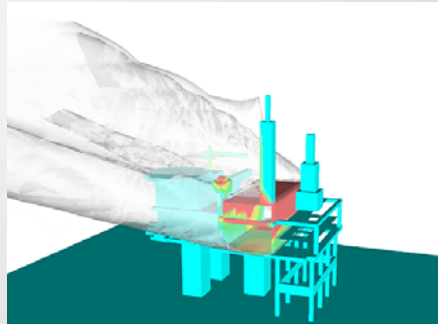

Investigation of Fire Accident in Offshore Industry

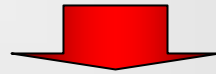
(Presented in Indonesian Petroleum Assoc Meeting 2003)



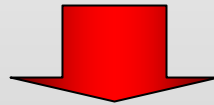
Edi Hamdi, Kashif K Toor, Karim Yacine

Offshore Industry of Oil and Gas :

- Remote Location
- Consists of Congested Structure
Compartments
- Contains Hydrocarbon : Flammable Material



Uncontrolled escape of a combustible
fluid followed by ignition



FIRE ACCIDENT RISK EVALUATION

Fire Risk Assessment:

An approach in a systematic manner in evaluating fire risk associated with a system, in order to pinpoint factors, which contribute to the risk and where risk reducing measures can be implemented in a cost-effective way

Steps:

System Familiarization

Hazard Identification

Cause Analysis: Probability of Occurrence

 Risk Evaluation

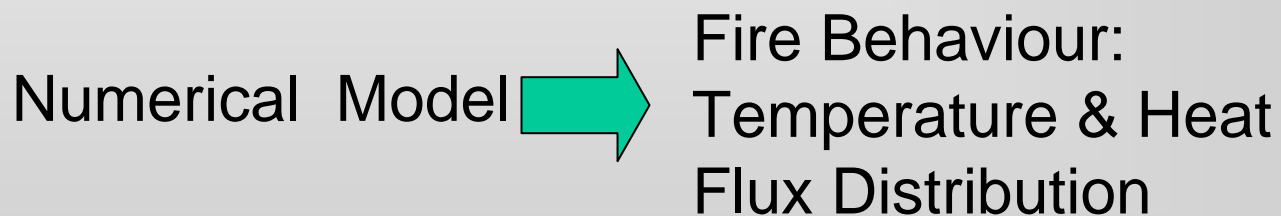
Comparison to Established Acceptance Criteria

Investigation of Fire

Accident

Should be able to predict

- *Ignition and burning rates of fuels*
- *Fire growth and spread*
- *Smoke, toxics products and radiation hazard*
- *Extinguishments*
- *Fire impact on structures*



The Aim of Project:

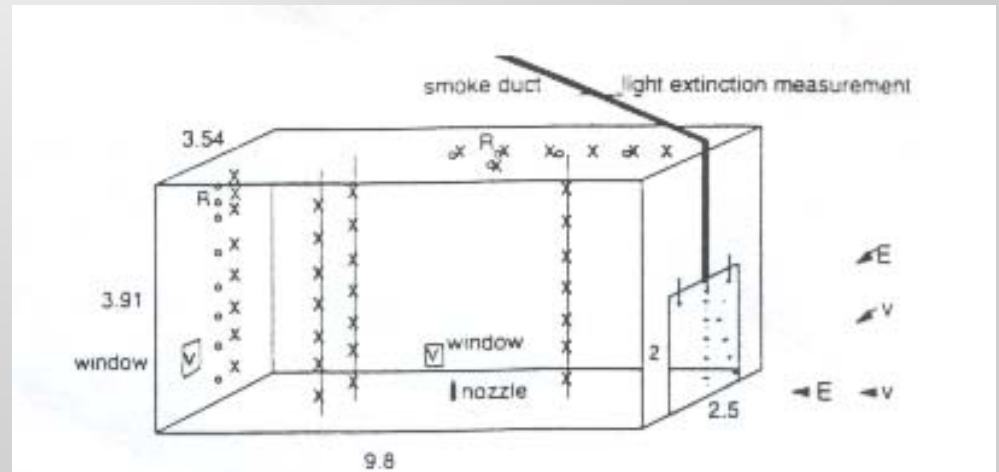
Evaluating risk by modelling accidental load (temperature and heat flux) for different accidental events (compartment fire of full and half opening) in terms of fire behaviour and change in material properties

