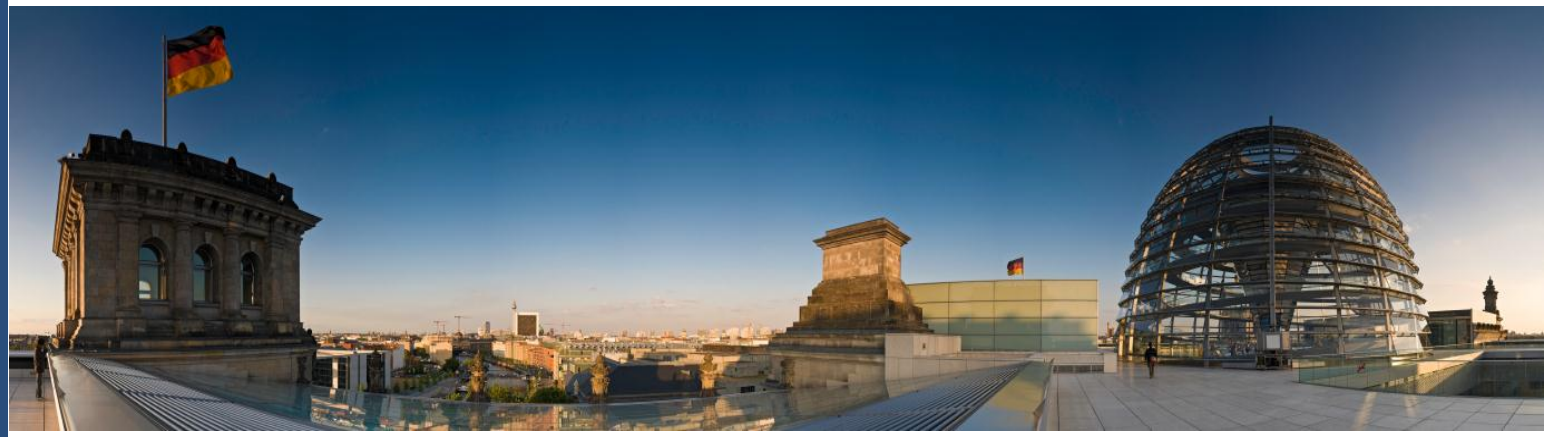
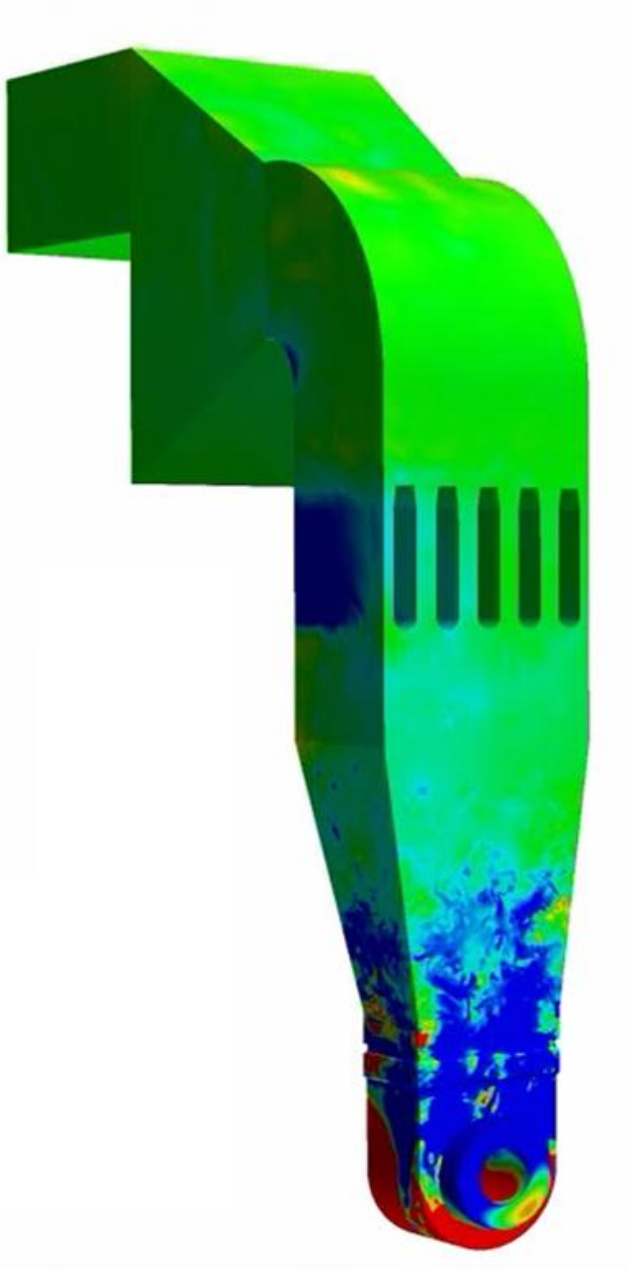
ETN



