

# CFD Analysis

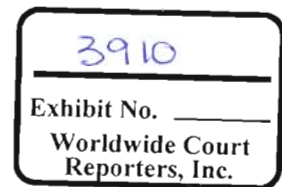
Horizon BOP Stack Top Flow (Oil-Gas Flow)

**PN 2361049**

**For: BP Exploration**

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Harbi Pordal, Ph.D  
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Taking on your toughest technical problems



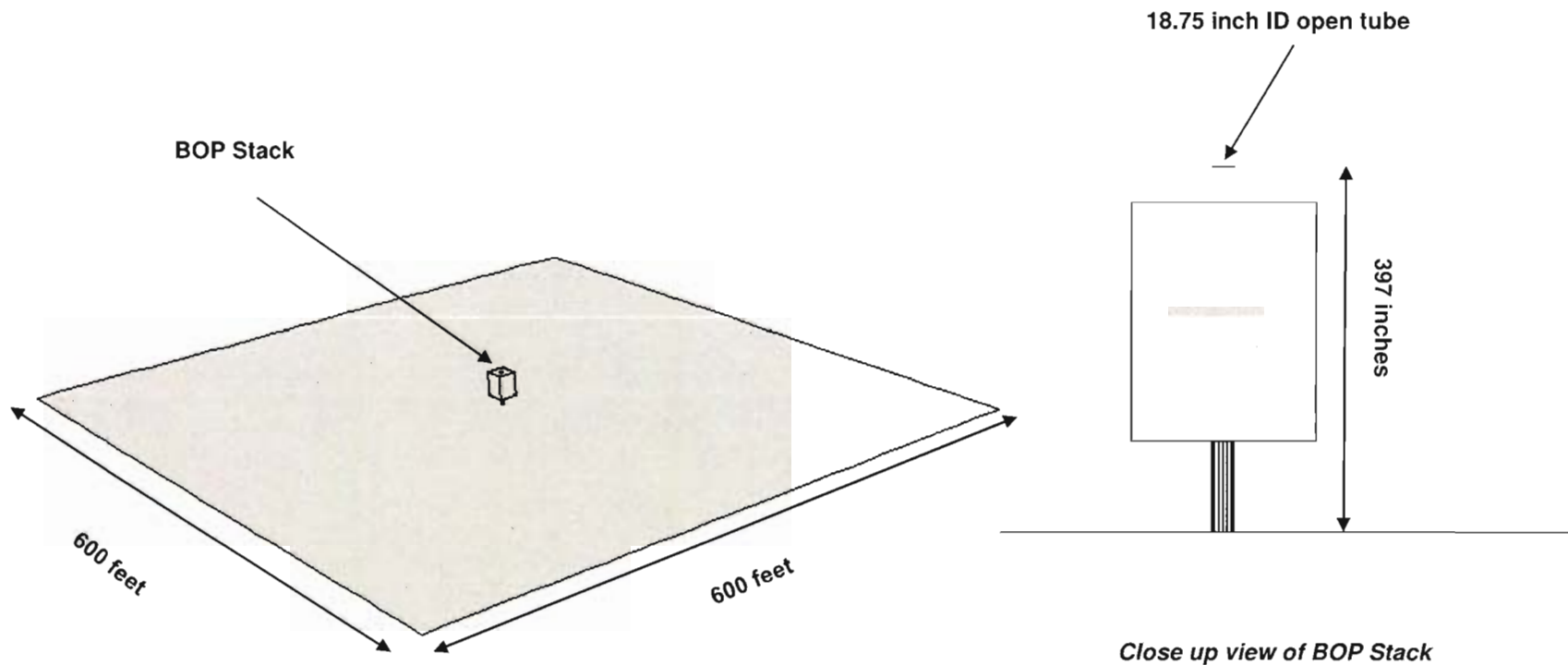
an employee-owned company

# Overview

- Analysis method
- Presentation of results
- Conclusions

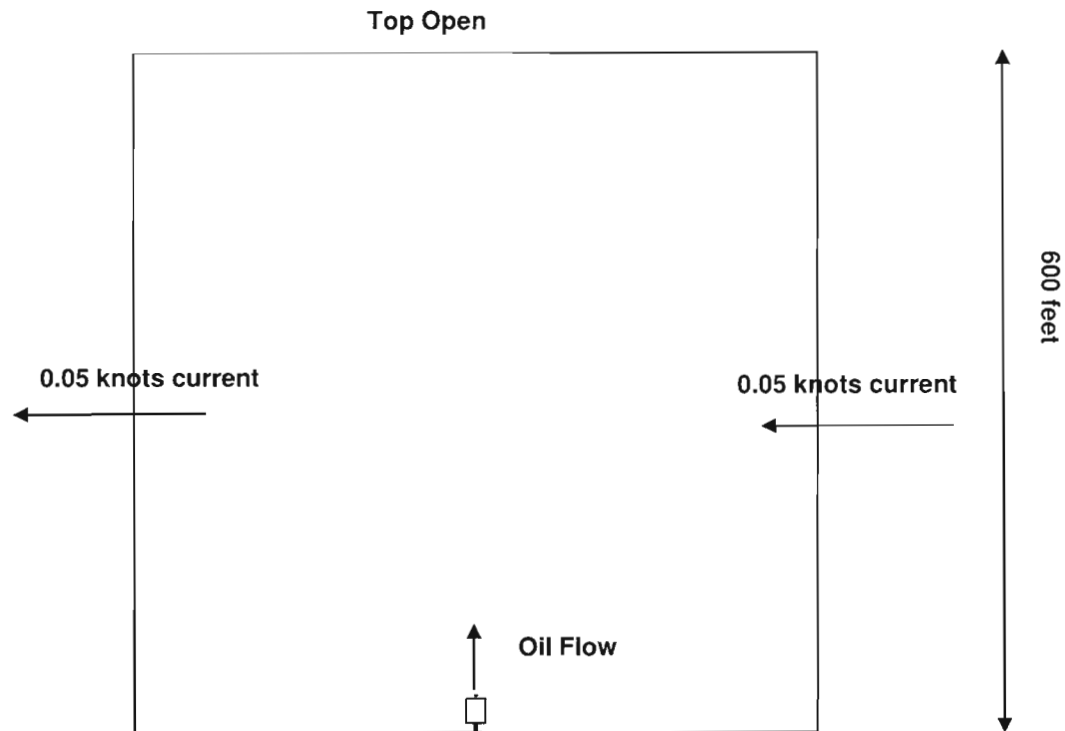
# Analysis Method

- Model Geometry: A 3-dimensional flow model of the BOP stack with the top connector open is constructed.



