

SIG45: DNV AND CFD

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Outline

- Det Norske Veritas (DNV)
- DNV Maritime and Oil & Gas
- CFD and hydrodynamics at DNV
- CFD and Hydrodynamics challenges
- Response Surfaces: Fire & Explosion Risk Analyses
- Uncertainty Quantification
- Cross disciplinary learning

Det Norske Veritas (DNV)

- DNV is an independent foundation with the purpose of **safeguarding life, property, and the environment.**
- DNV's core competence is to manage risks:
 - Identify, assess, and advise on how to manage risk.
 - Have an overview of the most critical risks and manage them professionally
- We have divided our activities into three operating companies
 - DNV Maritime and Oil & Gas*
 - DNV KEMA Energy & Sustainability*
 - DNV Business Assurance*



DNV has established approximately 300 offices in 100 countries, with more than 10,000 employees. Corporate Headquarters in Oslo, Norway



DNV Maritime and Oil & Gas

- DNV Maritime and Oil & Gas provides classification, verification, risk management and technical advisory services to the global maritime and oil & gas industries
- CFD services is core competence in several sections
 - Safety Risk Management (Offshore)
 - E.g. Fire and Explosion modelling
 - Ship Hydrodynamics and Stability (Maritime)
 - Hydrodynamics & Moorings (Offshore)



VINNERBILDET: «Uvær på Frigg».
Foto: Ingmar Bø

CFD and Hydrodynamics at DNV

■ SHE Risk Management

- Fire CFD modelling
- Explosion CFD modelling
- Helideck analysis
- Working environment

■ Simulation of marine operations

■ Wave and current loads on

- Ships and offshore platforms
- Mooring systems
- Risers and umbilicals
- Pipelines
- Subsea structures

■ Typical problem areas:

- Fire and Explosion DAL loads
- Offshore escape and evacuation (major event)
- Weather protection requirements

- Sloshing in tanks
- Operational limits for Lifeboats
- Hull design optimisation (fuel costs optimisation)

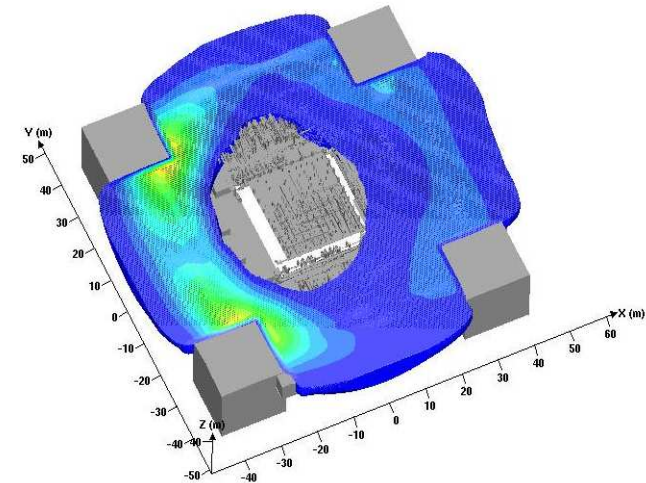
- Hydrodynamic interactions
- Wave slamming
- Wave run-up
- Wave-in-deck loads
- Vortex induced oscillations

CFD and Hydrodynamics challenges

- Fire and Explosion safety of novel offshore designs (safety risks)
 - FLNG and Cryogenic safety risk
 - Aging of offshore platforms
 - Helideck safety
 - Uncertainty quantification
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- Extreme wave excitation of offshore structures
 - Air gap / wave run-up for floating platforms
 - 3D slamming and ventilated flows (free-fall lifeboats)
 - Hydrodynamics for wave and tidal energy
 - Simulation of marine operations
 - Disturbed random wave kinematics
 - Fuel optimisation of vessels