Exhaust Systems Project

Gary Lock, Frazer Nash Consultancy

Exhaust Systems Working Group

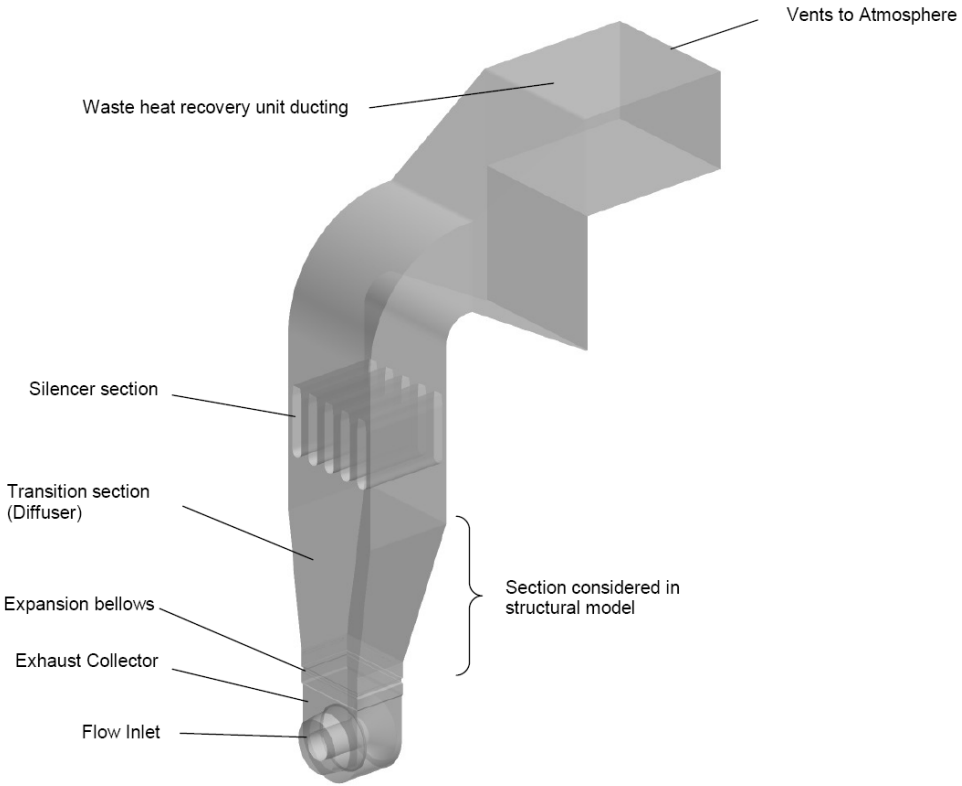


Exhaust Systems Working Group

Meetings since the last ETN meeting - October 2011:

- A teleconference was held on 27 January 2012
- A meeting was held at Statoil (Bergen) on 15 March 2012

• **Contributors**: AAF, Aarding Thermal Acoustics, RWTH Aachen, Boustead International Heaters, Frazer-Nash Consultancy, Kanfa-Tec, Mjørud, Neste Oil, Statoil, TechPart, Total, ETN, Shell, Oxsensis, VBR Turbine Partners, Alstom, Camfil Farr, Dresser-Rand, Tulsa Heaters