# Analysis Method

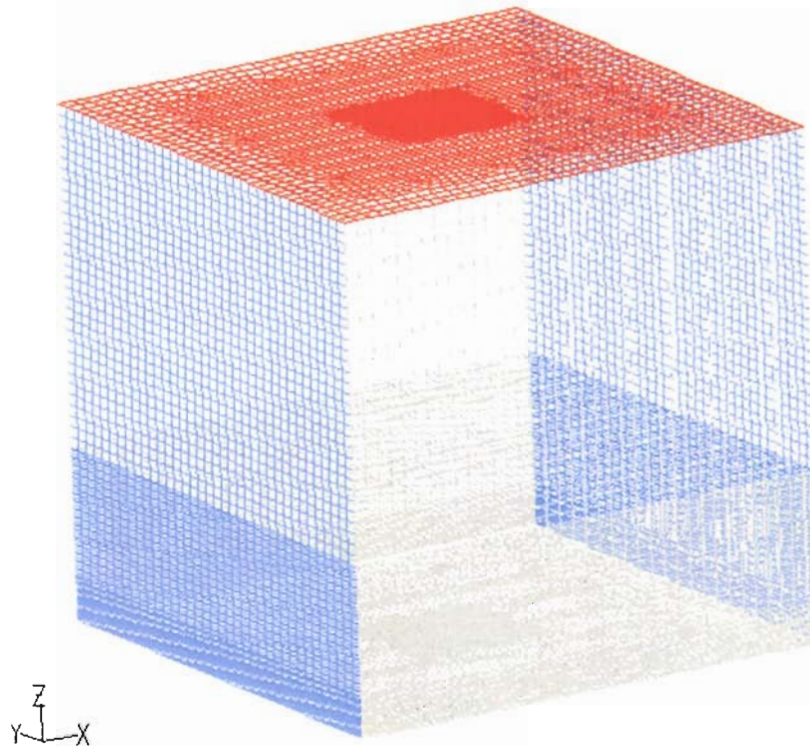
- Boundary Conditions





# Analysis Method

- CFD Mesh – total mesh size of ~1.3 million elements



# Analysis Method

- Fluid properties:
  - Oil Properties
    - Density =  $720 \text{ kg/m}^3$
    - Viscosity =  $2.03 \text{ cP}$
  - Sea Water Properties
    - Density =  $1027 \text{ kg/m}^3$
    - Viscosity =  $0.001 \text{ kg/m-s}$
  - Gas Properties
    - Density =  $109.1 \text{ kg/m}^3$
    - Viscosity =  $1.7\text{e-}5 \text{ kg/m-s}$