Numerical Simulation

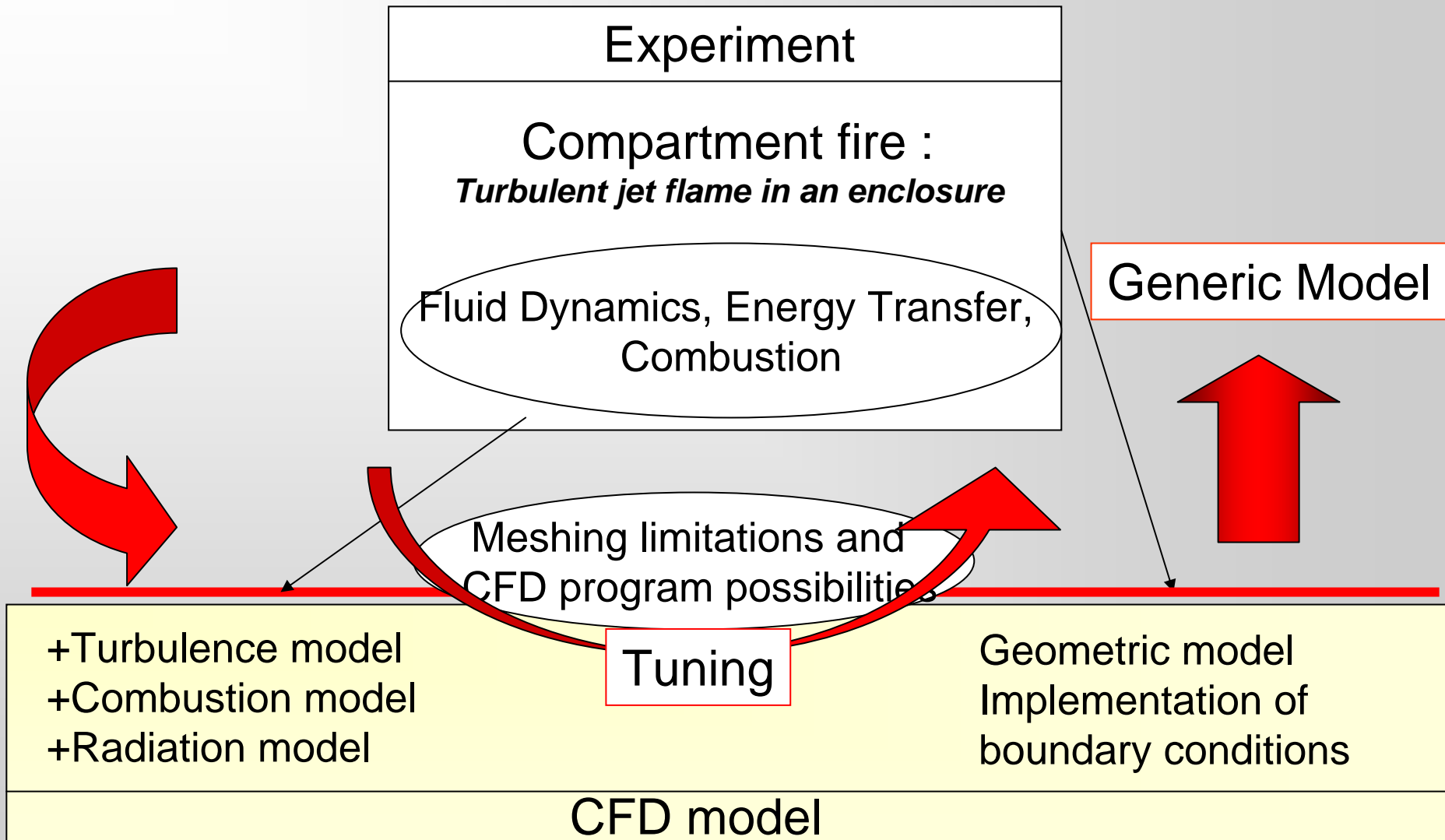
- *CFD Model*
- *Mathematical*
- *Geometrical*

in validation need to compare to:

