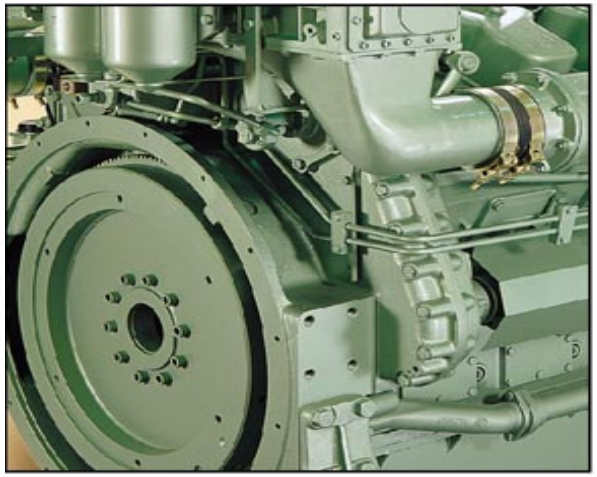
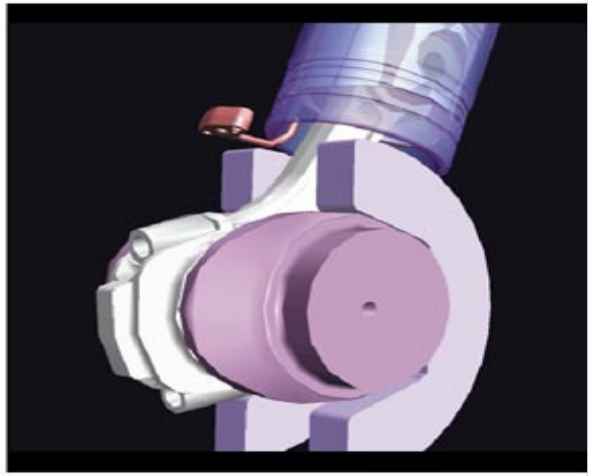
GUASCOR I+D







Gas engine marine applications with Propane fuel

5th INTERNATIONAL GAS ENGINE CONFERENCE

19-04-2007

Gas engine marine applications with Propane fuel

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- PSE Peixe Verde Project
- Development of the Propane gas engines
  - Generalities
  - Installation
  - Dual Fuel Concept. Control Logic. Development.
  - Propane Otto Engine. Development.

Gas engine marine applications with Propane fuel

- Guascor I+D takes part in the Spanish Singular Strategic Project PEIXE VERDE, with the objective of reducing the cost of exploitation of fishing industry

Partners PSE Peixe Verde

Peixe Verde: Mapa de Participantes, por especialización.

Participantes	Barcos	Pesca	Energía	S.C.A.D.A.
Empresas privadas	Altum Astilleros Armón Astilleros M.Cíes Imix	Pescanova Puerto de Celeiro Servicel	Ariema Elcogas Flue Gas Natural Guascor Repsol-Ypf	Arteixo Telecom Ictel
Administraciones, Organismos Públicos y otras entidades	Univ. La Coruña	**CETPEC** Consellería de Pesca de la Xunta de Galicia.	IDAE INEGA INTA Univ. Pol.Madrid. Univ. Rovira i Virgili	Univ. Santiago de Compostela

- The objective of operational costs reductions will be achieved by the use of fuel alternatives to the diesel. Guascor will develop engines capable to use substitute fuels including gas, both gas only engines and dual fuel engines.

- The development will start with the use of propane as alternative fuel in both engine types:
  - Gas engine (Otto Cycle)
  - Dual Fuel (Diesel Cycle)