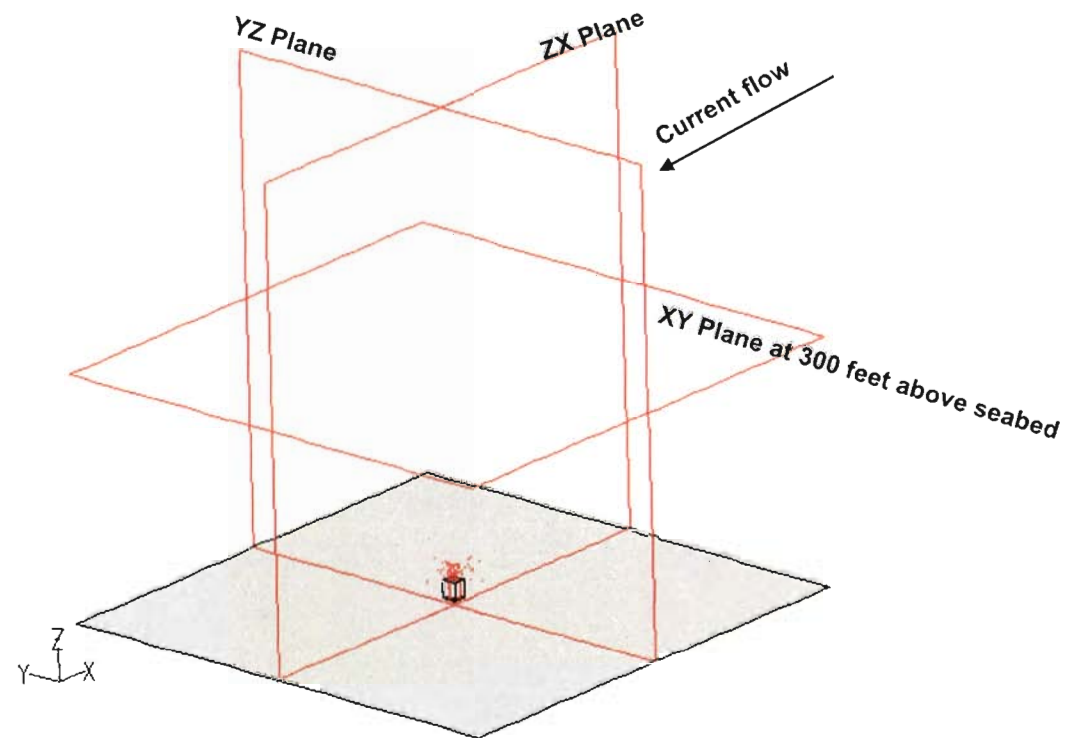
Oil flow rate: 69,500 bpd (92.16 Kg/s)

Gas flow rate: 70 mmSCF/day (22.15 Kg/s). The gas is modeled as a dispersed fluid with a mean bubble diameter of 1 cm. Gas volume fraction at inflow boundary is 0.61

- Multi-phase, turbulent flow analysis is conducted

# Results

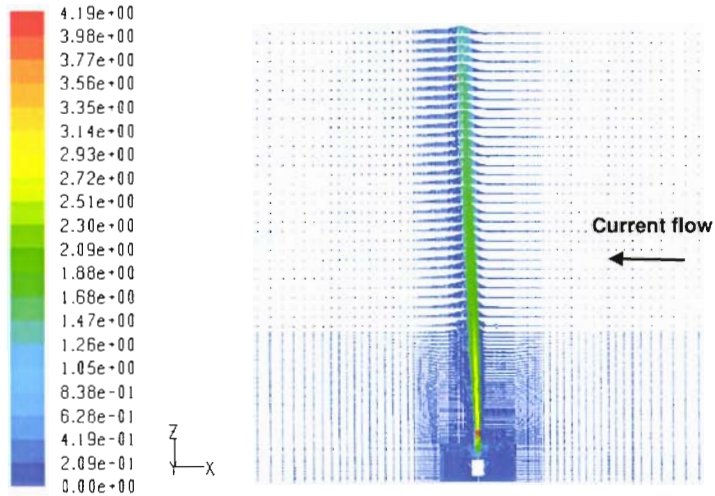
- Results are shown on two vertical planes