Experimental Results



Experiment from Chamberlain, SINTEF, 1994



Assumptions :

- *Steady state*
- *Incompressible*
- *2D Model*
- *Very fast chemical reaction of combustion*
- *Simple radiation model*
- *Jet Fire -> Zero Inertia & Highly Turbulent*

The Turbulence controlled the flow motion and transport of energy and combustion

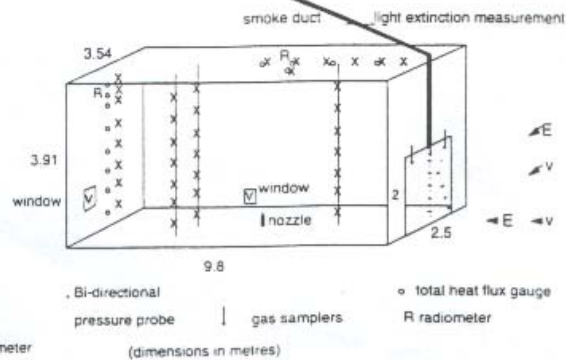
$$\frac{\partial \rho \bar{\Phi}}{\partial t} + \frac{\partial (\rho u_i \bar{\Phi})}{\partial x_i} = \frac{\partial}{\partial x_i} \left(\Gamma_{\Phi} \frac{\partial \bar{\Phi}}{\partial x_i} \right) - \frac{\partial (\rho u_i' \bar{\Phi}')}{\partial x_i} + \bar{S}'_{\Phi}$$

Unsteady

Diffusion

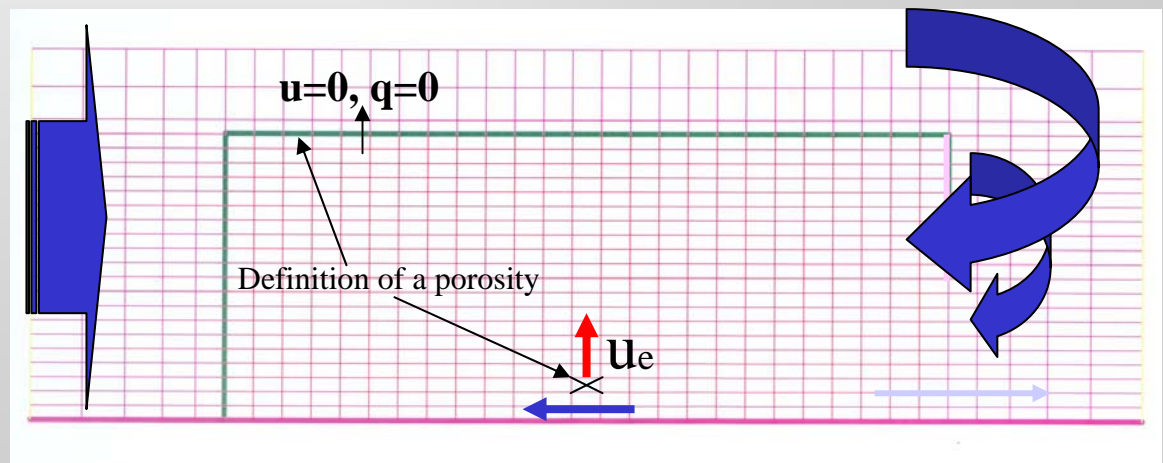
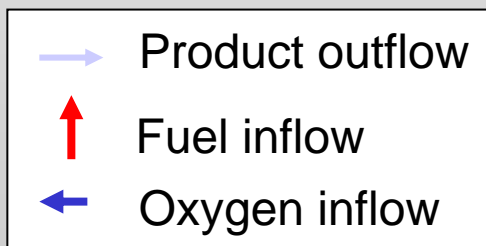
Convection