Response Surfaces: Fire & Explosion Risk Analyses

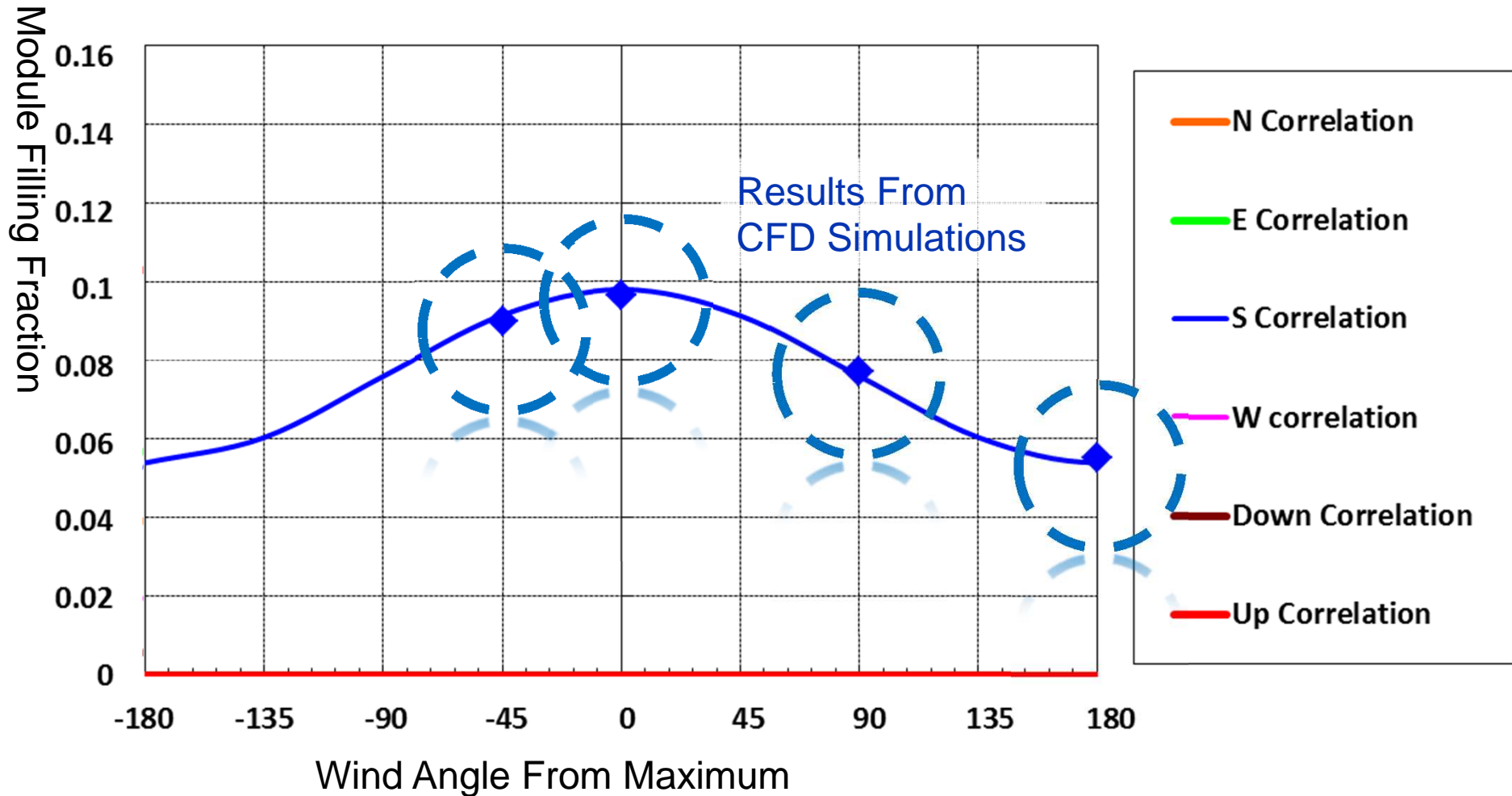
- Approaches used at DNV
 - DNV's Fire & Explosion group (SHE Risk Management) uses Response Surfaces (or simplified models fitted to CFD) to calculate Fire&Explosion Dimensioning Accidental Loads (design input).
 - The simplified models allow for quick Montecarlo analyses (1E4, 1E5 simulations) to provide probabilistic explosion and fire design values.