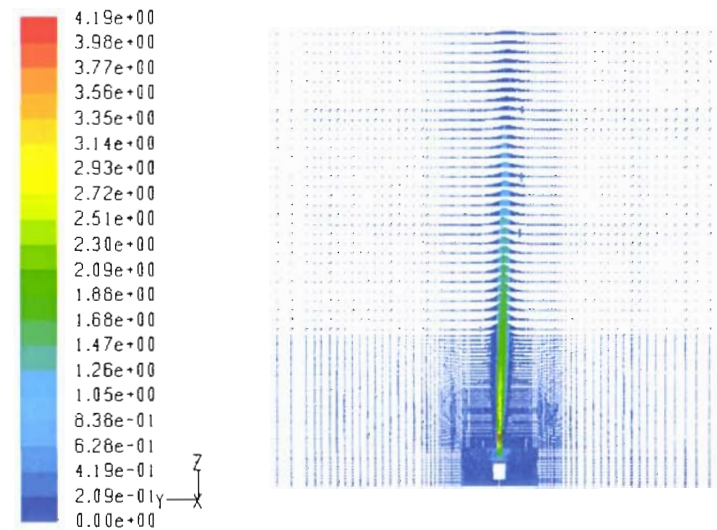
# Results

Gas velocity vectors (m/s) on vertical planes

ZX Plane



YZ Plane

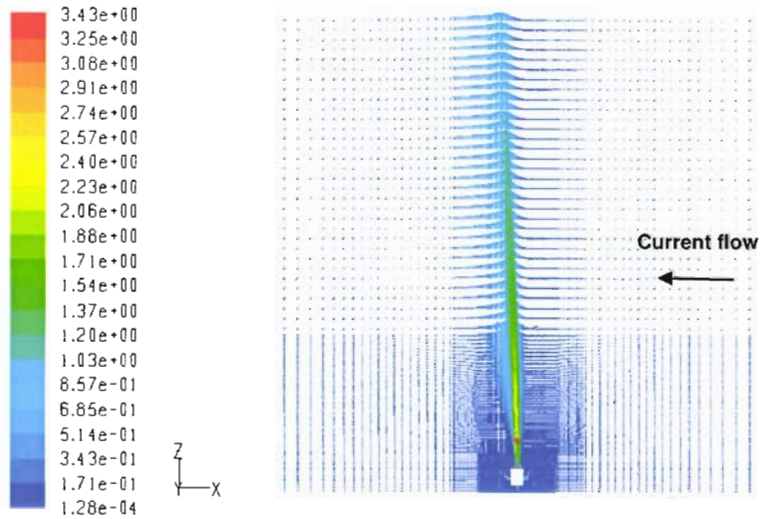




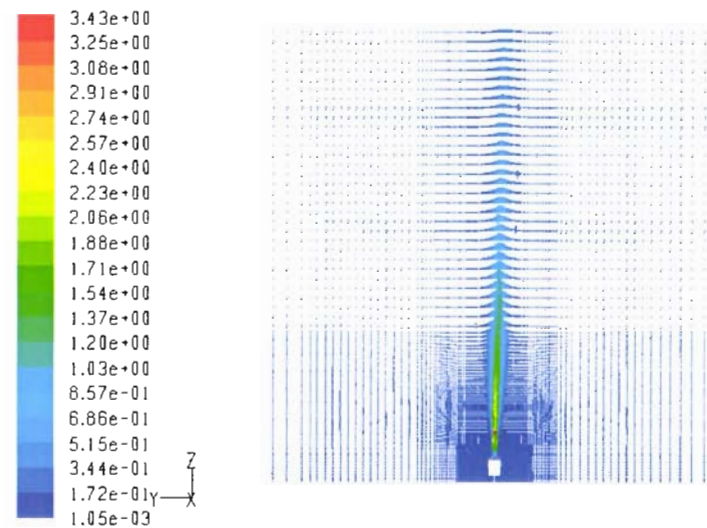
# Results

Oil and water velocity vectors (m/s) on vertical planes

ZX Plane



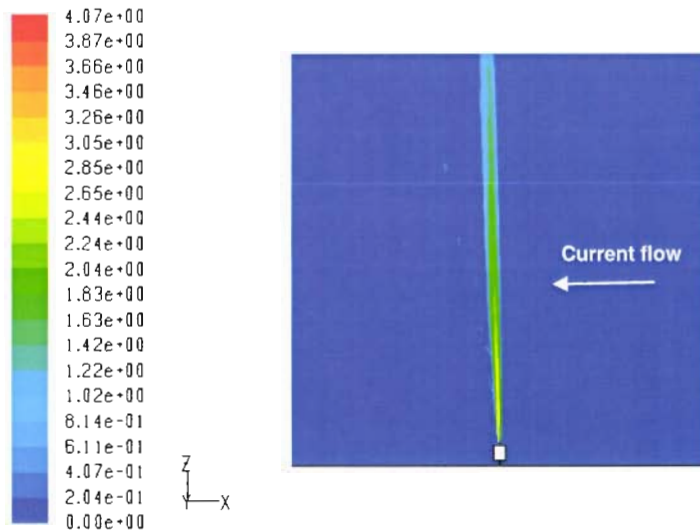