Exhaust Systems Working Group

Progress to date:

- A first draft of the standard is being generated by ETN, expected issue for review by end of April 2012
- All sections of the standard have been individually reviewed by working group members

Next steps:

- Review of the first draft document by interested ETN members, with comments to ETN by end-August 2012
- Generate ETN member funding and start measurement trials and benchmark CFD programme, by end-May 2012

Exhaust Systems Working Group

The main developments are:

- Initial focus has been on gas turbine exhaust systems that include WHRUs
- The group has generated a draft ETN standard for use by members
- The ETN standard will be submitted for development into an International Standard (ISO)
- Once the Exhaust Systems with WHRU standard is complete, the group will focus on HRSGs. The aim will be to submit comments for improving the current standard, API-534
- Measurement trials and benchmark CFD programme has been defined, pending funding. The standard requires this validation to ensure that it provides:
  - "Best practice guidelines for CFD modelling of exhuast flows"
  - Validation of different CFD methods, geometric and boundary condition assumptions
  - A set of validation data for evaluating future CFD methods

Exhaust Systems Working Group

Measurement trials and benchmark CFD programme:

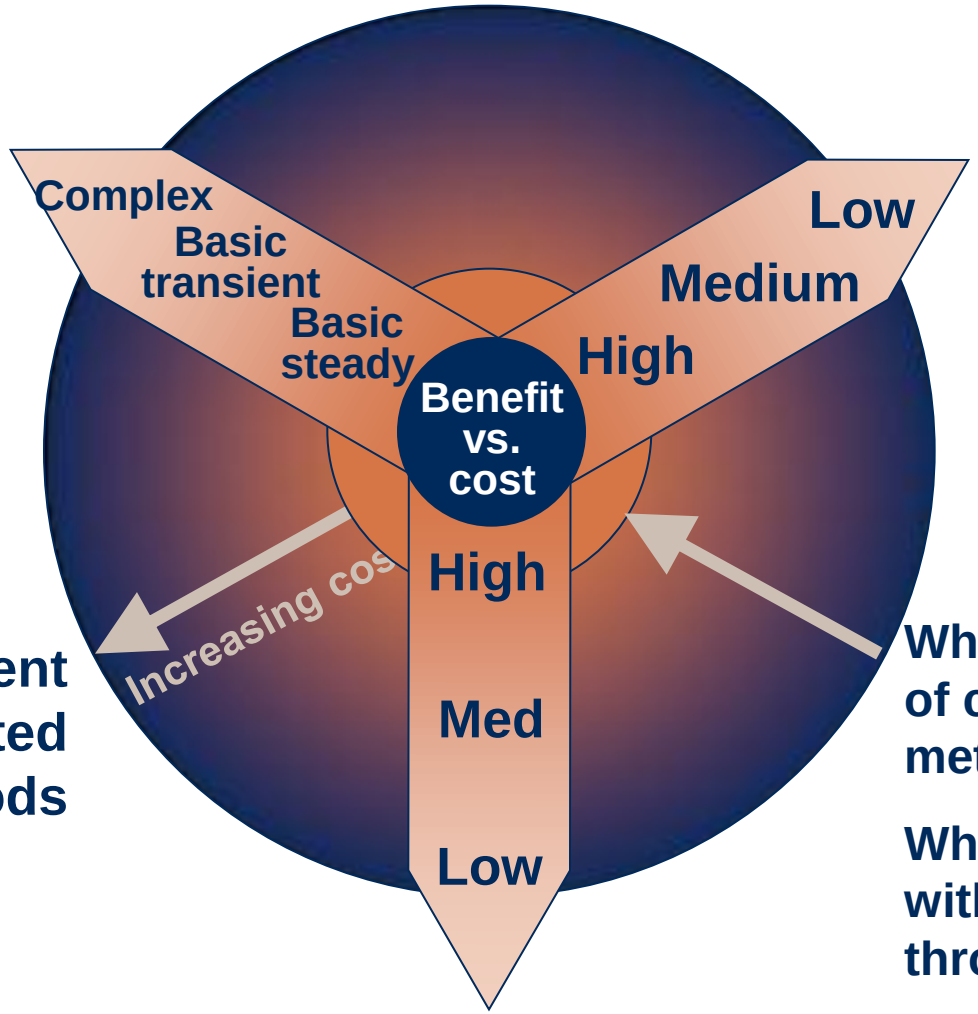
- CFD analysis can provide valuable data on flow velocities, pressures and temperatures, for use in:
  - Structural design and integrity assessment of exhaust ducting
  - The design of auxilliary burners
  - The design of process equipment (WHRUs, HRSGs)

