Marine

- Advanced engine design and development
- Emissions and environment
- Marine operations improvement
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An unparalleled portfolio of marine propulsion engineering services

Our mission at Ricardo is to support the evolution of the marine industry towards an efficient, sustainable and low-carbon future. Ricardo has long been engaged in the marine sector and fully understands the challenges of increasingly strict emissions legislation, and the imperative of improving ship energy efficiency and reducing fuel consumption.

Ricardo supports the marine industry in meeting these challenges by offering its expertise in an independent and impartial manner. We offer a level of industry expertise and technical capability that few others are able to match. For an industry under pressure to improve engine fuel efficiency, tackle emissions and reduce total cost of ownership, we are uniquely placed to assist with engine projects of all types and applications.

Whether for minor component upgrades or new high-volume product families for multiple international markets, our expertise extends across the full product life cycle. Deep technical knowledge, complemented by an expansive strategic consultancy offering, uniquely positions us to support clients across every stage of the product development process, from clean-sheet design to manufacture, testing and product launch.

In a sector under more scrutiny than ever, and on the cusp of a new technological era, choosing Ricardo as your technical partner sends a clear message to the market that your business is committed to delivering innovative, high-quality products to its customers.
How we help

We provide a global, multi-sector pool of expertise that combines local industry knowledge with international viewpoints, coupled with world-leading engineering facilities.

Services include

- Advanced engine design and development
- Gas engine integration expertise for ships
- Engine retrofitting strategies for new fuels and engine upgrades for performance and/or emissions improvements
- Multi fuels engine design considerations
- Innovative and imaginative engineering solutions for all types of large commercial vessel

- Expertise in efficient NOx control and strategies
- Design and development of hybrid propulsion systems
- Energy storage system design, including battery packs, high-speed flywheels and hydraulic energy storage concepts
- Emissions monitoring strategies and equipment implementation
- Environmental monitoring and modelling

Advanced engine design and development

Engine right sizing and design optimisation help to improve the overall efficiency of the vessel and minimise manning expenditure.

Emissions and environment

Ricardo is aware that environmental regulations and their impact on day-to-day business is at the top of customers' agendas.

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Marine operations improvement

A number of approaches and technologies can be applied to facilitate through-life cost reduction and increase operational efficiency.

Services include

- Innovative control strategies for engines (telematics and data acquisition)
- Condition monitoring system (CMS) approach for propulsion packages and ancillaries
- Condition-based maintenance (CBM) strategies
- Noise and vibration sources identification and reduction
- Failure and in-service problem investigation
- Marine energy systems optimisation
Who we help

Our clients include:

Commercial shipping

From commercial ships propulsion system efficiency simulation to complete propulsion system, including waste-heat recovery, battery pack, electrical motors, clutch, driveline, fuel cells, main and auxiliary diesel engines. Benefit versus cost analysis for energy storage and return on investment.

Defence

Technical support agreement in place with one of the major navies. Ricardo is a nominated supplier of marine support to the UK MoD. For over 30 years, Ricardo has been a selected key supplier to the Marine Engine Group of the MoD’s Defence Equipment Support Team, providing independent, wide-ranging specialist technical services in the fields of power plant selection and operation. Ricardo is a member of the Naval Advisers on fuels and lubricants working groups.

Pleasure

Innovative stern drive design with the objective to achieve reduced cost, increased efficiency compared to conventional Z-drive, concept design of down-leg drive; shift and reversing mechanisms. Production of layout drawings, including component selection and system-level FMEA (Failure Modes and Effect Analysis) study.
We need here a picture of a vessel engine room simulation model of a marine propulsion system to design vessels with improved fuel economy and NOx emissions.

In order to satisfy operational and regulatory demands, our client wished to offer new variants of their hybrid marine propulsion systems for tugs, supply vessels and ferries. Ricardo was engaged to create a flexible vessel simulation model that would predict the impact that different propulsion packages’ architectures (diesel and diesel-electric) and different power management strategies have on fuel consumption and emissions. The model must also assist the dimensioning of components. In order to achieve that, Ricardo engineers created Matlab-Simulink models of current vessel with diesel mechanical propulsion system and validated with test data. Develop diesel-electric model with a modular approach adding in new sub systems: Power Management System (PMS), e-machines (generators & motors) and electric power converters. An investigation was carried out as part of the study elucidating the most effective running pattern (PMS logic and setup) judged on fuel consumption and emissions. Evaluation was carried out for a range of duty cycles that vary propulsion and hotel loads.

