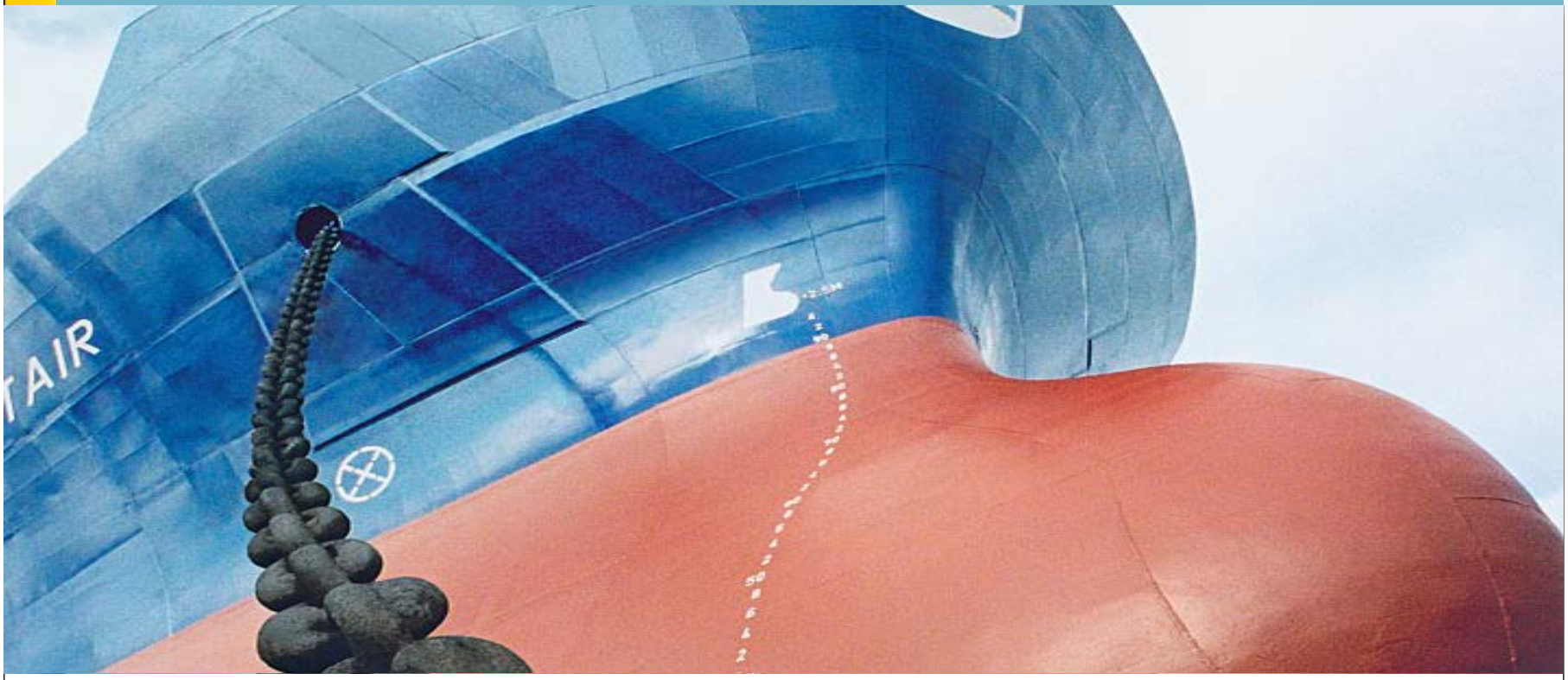
Workshop „Alternative Kraftstoffe“

LNG-Motorensicherheit



Dr. Reinhard Krapp
Umweltschutz
Hamburg und Leer, 31.5./1.6.2016

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Ignition and explosion

- Wat is necessary?

