

## CFD Model Sensitivity Study Notes

Summary notes for the CFD model sensitivity study are provided in this document. Prior to performing “production calculations” a series of CFD calculations were performed to assess the sensitivity of the calculation results to grid parameters (e.g., mesh resolution), as well as other modeling aspects (such as the effect of neglecting short buildings on the overall solution). The sensitivity study examined qualitative features (vorticity isosurfaces) and predicted velocity data at several “slice planes”. Note that the input geometry used for the sensitivity study was different than the model used for production calculations, and most notably, did not include the Children’s Memorial Hospital. Significant structures near the hospital (John Hancock Tower, Water Tower Place, Olympia Centre, etc.) were included in the sensitivity study model.

Velocity data for the sensitivity study are presented in separate (PDF) files, with descriptions provided below.

### CGEMeshSensitivity

- Compares effect of CGE base mesh resolution; base mesh dimension represents minimum mesh dimension nearest to building surfaces
- Cases plotted:
  - S1 – 1.3m mesh
  - S2 – 2.7m mesh
  - S5 – 0.7m mesh
- Production calculations used 1.3m base mesh size

### CGESurfMeshSensitivity

- Compares effect of CGE mesh coarsening parameter (NLSMOO); octree mesh becomes more coarse farther away from surface based on numerical parameter with larger value indicating the number of cells before cell size is increased (more refined mesh near surface)
- Cases plotted:
  - S1A – NLSMOO = 4
  - S6 – NLSMOO = 6
  - S6A – NLSMOO = 8
- Production calculations used NLSMOO = 6

### VTMMeshSensitivity

- Compares effect of VorTran-M (VTM) base mesh resolution (DS\_VTM); base mesh resolution defines minimum cell size for VorTran-M
- VorTran-M mesh also adaptively coarsens further away from model although any mesh coarsening was well outside computational domain of interest
- Cases plotted:
  - S1 – DS\_VTM = 2.0
  - S4 – DS\_VTM = 4.0

- VorTran-M time step size was also reduced in conjunction with mesh size to maintain numerical stability
- Smaller values of DS\_VTM were not able to be run as part of sensitivity study
- Production calculations used DS\_VTM = 2.0