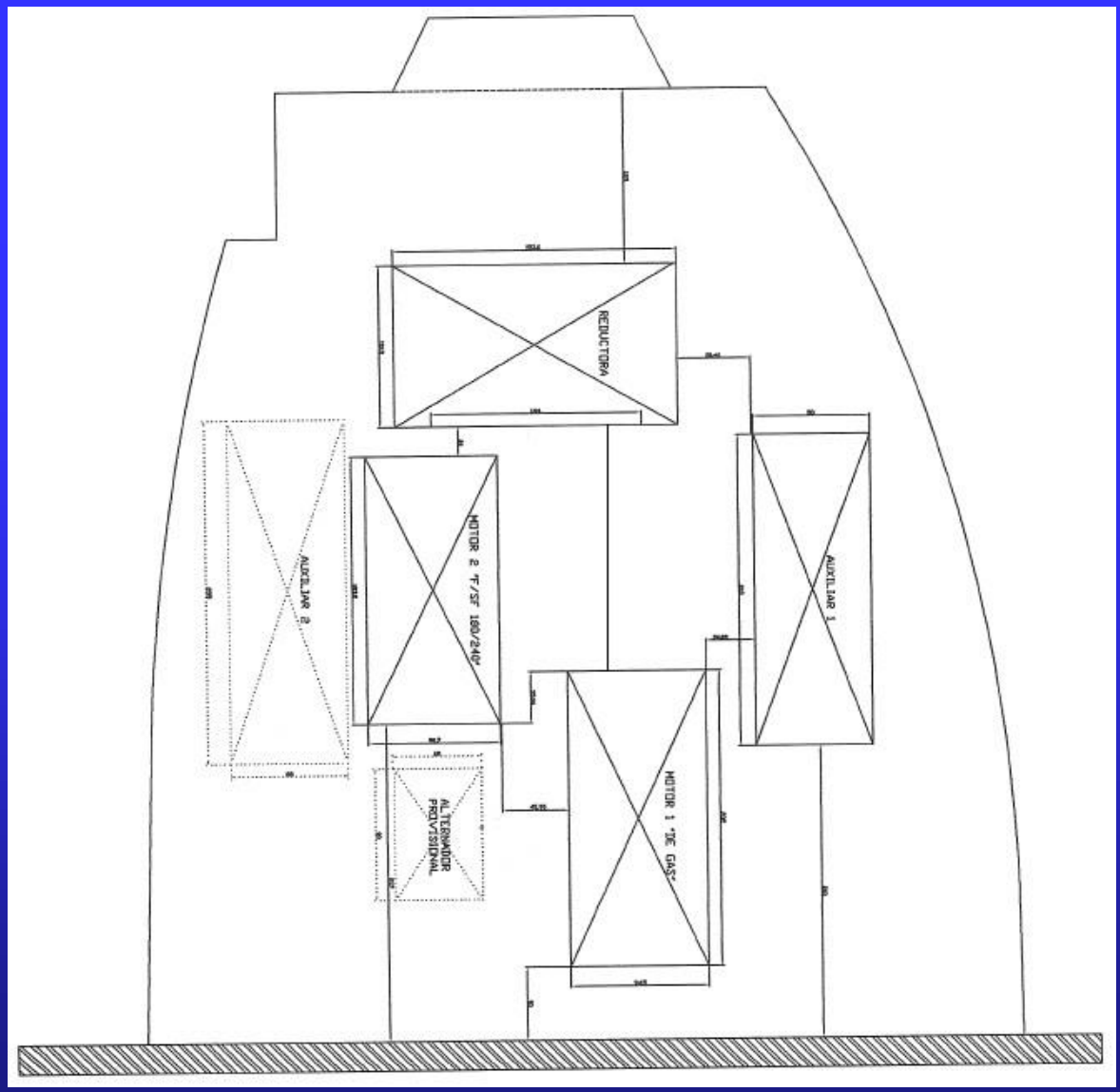
Field tests. Santiago Apostolo Ship

- Both engines will be installed in the Santiago Apostolo ship, property of Celeiro Port, that will perform the field test

Santiago Apostolo Ship

Configuration of engine room

- From the actual propulsion configuration it will be removed the current propulsion engine and one of the two current auxiliary engines
- Both new engines are going to be connected to a twin gearbox
- The dual fuel engine has a generator to engine tail of 120 Kva
- Will maintain variable pitch propeller so the engines work close to constant speed


REDUCTORA
MOTOR 2 "F/SF 180/240"
AUXILIAR 2
AUXILIAR 1
ALTERNADOR PROVISIONAL
MOTOR 1 "DE GAS"

Engine Development

- Considering the propulsion needs of the ship, of 600 CV, Guascor is developing two engines :
- Propane Dual fuel engine of 330CV. SFDF180TASP
- Propane Cycle Otto gas engine of 300 CV. FPLD180SP

Dual Fuel Engine

- The engine Dual Fuel is based on a diesel engine.
- Its advantage is the capability to use a gas cheaper than the diesel to reduce the cost in fuel.
- The Dual Fuel engine must reach 100 % of full load with only diesel.
- % LPG will depend on the load.

