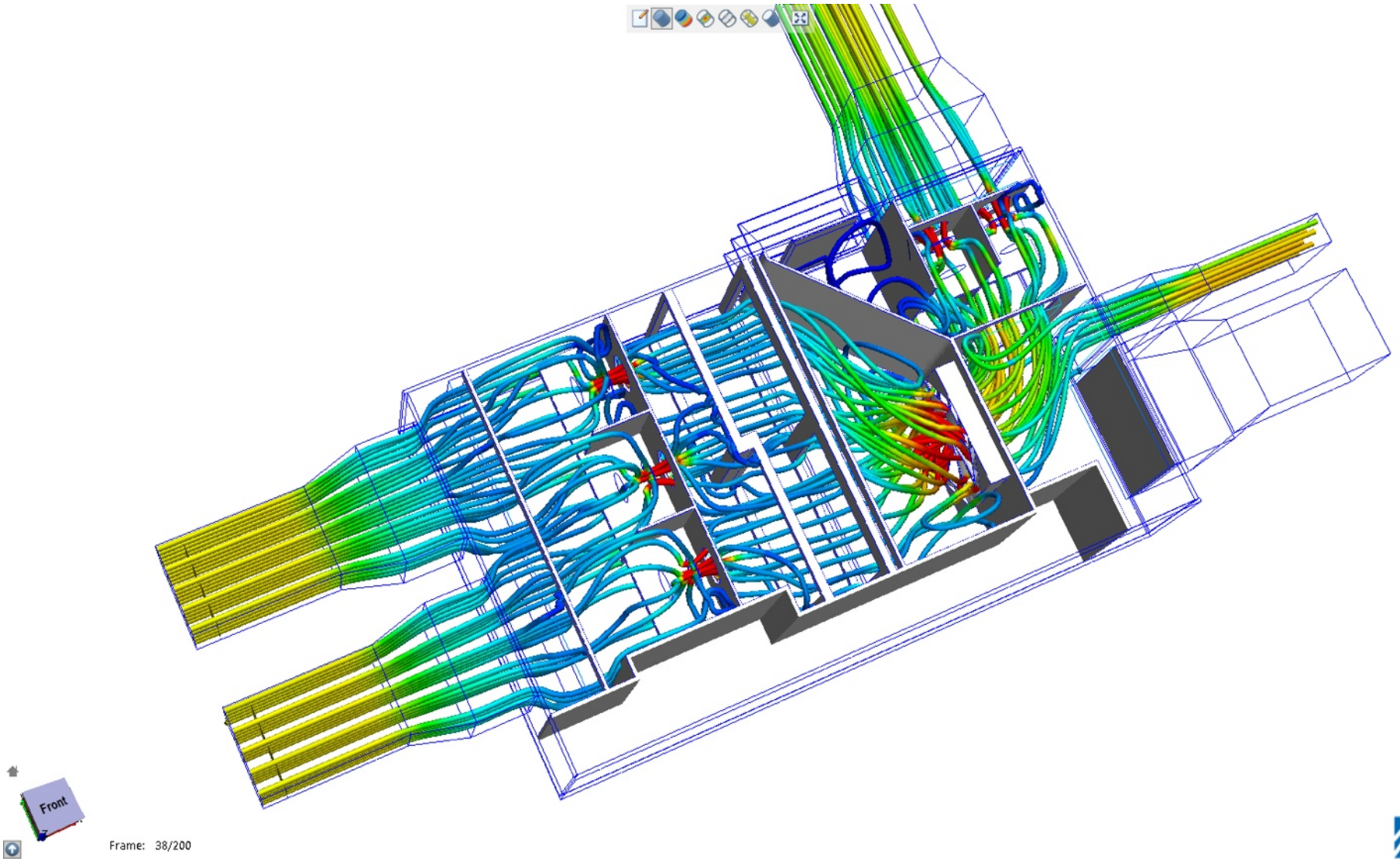
The flow conditions for Winter are shown above.

Computation Fluid Dynamics Analysis of Roof-top Mounted Hospital Air Handler System



The following sequence of section plots show the flow field at 0.25, 0.50 and 0.75 ratios of the height of the air handler.

Computation Fluid Dynamics Analysis of Roof-top Mounted Hospital Air Handler System



A flow particle trace is shown above indicating how air moves through the air handler. Note: density of particle traces does not reflect volumetric flow. The particle traces only illustrate flow path and contour velocity.