Modelling approach : geometry and implementation of boundary conditions



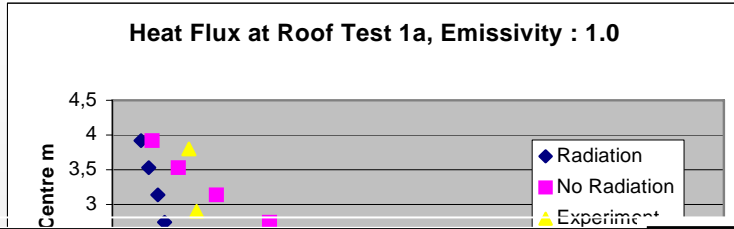
- Turbulence Model: Eddy Viscosity
- Combustion Model: SCRS, infinitely fast
- Radiation Model: Composite Flux

- ✓ Half opening case : ventilation controlled
- ✓ Full opening case : fuel controlled

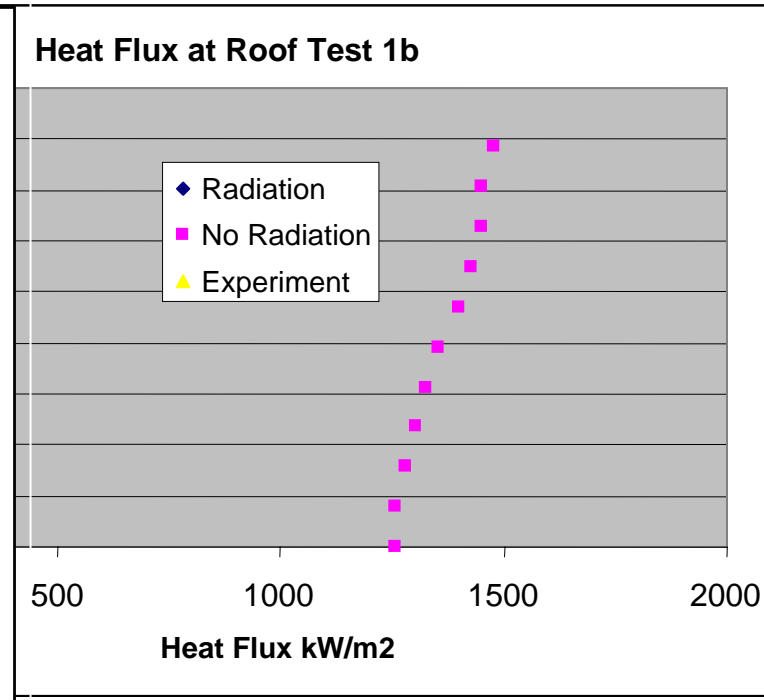
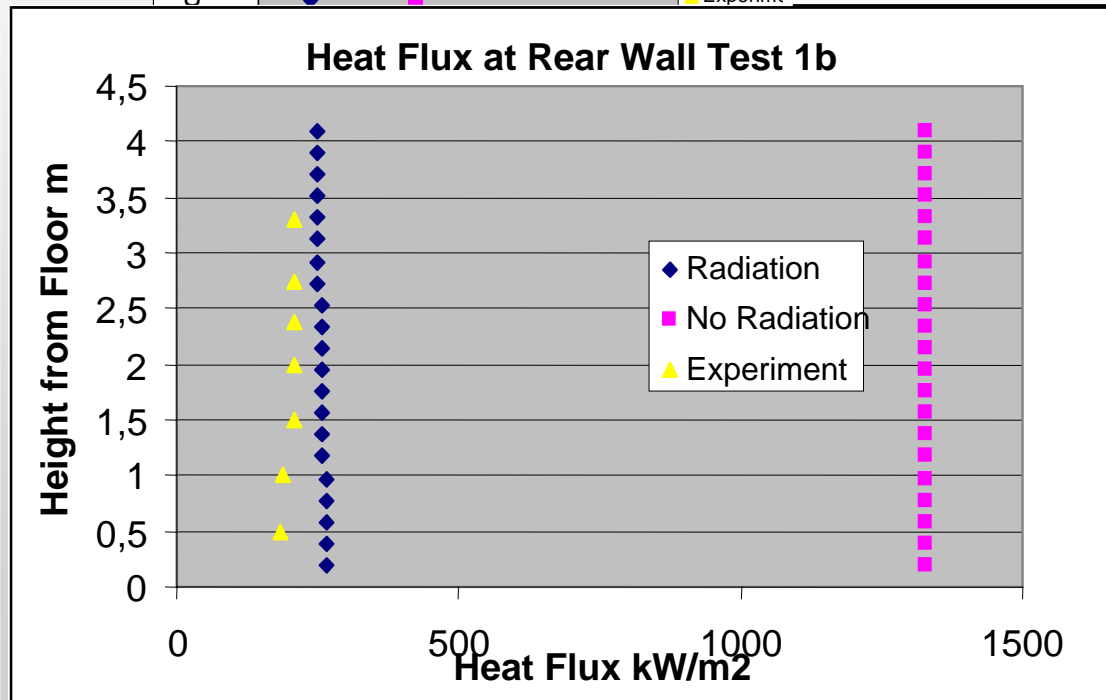
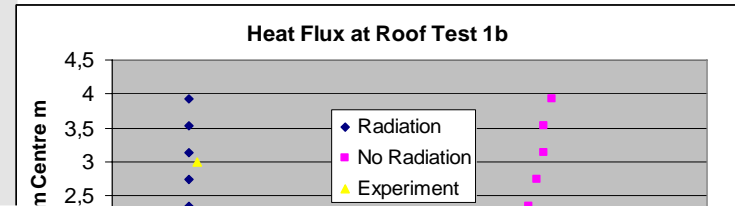