Dual Fuel Engine

- In this type of engine it is not possible to use diesel or gas indistinctly
- The combustion is produced by the autoinflammation , therefore it is always necessary to use some diesel
- The gas is mixed with the air at the carburetor

Control logic of carburation of the dual engine fuel

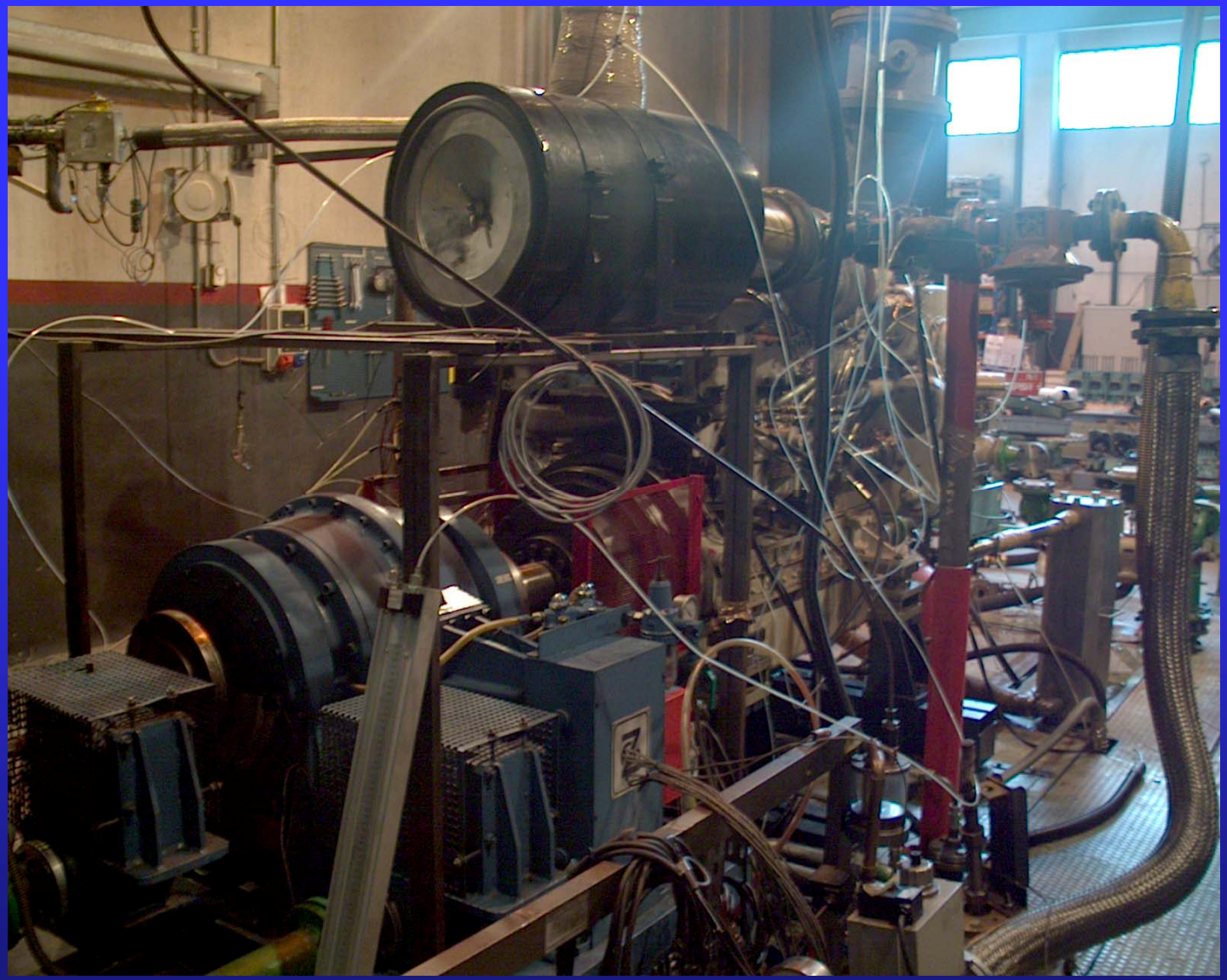
- The gas guantity is controled by a 4-20 mA signal valve
- The valve will start to open when a % os diesel pump rack position is reached, and then will open gradually depending of the desired gas quantity