Explosion wave

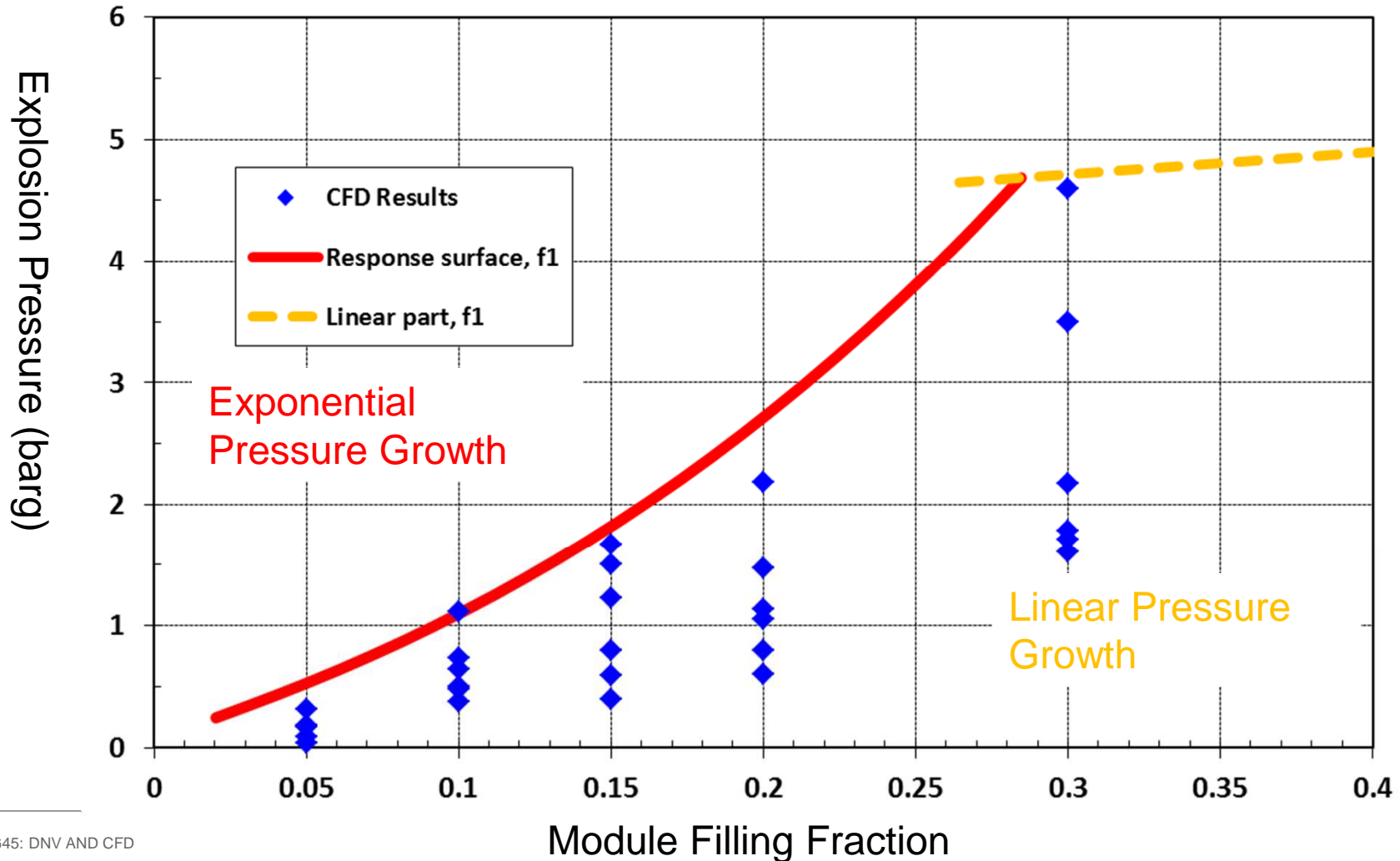
Dispersion RS: Maximum Steady State Cloud Size