YZ Plane



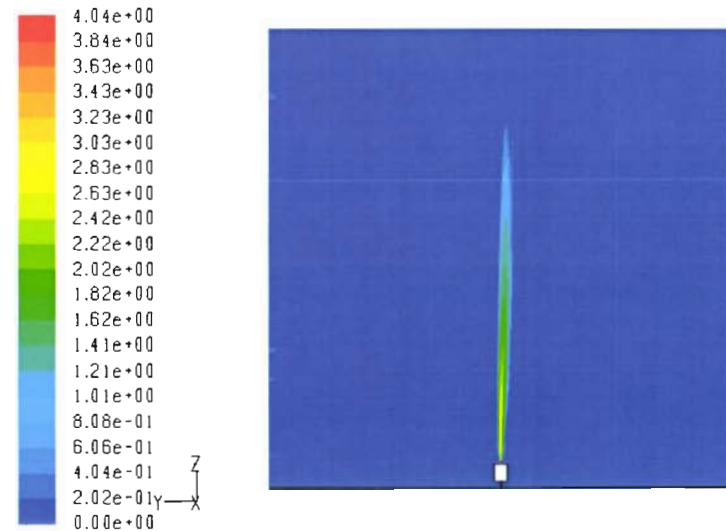
# Results

Gas speed (m/s) contours on vertical planes

ZX Plane



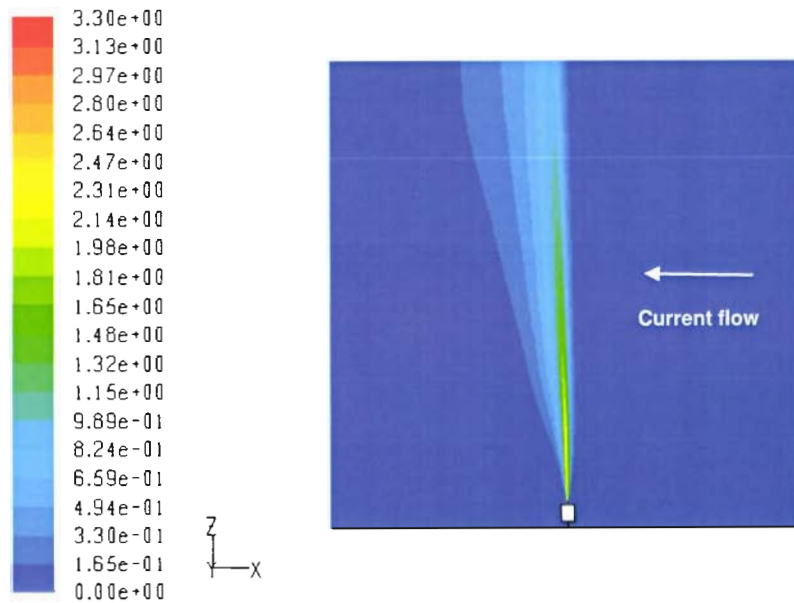
YZ Plane



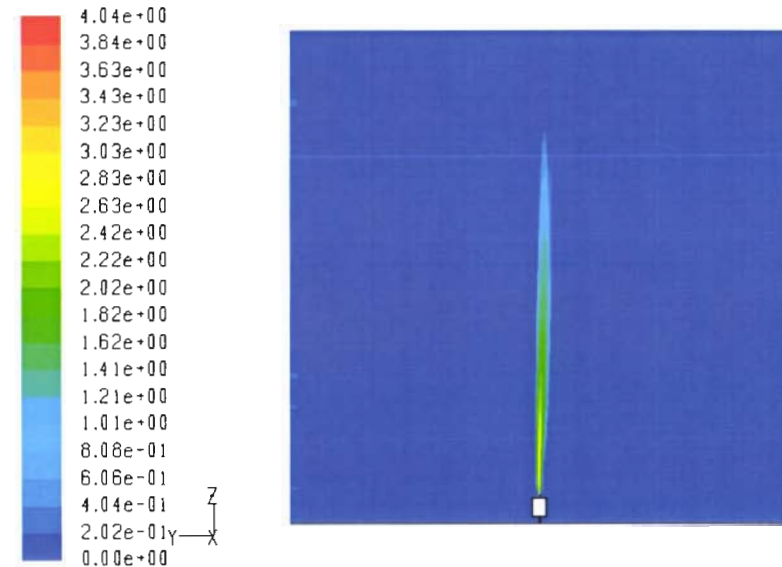
# Results

Oil and water speed (m/s) contours on vertical planes

ZX Plane