- Numerous factors contribute to a achieving a correct CFD simulation:
  - The cost-benefit balance of difference CFD methods
  - The applicability of different CFD methods to exhaust flows
  - The correct implementation and interpretation of results from different CFD methods
  - Geometric and boundary condition assumptions

Exhaust Systems Working Group

Different CFD methods

Geometric assumptions



Current validated methods

What are the benefits of cheaper CFD methods?

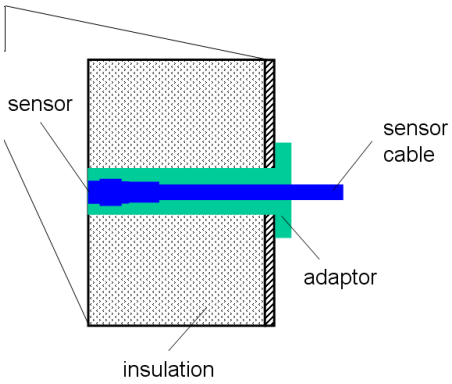
Where to use them with confidence, through validation?

Flow boundary condition assumptions

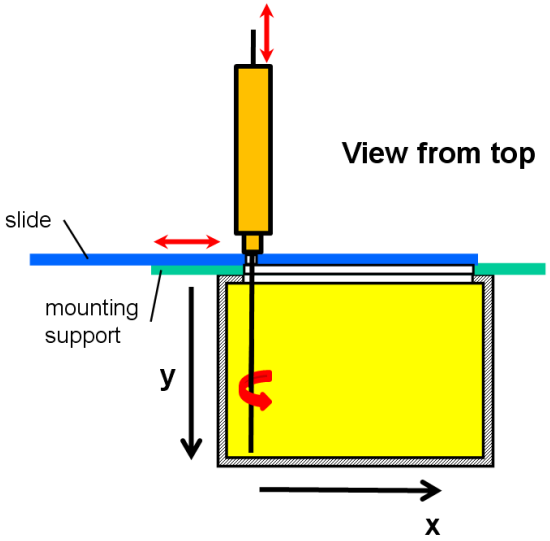
Exhaust Systems Working Group

Measurement trials and benchmark CFD programme overview:

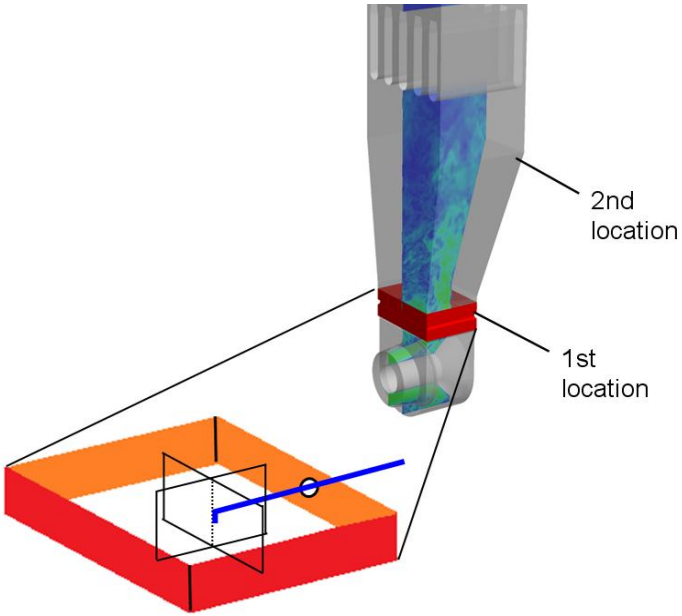
- Measurement trials on a LM2500+, courtesy of Total (CLOV FPSO project)
  - Static and dynamic flow measurements: Velocity, pressure, temperature
  - Structural measurements: Surface temperatures, strains, vibration accelerations