#### ModelDetailSensitivity

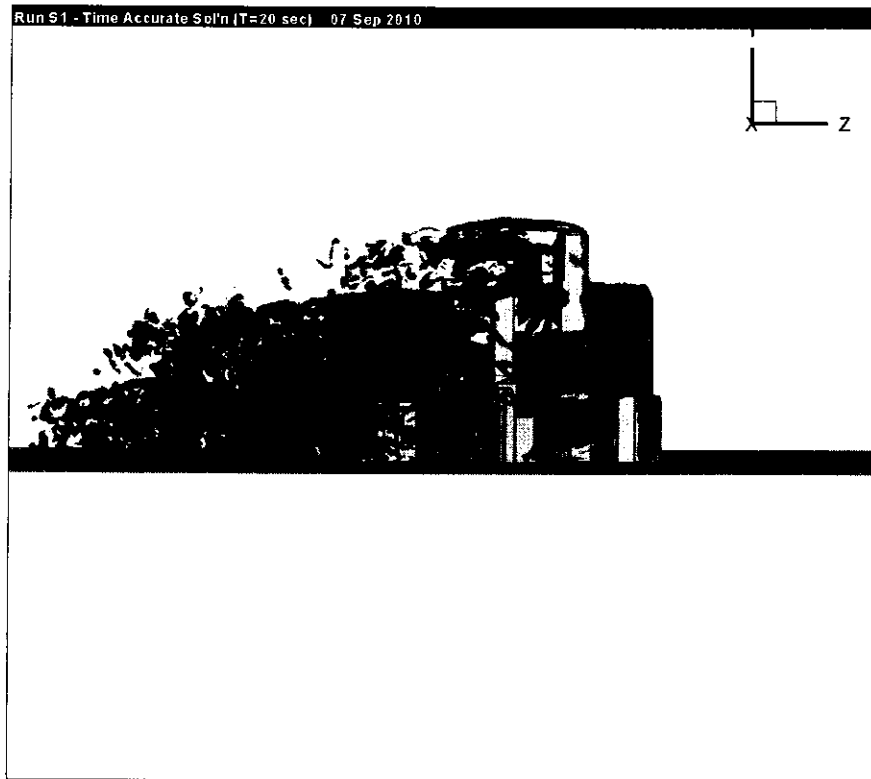
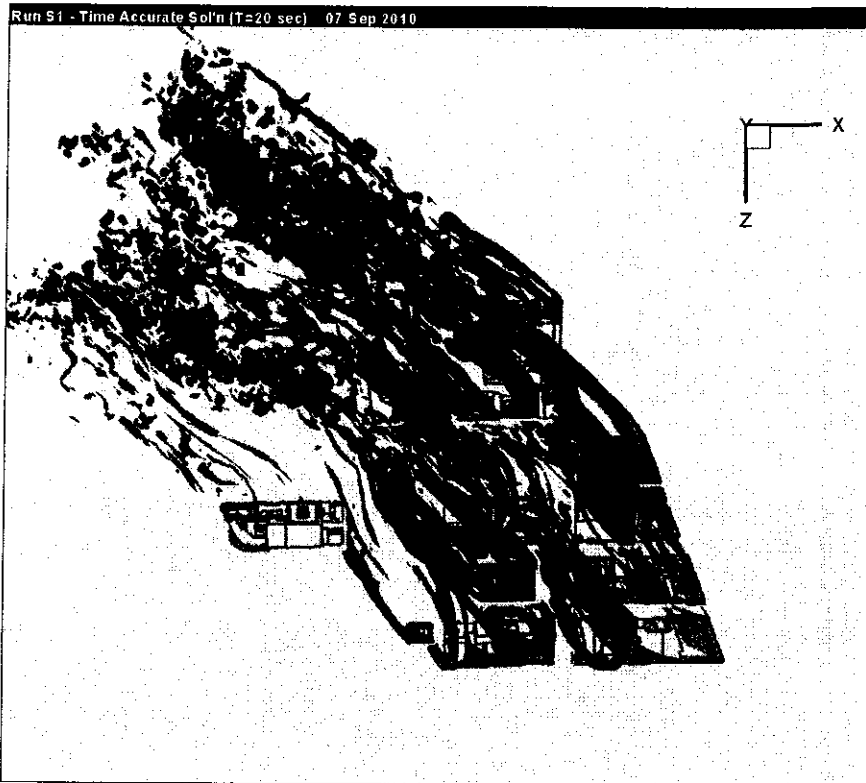
- One calculation (S3A) was performed with “short buildings” added to the model; all other sensitivity calculations were performed with short buildings removed
- Cases plotted:
  - S1A – without short buildings
  - S3A – with short buildings
- Production calculations included all buildings in model