Development Propane Dual Fuel engine

- Engine is based on the Guascor SF180TA 500 CV
- Aim: to optimize performance to reduce the cost of fuel, defining the optimum % of gas

Development Propane Dual Fuel engine

- Calculation and design of specific components for dual fuel engines with propane
- Assembly of the engine
- To adapt testbed and instrumentation of the engine
- Definition of the safety parameters of system of knocking detection
- Definition of the optimal refrigeration configuration



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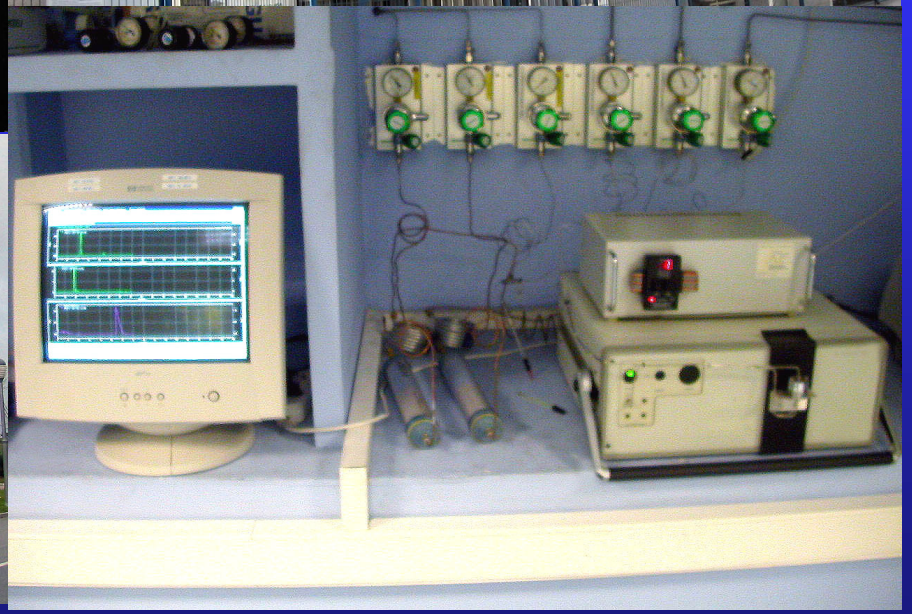
INGENIERÍA DE MOTORES