Wall measurements



Flow measurements



Measurement plane

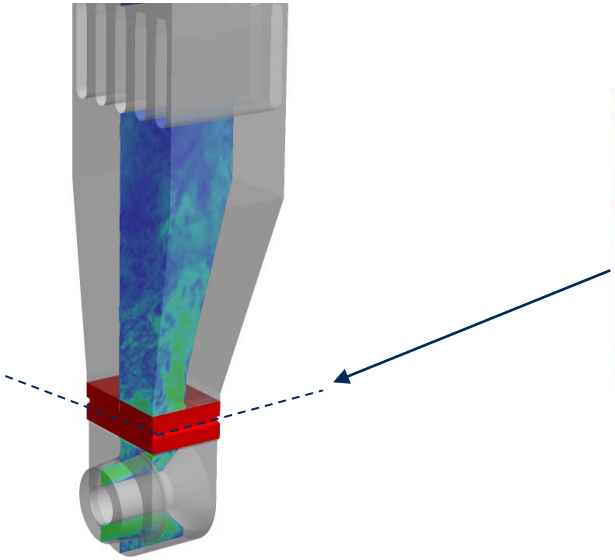
Exhaust Systems Working Group

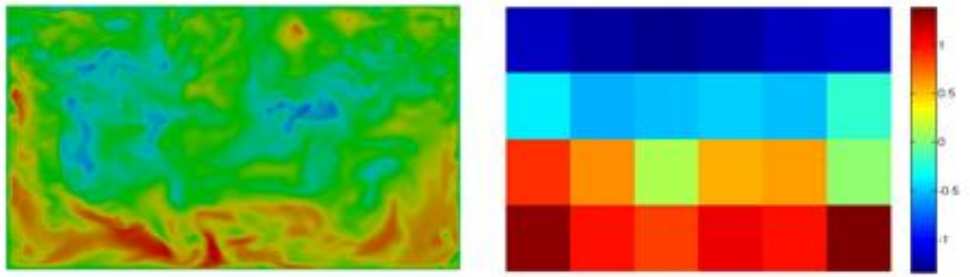
Programme overview:

Benchmark CFD programme

- Perform 9 CFD cases, with different turbulence models, geometry and boundary conditions
- Validate results against the measurement trials

- Best Practice CFD Guidelines
  - Generate a best practice CFD guidance document





Velocity boundary conditions at inlet plane

Exhaust Systems Working Group

Phase		Timescales
1	Development of Validation Strategy	Completed by Frazer-Nash Consultancy Ltd
2	Development of Measurement Strategy	Completed by RWTH Aachen University
3	Instrumentation Design and Build	April – July 2012
4	Build Management	April – July 2012
5	Installation and Trials	August 2012 January 2013
6	Supporting Modelling	Ongoing
7	Validation and Development of Best Practice Guidelines	June 2013

- Total investment required is €250k to €350k
- Read the detailed proposal, to be issued by ETN
- Decide whether to help fund and benefit from access to the work
- Commitment to invest is required by May 2012 to meet very tight timescales

Exhaust Systems Working Group

Benefits of “Best practice guidelines for CFD modelling of exhaust flows” to **Operators, GT OEMs, Exhaust & WHRU suppliers, Consultancies and Academia:**

- Understand the **confidence in the structural integrity and performance** predictions of equipment
- **A benchmark CFD case** and for evaluating the proficiency of subcontractors in CFD modelling
- An understanding of the **cost-benefit of different CFD methods** used to design equipment
- Understand **what simplifications can be made to the geometric representation of exhaust for CFD modelling**
- Will understand **how to represent boundary conditions for CFD modelling**
- **Validation of current and future CFD methods**
- Understand **what information is required by exhaust suppliers**