- Fuel AND
- Oxygen (air) AND
- Ignition source

- BUT

- Fuel and air mixtures need certain compositions for ignition
- Explosion pressure also depends on fuel concentration

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Risk mitigation

- Reminder:

Risk = Frequency x Consequence

- Reduce Frequency (probability)
  - Engine automation and control

- Reduce Consequence
  - Minimize methane concentration by engine control
  - **Reduce maximum explosion pressure**

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Risk mitigation by control of consequence

- Ignition source available
- Accidental spill possible
- Mixture of gas with air intended by function
- BUT
- Small amount of gas

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Explosion test with pressure relief

Source:REMBE

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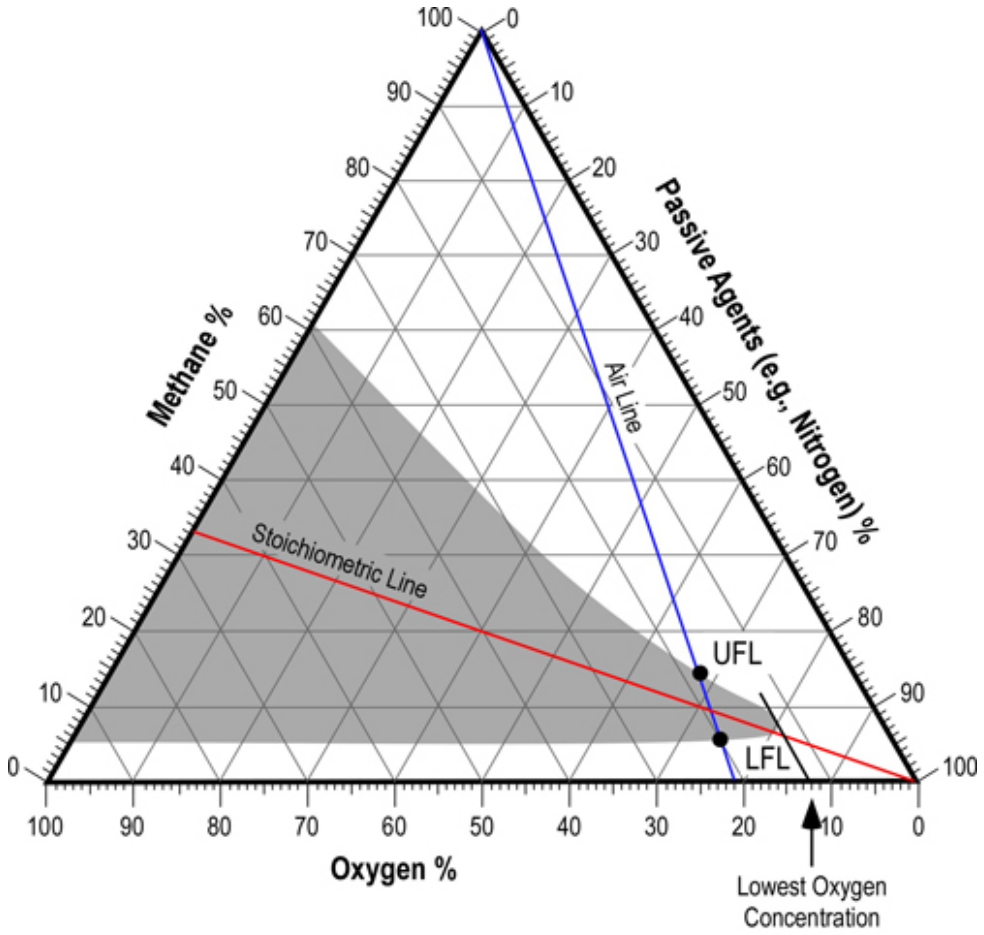
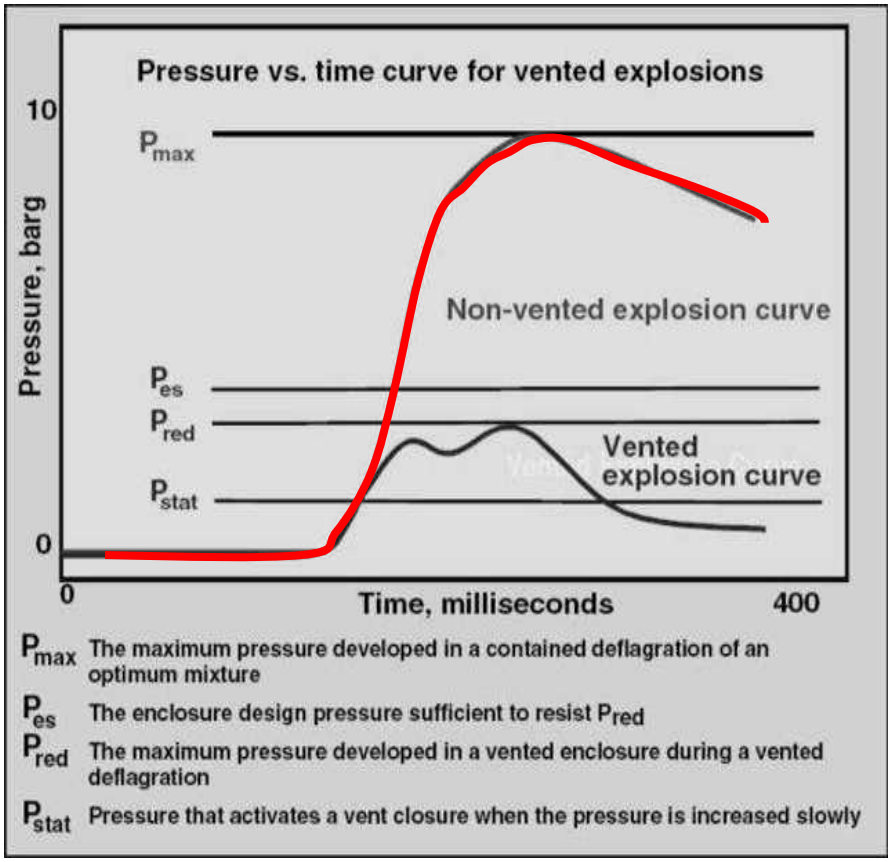
Ignition and explosion limits