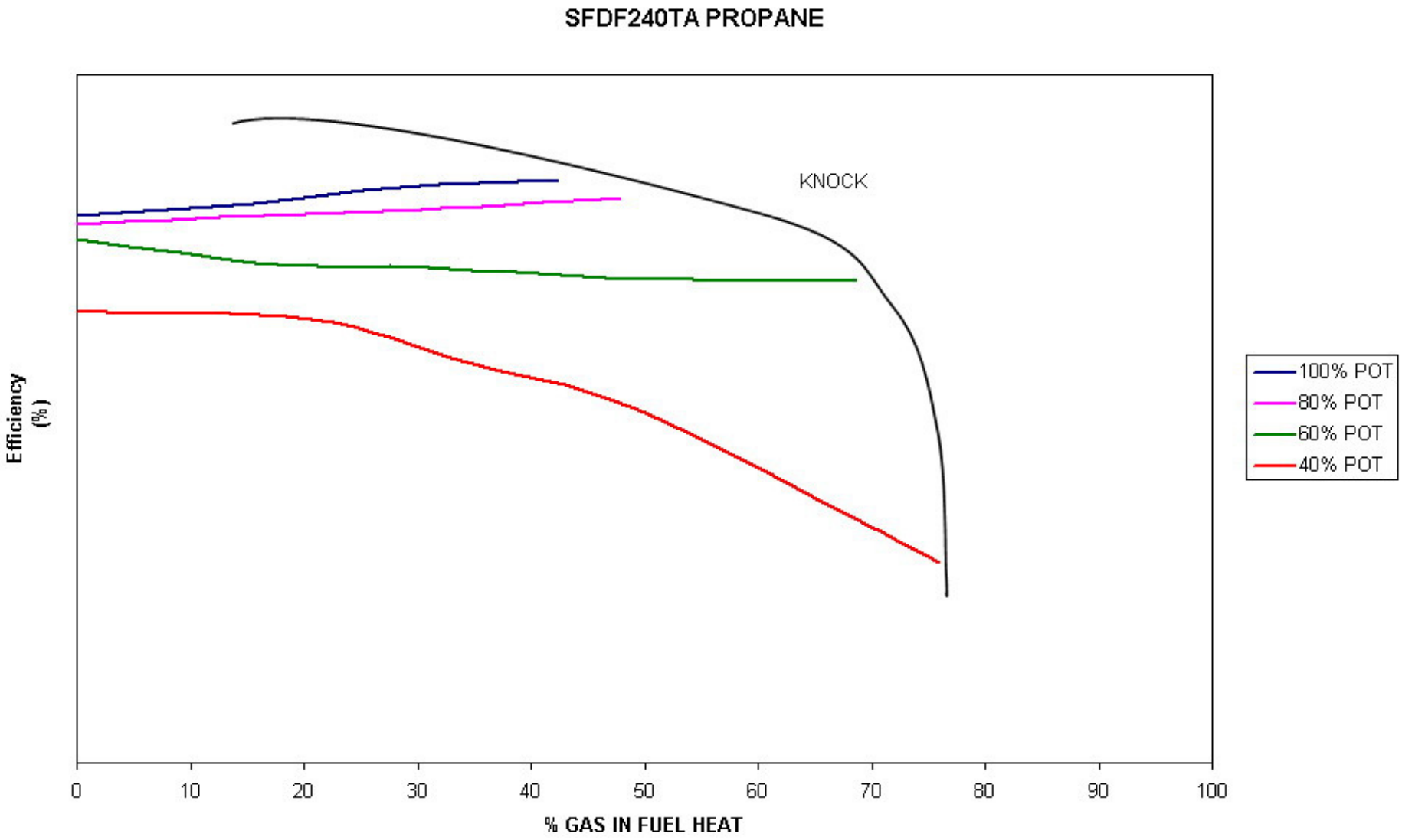

REPSOLGAS

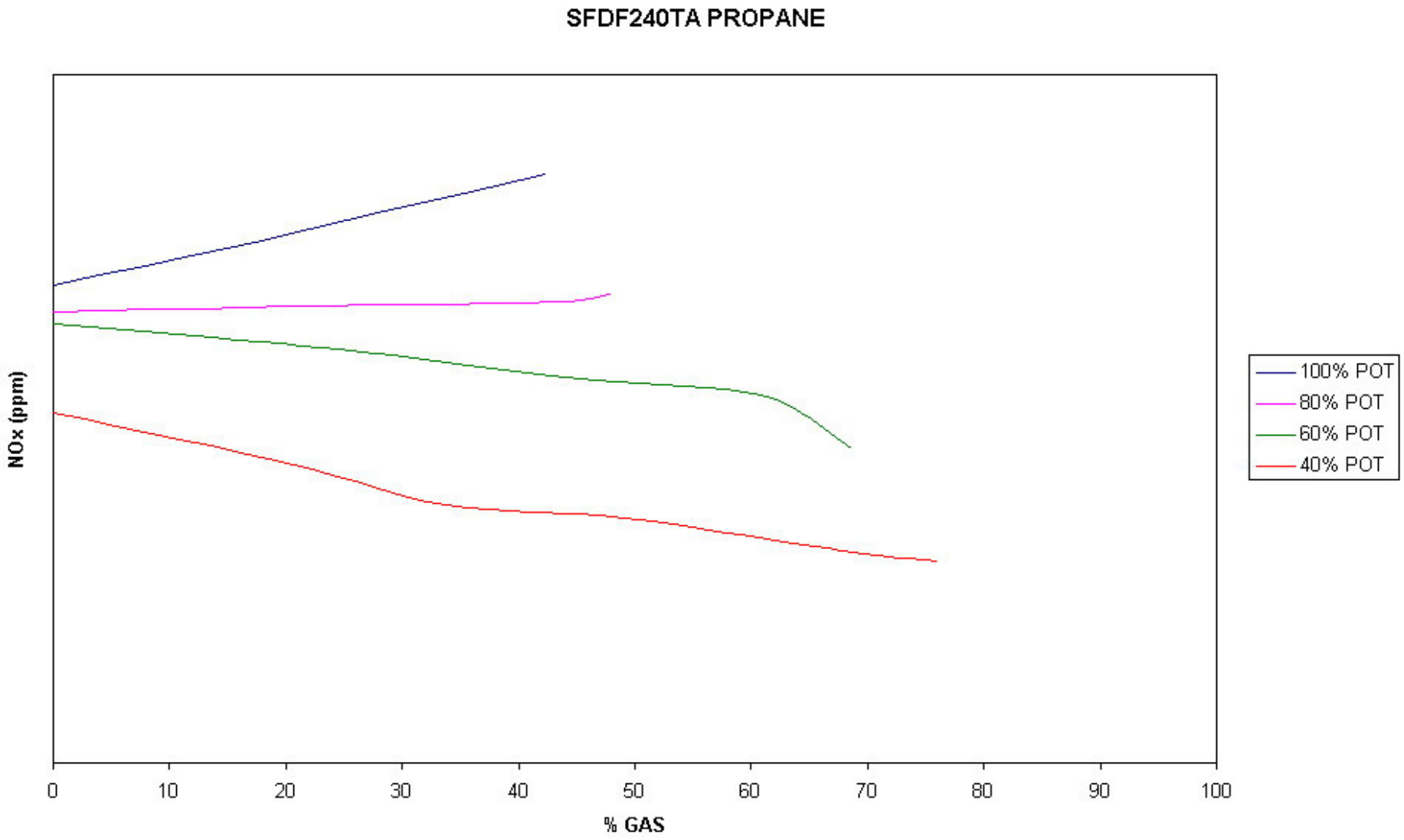
Final adjustment tunning in dual fuel engine with propane

- Verification and validation of the dual fuel initial configuration
- Engine maps (Timing and % of suitable gas)
- Performance depending on the variation of the gas composition

Influence of the gas composition in the dual engine fuel with propane

- The LPG is formed by propane and n-butane
- The percentage of LPG that can be feed to a dual fuel engine is influenced by the LPG composition. It will be maximum when the LPG is 100 % propane and minimum when it is 100 % n-butane.


SFDF240TA PROPANE
KNOCK
Efficiency (%)
100% POT
80% POT
60% POT
40% POT
0
10
20
30
40
50
60
70
80
90
100
% GAS IN FUEL HEAT


SFDF240TA PROPANE
NOx (ppm)
0
10
20
30
40
50
60
70
80
90
100
% GAS
100% POT
80% POT
60% POT
40% POT

Propane Gas engine (Otto Cycle)

- Otto Cycle Engine
- LPG Knoking tendency
- Basic changes from natural gas configuration:
  - Carburation
  - Compression ratio
  - Safeties