- Variation of Maximum Filling Fraction with Leak direction and wind direction



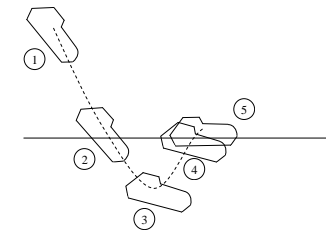
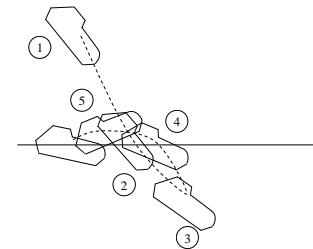
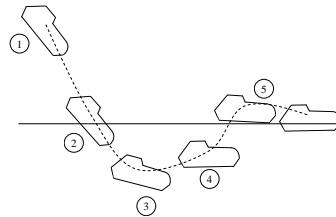
Explosion RS: Maximum Explosion Pressure Curve

- Variation of Explosion Pressure with Filling Fraction



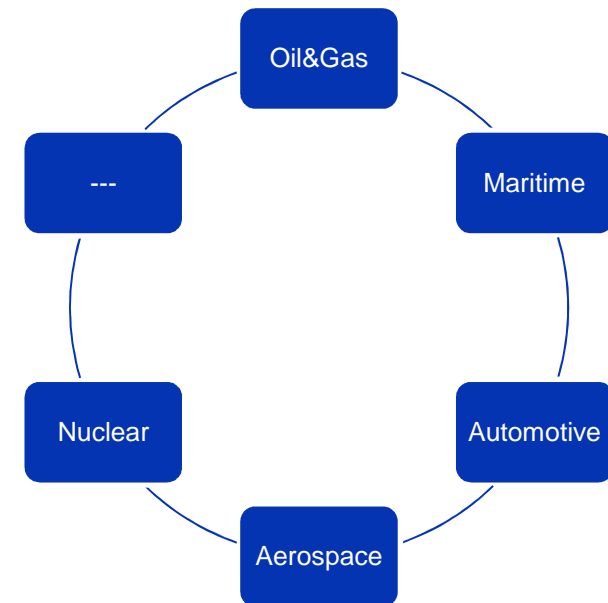
Uncertainty Quantification.

- Uncertainty for Escape and Evacuation: Fire modelling
 - Escape routes impairment : CFD Fire modelling and Risk of impairment (risk picture).
- Uncertainty for Explosion loads:
 - Offshore Concept Selection (pre-FEED, FEED)
 - Uncertainty in the response surfaces (interval of confidence).
 - Note: Currently always assumed on the conservative side
- Uncertainty in wave statistics with high non-linear effects
 - Slamming, green water, sloshing induced impacts
- Free fall lifeboats motion patterns
- ...



Cross disciplinary learning

- Uncertainty management is a challenge for many industrial sectors,
 - Aerospace
 - Automotive
 - Maritime
 - Offshore
 - Nuclear
- Can the different sectors learn from each other something?



- J. Pujol, A Mayer “New Automatic Design Method for Automotive Plastic Parts using Optimisation Techniques with Reduced Models,” *Fisita 2004 World Automotive Congress, Barcelona*
- J. Pujol, C.Jones “Development of a Response Surface Approach for Probabilistic Explosion Modelling for Large FPSOs and FLNG”, 69th FABIG Technical Meeting, March 2012

Safeguarding life, property and the environment

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MANAGING RISK