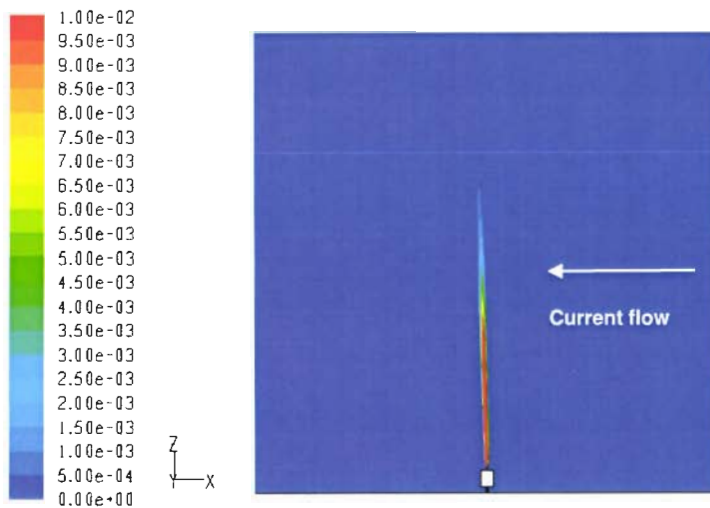
YZ Plane



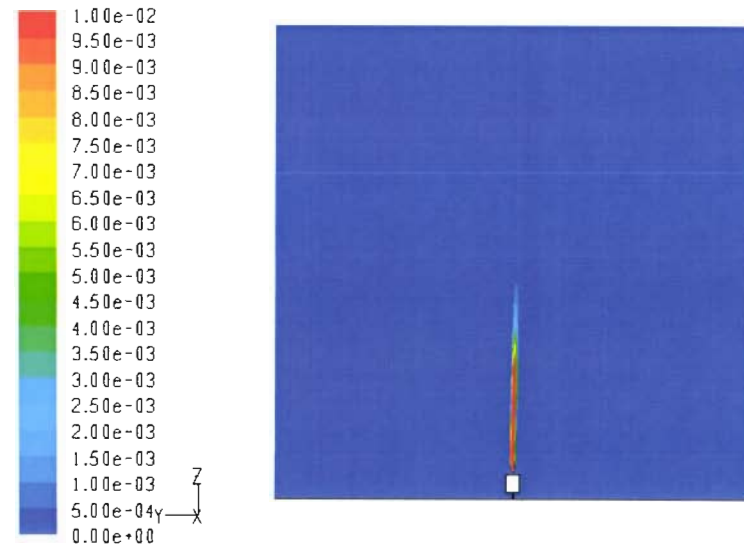
# Results

Gas volume fraction vertical planes (clipped to 0.01)

ZX Plane



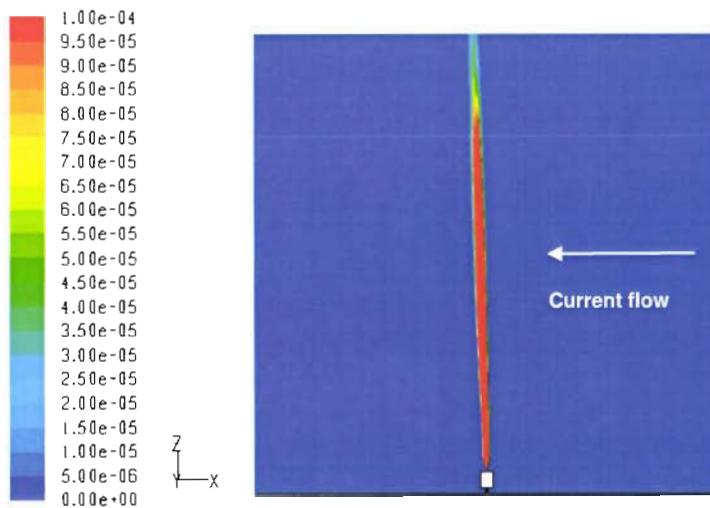
YZ Plane



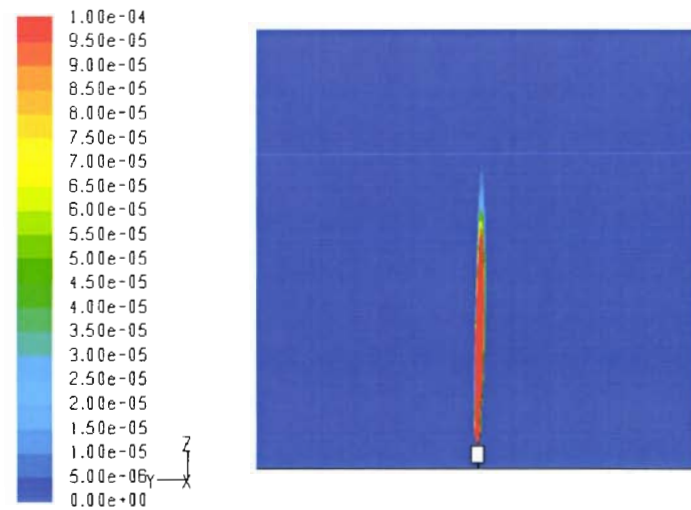
# Results

Gas volume fraction vertical planes (clipped to 0.0001)