Case studies

Simulation model of a marine propulsion system to design vessels with improved fuel economy and NOx emissions

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Marine engine IMO III/EPA Tier 4 marine emissions upgrade programme without SCR (Selective Catalytic Reduction) or DPF (Diesel Particulate Filter)

Client required an updated engine offering for marine market for high power density, high speed diesel application. Engine to meet IMO III and EPA Tier 4 marine emissions standards, without the use of SCR to minimise fluid logistics. Utilisation of Ricardo’s low-soot Twin Vortex Combustion System (TVCS) and cooled EGR (Exhaust Gas Recirculation) for NOx reduction to meet emissions requirements whilst maintaining current IMO II power ratings for both genset and propulsion variants without the additional requirement for post-engine DPF. Ricardo was responsible for the implementation of new combustion and emissions control system within existing engine architecture. Design, application and implementation of new TVCS combustion system with 2200bar HPCR FIE, air handling (intake, exhaust and turbo) and modular EGR systems (current engine does not have EGR). Development and implementation of EGR system control strategy. Design and development of new 220bar-rated cylinder head. Support for performance and emissions testing and development and supplier liaison to demonstrate successful achievement of programme targets.
Measurement and diagnosis of noise and vibration issues on a set of luxury yachts

Custom built yachts are, by definition, unique constructions. While a modular approach is used whenever possible, the hull, powertrain, internal layout and fixtures and fittings can combine to produce unacceptable noise and vibration levels that are unique to each vessel. The yacht builder had received a number of customer complaints and contacted Ricardo for a fresh-eyes review using an objective measurement and analysis approach. Ricardo installed noise and vibration measurement equipment in each yacht and then carried out a series of representative usage profiles. Detailed analysis of the data identified led Ricardo to address: frequency content, order-related content and amplification due to resonant behaviour. Using this information, the source of each issue could be diagnosed, and hence countermeasures suggested to solve the problems.
Advanced engine design and development

World-class expertise in design, build, calibration and compliance.

Engine efficiency was the expertise upon which the Ricardo group was founded. Today, we remain pioneers in engine technology with a global reputation for capabilities ranging from design through to manufacture, across petroleum, diesel and emerging biofuel and gas engines.

Design
We have a global community of over 800 specialist engineers providing designs for full engines or individual components. The projects we support range from performance upgrades through to multi-phase design programmes for new high-volume-production engine families.

Testing
More than 60 independent test cells operating 24 hours a day across Europe and North America provide rigorous testing of complete engines. Our cells perform tests tailored to the requirements of each client, helping them optimise the performance and durability of an engine throughout its development. Validation, performance and durability tests can be carried out in Ricardo or customer facilities according project specifications.

Retrofitting
Engineering study for retrofitting single fuel into dual fuel engine. Engine uprating and performance improvement within emissions compliance scenarios. This would cover fuel system, lub oil system, cooling packs and emissions control technologies.

Calibration
From initial design to full turnkey production calibrations, we prepare engines for international markets in full accordance with relevant legislation. We calibrate engines that use conventional fuels, as well as hybrid and biofuel, for various specifications, including turbochargers and EGR.

Simulation and analysis
Simulation of different running modes and conditions by means of in-house software and technical specialists. Our software teams develop simulations and analyses specific to each project, from concept layouts through to complete engine design and development programmes.
Methane slip

Methane slip is the unburned proportion of methane contained in the natural gas that is emitted. Methane slip could easily compromise other advantages of the use of natural gas as a fuel in the actual legislative context in the marine industry. For that reason, addressing methane slip is of paramount importance for marine industry stakeholders, not only from an environmental but also an operational angle. Ricardo can tailor a strategy to support you based on three angles:

- Methane health check by mapping of the stack emissions to assess gaps where engines are not achieving manufacturer specifications
- Optimise with engine hardware via a series of upgrades, all with Ricardo engineering backing support
- Tune-up service to improve environmental footprint and reduce fuel wastage
Efficient NOx control
IMO Tier III legislation is driving the NOx limit to be in the region of 2g/kWh, which is a significant reduction from Tier II legislation. This, in many cases, requires exhaust NOx control with significant efficiency requirements. The technology of choice for marine applications is Selective Catalytic Reduction (SCR).