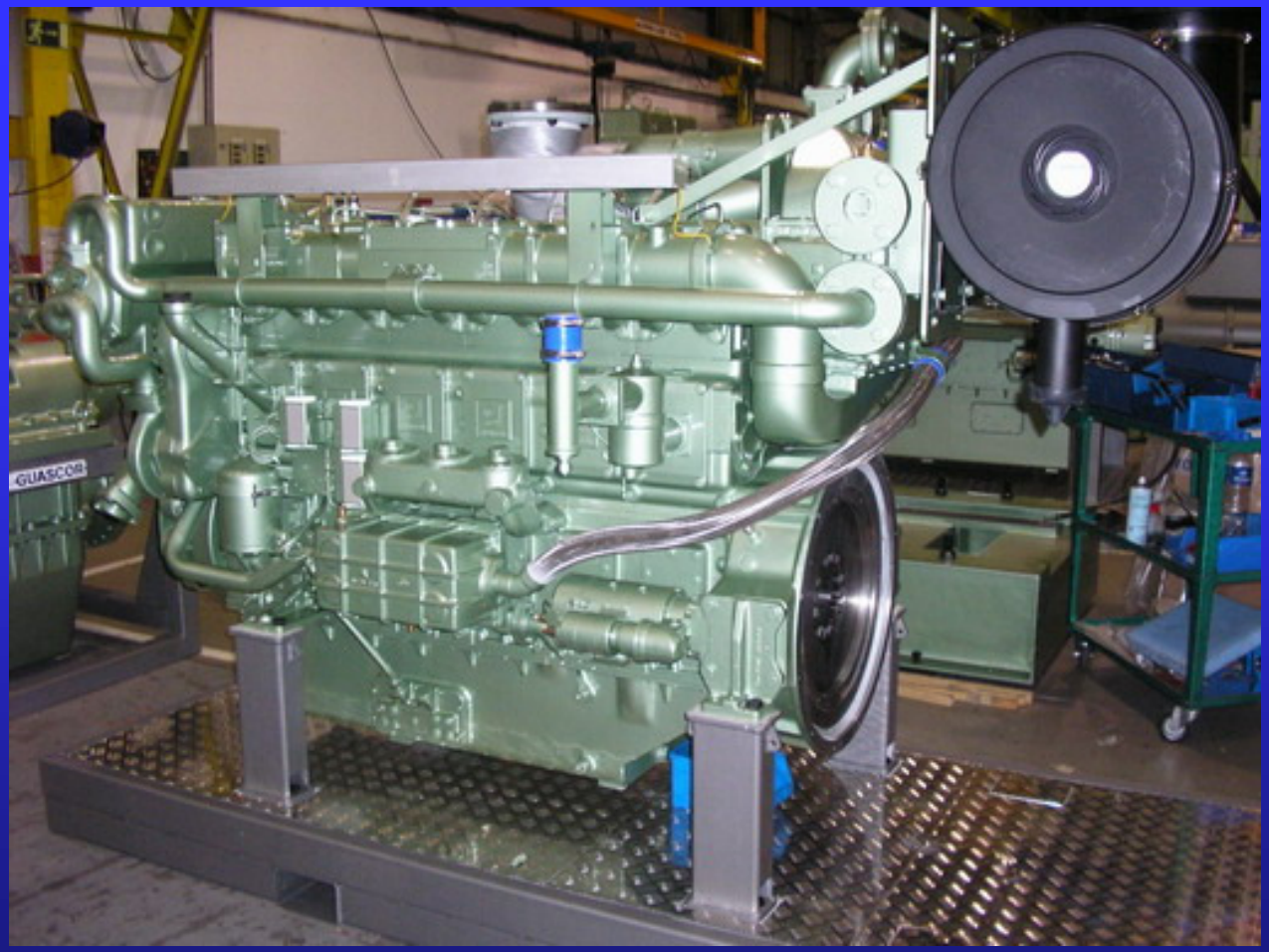
Propane Gas engine (Otto Cycle)

- Calculation and design of specific components for Otto cycle engines with propane
- Definition of the engine configuration (connecting rods, pistons, carburation,…)
- Assembly of the engine
- To adapt testbed and instrumentation of the engine