ZX Plane



YZ Plane

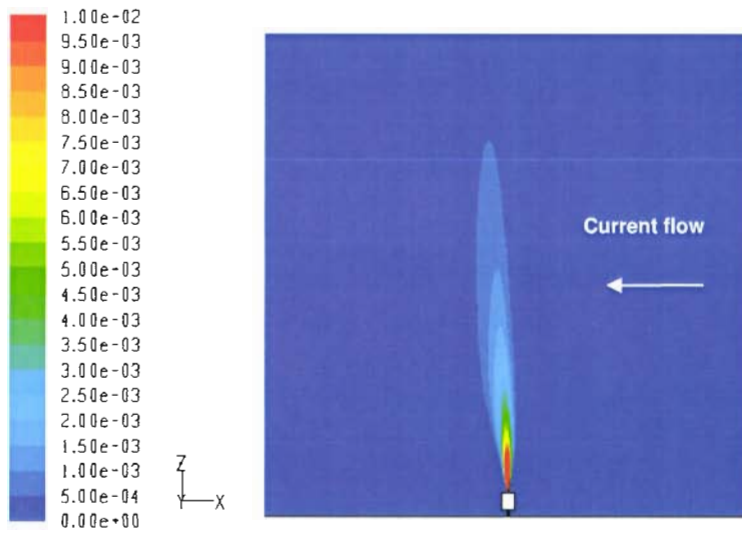




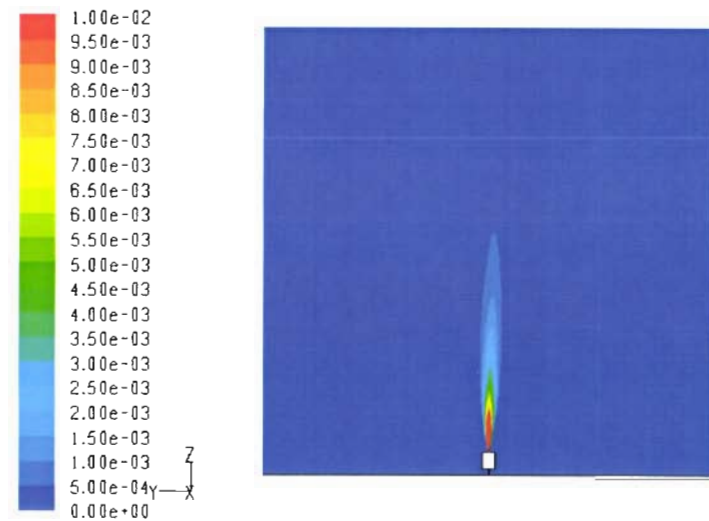
# Results

Oil mass fraction on vertical planes (clipped to 0.01)

ZX Plane



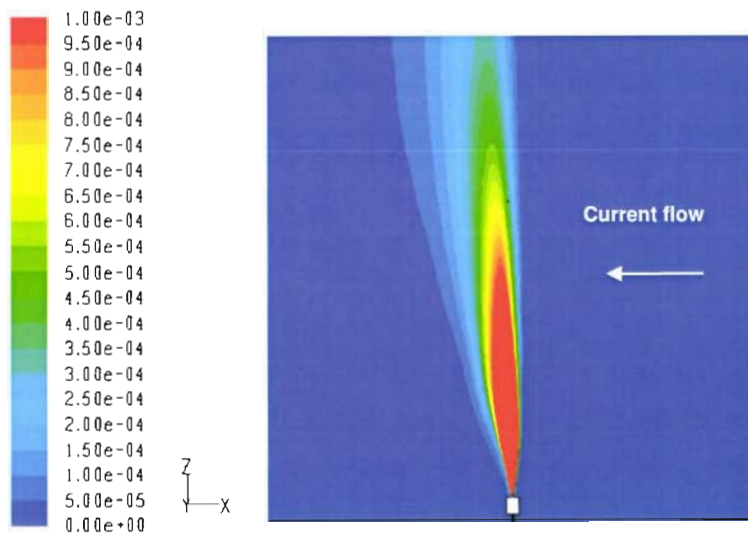
YZ Plane



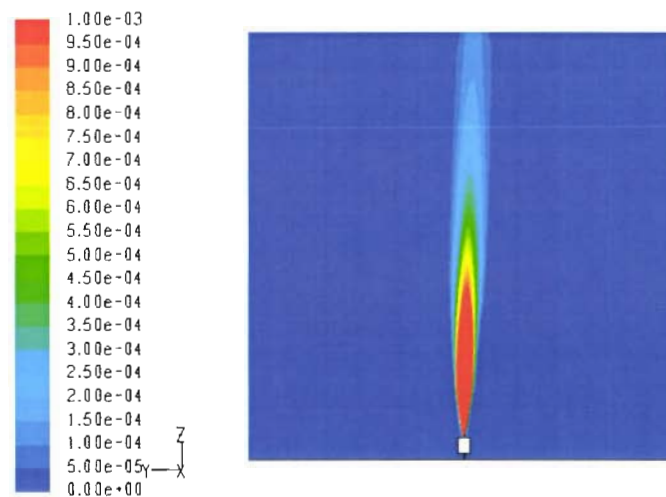
# Results

Oil mass fraction on vertical planes (clipped to 0.001)