#### EBLCodeVerification

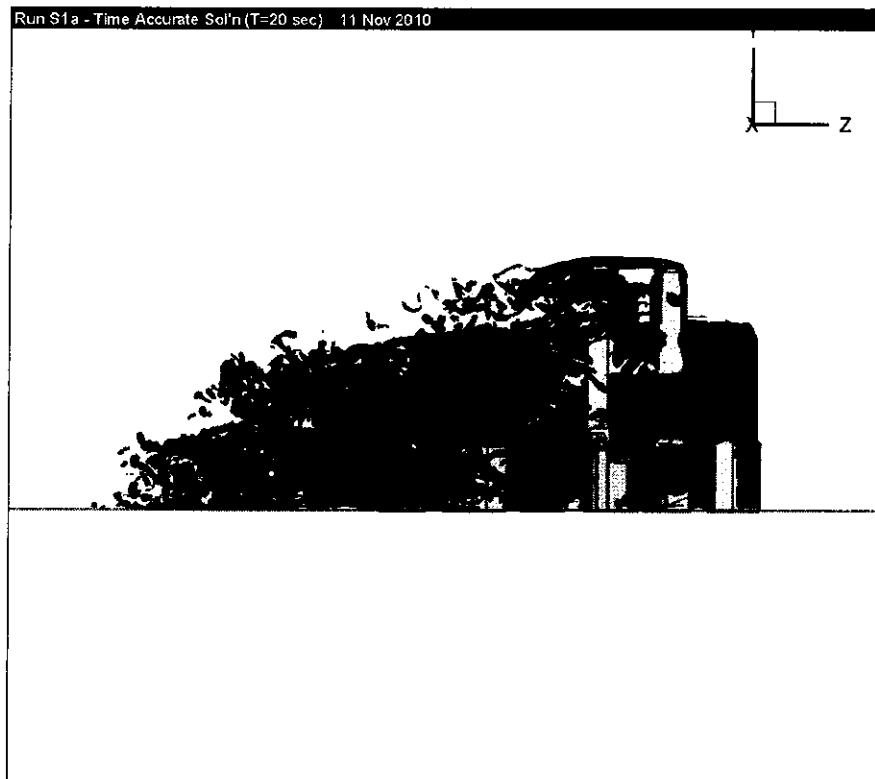
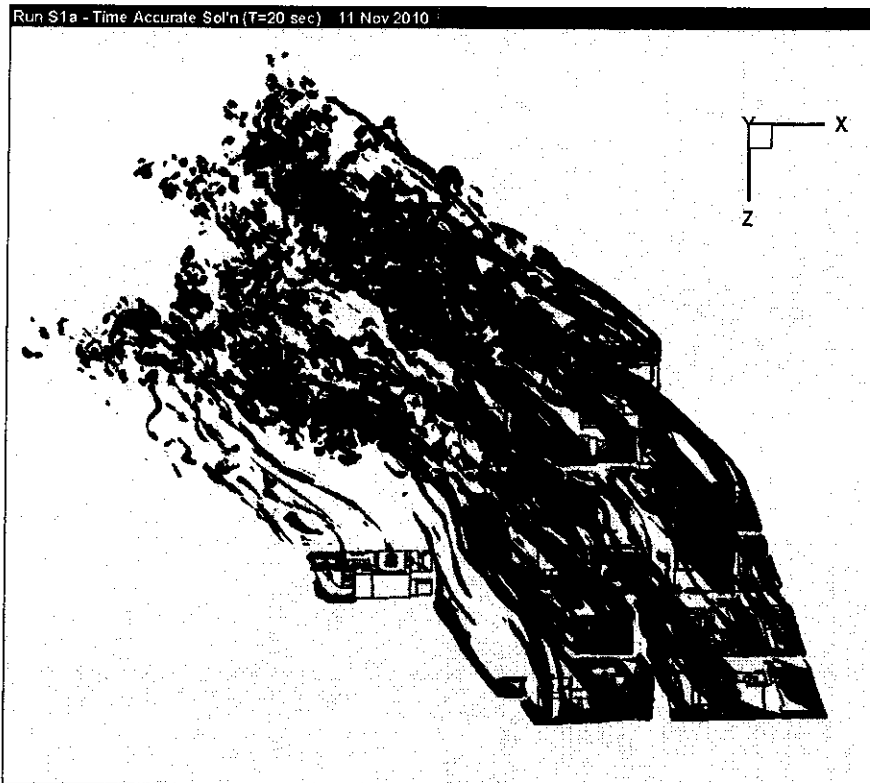
- The baseline CGE/VorTran-M model was modified to include a non-uniform upwind boundary condition to represent the earth boundary layer (EBL)
- Calculations were performed to verify that EBL model change did not affect results when upwind boundary condition was uniform
- Cases plotted:
  - S1 – baseline CGE/VorTran-M code version
  - S1A – modified CGE/VorTran-M code with EBL model
- Production calculations used EBL version with boundary layer model(s) as described in final report

Representative results illustrating qualitative changes in vorticity isosurfaces due to mesh coarsening are shown on the following pages.