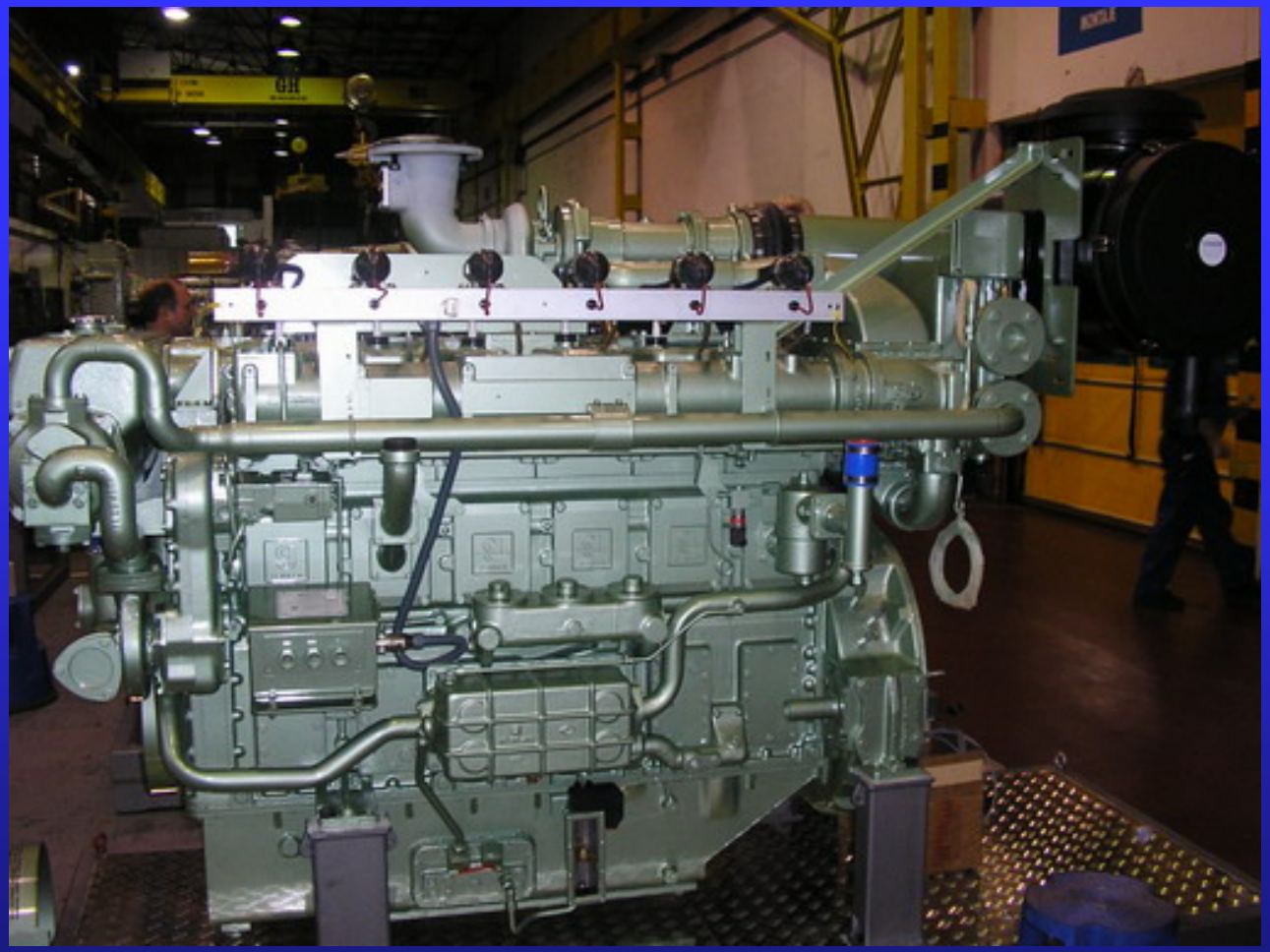
Parameters to define in the development Propane Gas engine

- Verification and validation of the initial configuration
- Best Timing
- Performance depending on the variation of the gas composition

SFDF180TASP



FPLD180TASP



THANKS FOR YOUR ATTENTION