- Explosion limits in Air
- 5.3% - 15%



P_{max} The maximum pressure developed in a contained deflagration of an optimum mixture

P_{es} The enclosure design pressure sufficient to resist P_{red}

P_{red} The maximum pressure developed in a vented enclosure during a vented deflagration

P_{stat} Pressure that activates a vent closure when the pressure is increased slowly

Source:REMBE

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Engine room of MS “Ostfriesland”

Source: AG Ems et.al

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Description of Problem 1

- Published results are based on experiments with a pressure vessel
- In the exhaust of a Diesel Engine, however, different conditions prevail :
  - Due to operation of the dual fuel/ gas engine oxygene is continuously present
  - A potential ignition source is present (turbo charger turbine)
  - An ignition (if it happens) will occur at higher temperatures
  - The methane /air / exhaust mixture is moving with a high level of turbulence
  - The exhaust usually includes several bends and complex installations , e.g. silencer, waste heat recovery boiler, SCR catalyst.

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Description of Problem 2

- Currently the expected maximum explosion pressure is calculated with CFD-Programs that require:
  - Modelling of the exhaust geometry
  - Detailed (locally different) models of the moving fluid
  - Decision for the turbulence model used in the calculations
  - Models for the combustion of methane, heat transfer and flame propagation
  - Etc.

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Description of Problem 3

- These extensive calculations have to be performed for each different exhaust installation on board with
  - Variation of number, size and arrangement of pressure relieve valves
  - Check if there are constraints from engine room design and operational requirements

- The resulting financial effort may prevent the use of LNG especially for small RoRo Passenger vessels

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Intended way forward

- Perform model experiments that are closer to the conditions in the exhaust of marine engines than available experiments
- Validation of CFD programs with the results
- Derivation of a CFD calculation standard
- Systematic calculations with these programs to develop a simpler design methodology with sufficient accuracy for smaller engine plants

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Details of work plan

- The investigations and model explosion tests cover:
- Engines up to 2 MW
- Engines from 2 to 10 MW

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Project partners

- 1 **DEKRA EXAM GmbH** Bochum
- 2 **DNV GL SE** Hamburg
- 3 **FEV GmbH** Aachen
- 4 **Hochschule Emden/Leer, Fachbereich Seefahrt** , Leer
- 5 **Meyer Werft GmbH & Co. KG** Papenburg
- 6 **REMBE GmbH Safety+Control**
- 7 **VDR Hamburg** Verband
- 8 **MARIKO GmbH** Leer.
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Associated partners

- 1 **Wärtsilä Netherlands B. V.** Drunen (NL)
- 2 **Sandfirden Technics B. V.** Den Oever (NL)
- 3 **GexCon AS** Bergen (NOR)

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Source: REMBE

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