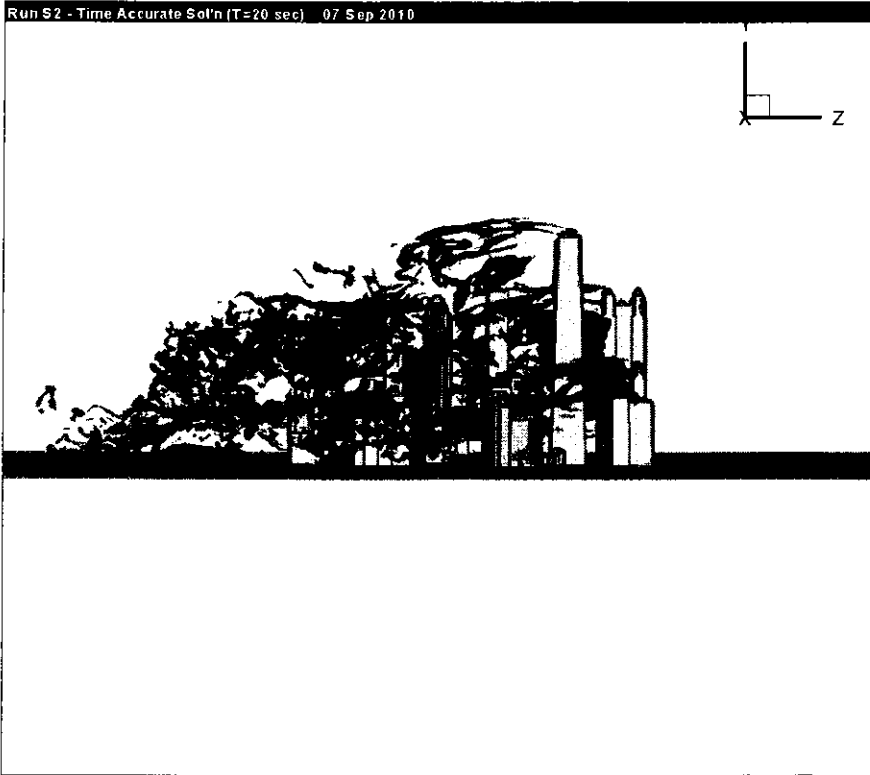
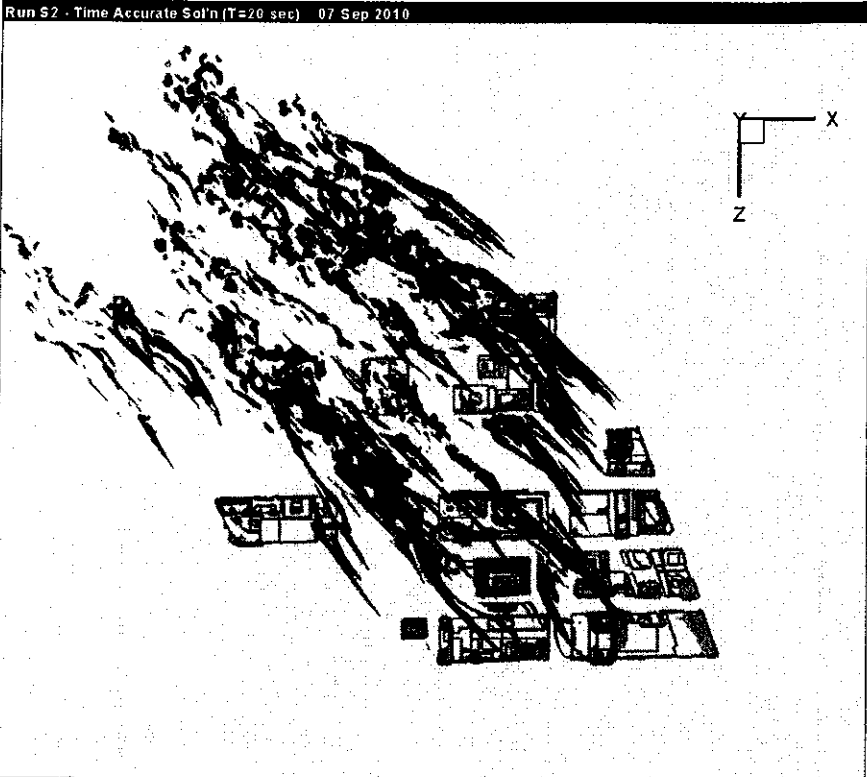
# Case S1 – Baseline Model/Computational Mesh



# Case S1a – Baseline Model/Computational Mesh (Using EBL Model)



# Case S2 – Coarsened CGE Computational Mesh



# Case S4 -- Coarsened VTM Computational Mesh