Results and discussion : heat transfer

Full opening case

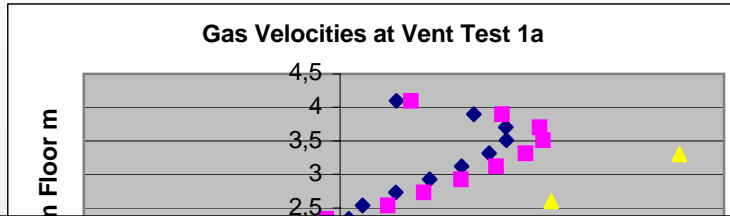


Half opening case

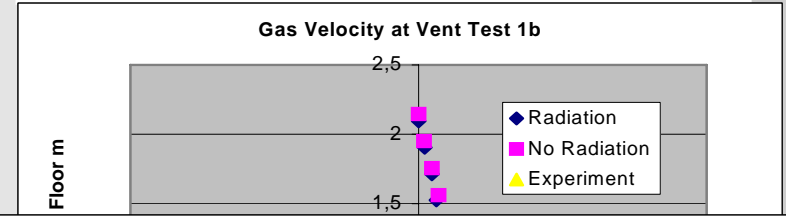


Results and discussion : Vent results

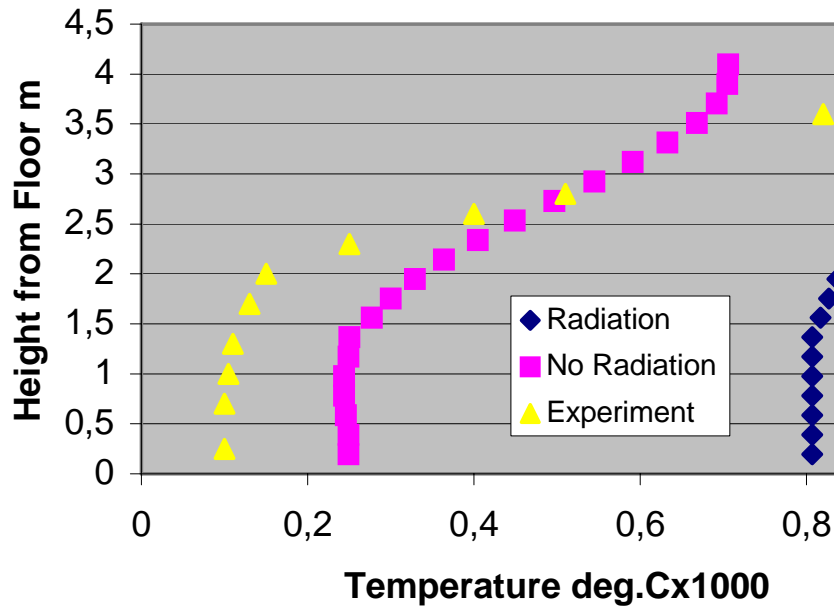
Full opening case



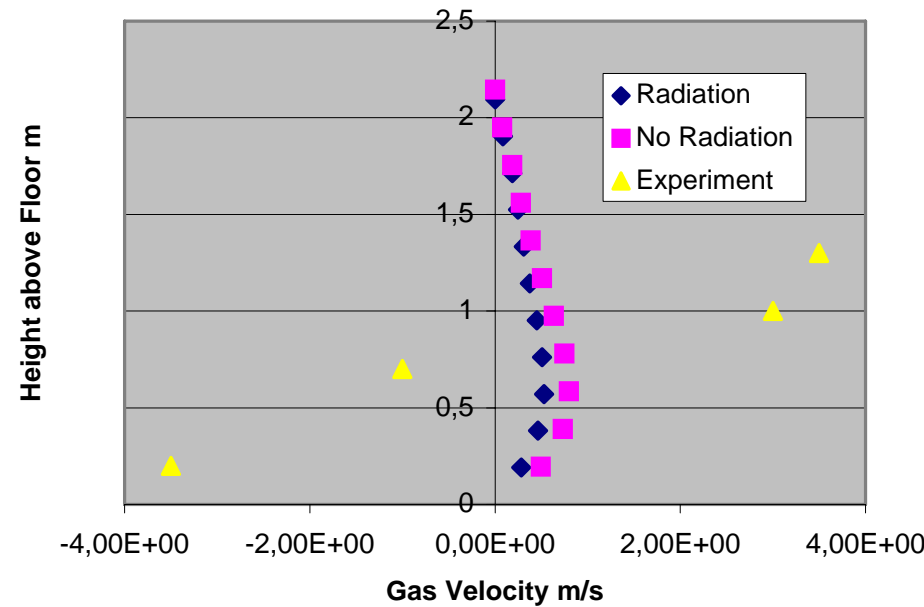
Half opening case



Temperature at Vent Test 1a



Gas Velocity at Vent Test 1b



Important feature of turbulent diffusion jet flame

Mixing controlled

Steady state

The Turbulence controlled the flow motion and transport of energy and combustion

Enclosure

Geometric model

Model based on the theory and semi empirical equation for an axisymmetric isotherm turbulent jet

Numerical Simulation by CFD in 2D shows:

- *General trend agreement exist*
- *Limitation of 2D Model*
- *Radiation Model Improve The Accuracy*
- *General Behavior of the Model*

Marching Towards Accuracy And Efficiency

- *3-D System*
- *Consideration Compressible Flow*
- *Improved Turbulence Model*
 - ➔ **Using k- ϵ model**
 - ➔ **Implementation of wall function**
- *Refined Grid Resolution*

Computational Fluid Dynamics as a numerical approach for Fire in Offshore Study has been developed