ZX Plane

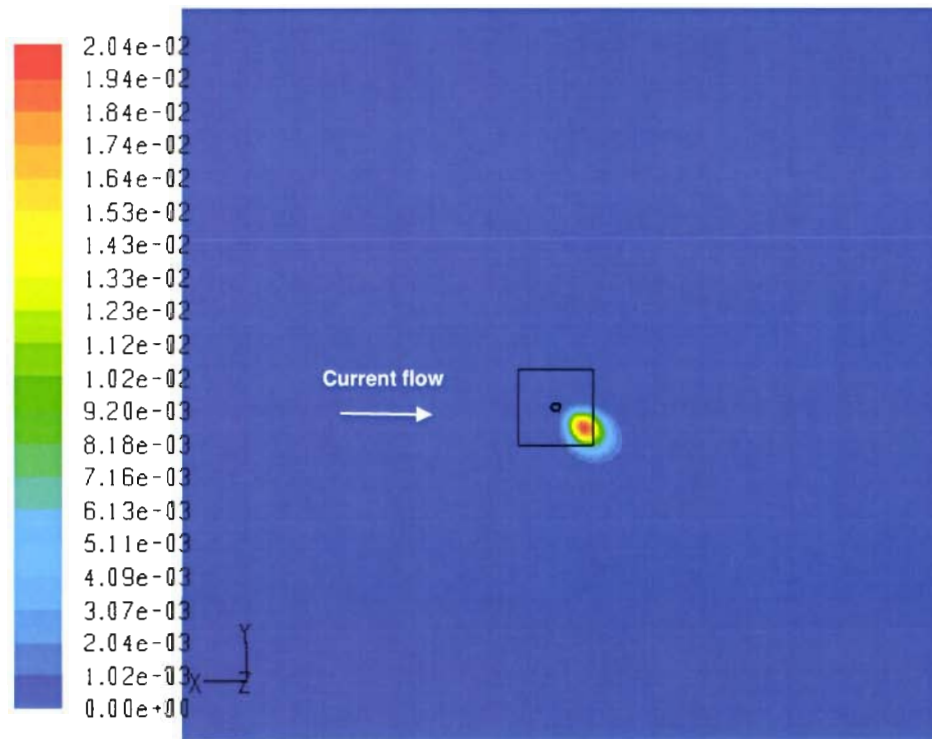


YZ Plane



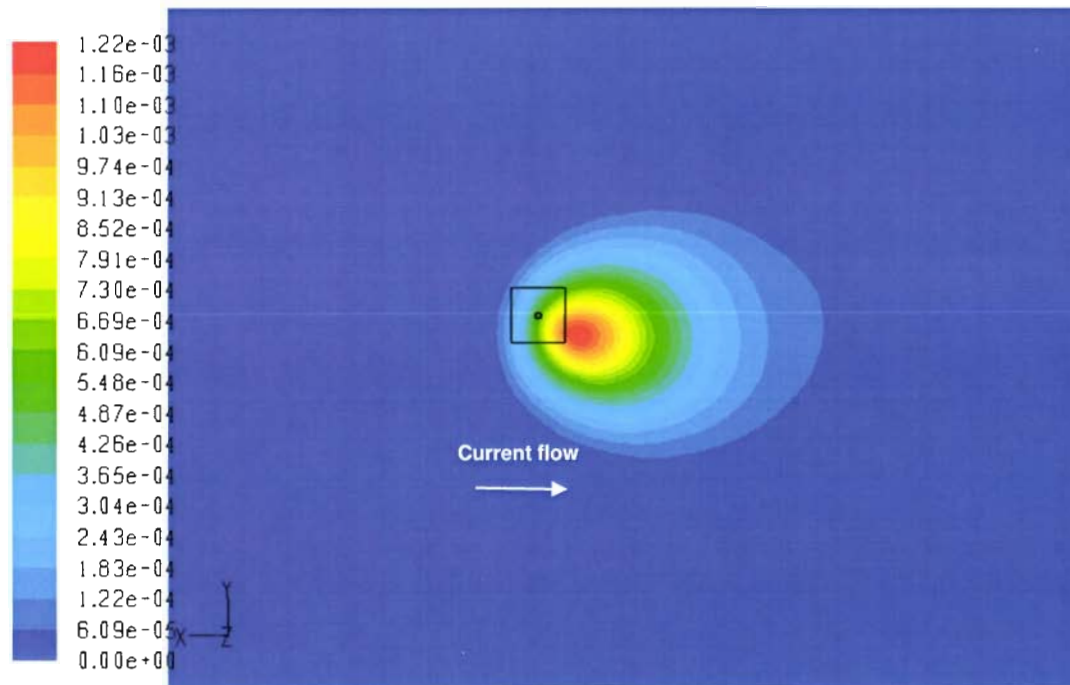
# Results

Gas volume fraction on horizontal plane at 300 ft above seabed



# Results

Gas volume fraction on horizontal plane at 300 ft above seabed



## Conclusions

- The center line of gas plume shifts about 14 feet downstream at 600 feet above seabed in the current direction.
- The center line of oil plume shifts about 32 feet downstream at 600 ft above seabed in the current direction.