Specification and design
Many challenges exist in the specification, design, control and implementation of SCR technology to marine applications. Ricardo has vast experience of delivering SCR technology into many engine sectors and has transferred this knowledge to the marine industry.

Measuring
Ricardo offers the full range of services for exhaust emissions control implementation from initial specification and design to control and calibration of the final solution. Meeting the legislative limits with a robust cost-effective solution is key to ensuring efficient NOx control for marine applications. This can be achieved via Ricardo’s proven approach to exhaust emissions control via its aftertreatment development process.

Emissions and environment
In response to increasing demand for emissions aspects, we help clients meet their challenges in efficient NOx control and environmental monitoring and modelling.

Maritime transport sector is an important component of the global economy. The continuous movement of cargo around the globe generates different types of pollution, affecting the air, oceans and rivers. In that context, the environmental footprint from international shipping becomes of paramount importance, not only for the marine industry but for society as a whole.
Environmental monitoring
Ricardo can help with the environmental monitoring and modelling of emissions from ships and port activities supporting national and local authorities related to quantifying shipping emissions, and identifying reduction strategies.

Environmental modelling
Port and local authorities can be supported by means of compilation of modelled air pollutant and greenhouse gas emission inventories of vessels at national, regional and local level, and shoreside port operations at local level.

An inventory evidence base, coupled with detailed dispersion modelling and forecasting future trends can be used to understand the sources of pollution. Provision of advice on current best practice, emerging technologies and emission-improvement strategies to help drive down emissions and improve air quality, and help local authorities, port authorities and vessel operators target and assess improvement strategies and measures.
Helping you to shape your operational strategy

The marine industry is facing fierce competition in an unpredictable economic environment.

Assessing the reliability of an asset in its actual life cycle conditions, to determine the advent of failures and mitigate system risks, is of paramount importance. Retaining competitiveness, especially in high-tech sectors, requires continuous incorporation of new approaches and advances in technology that yield higher levels of reliability whilst optimising operation and maintenance.

**CMS - CBM**

Ricardo can assist you in the development of CMS and CBM strategy either in a holistic manner or for specific parts/equipment of your asset by means of expert and extensive knowledge of engine performance and behaviours. Ricardo has jointly developed a number of new sensors that can allow a significantly greater level of detail and characteristics to be monitored. Extended application of these new toolsets to internal combustion engines for condition monitoring of critical systems for reliability will provide greater clarity and knowledge of real-time conditions within the engine and hence allow for adaptive maintenance and early fault detection.

**Sensor technologies**

Two sensor technologies are key in development for these applications; Acoustic Emission (AE) sensors for assessment and location of material damage, and Ultrasonic Reflection (UR) sensors for assessment of oil film thickness, surface finish and load. By means of real-time software simulation, such as 1D thermodynamic performance code WAVE-RT, Ricardo is able to recreate working conditions within the engine environment and identify any deviations from normal operating parameters.

**Noise, Vibration and Harshness**

We have been a leader in NVH development and optimisation for over 40 years, offering expertise in problem identification and resolution, optimisation and concept design simulation.

**NVH Analysis and prediction**

Analysis and prediction of noise and vibration phenomena can support during the design and operational stages. Ricardo can support with NVH benchmarking, Transfer Path Analysis (TPA), NVH simulation, Structural Dynamics Analysis and Intake and Exhaust noise simulation. Ricardo software WAVE is ideal for prediction of sound quality and development.
Innovation

Assessment of leading innovations through research and technology development.

Technology driven trends are transforming business models and supply chains across the marine industry. Ricardo understands the importance to be at the forefront of this new age, helping clients to develop proven, realistic responses without the hyperbole. Innovation is the enabler for Ricardo future strategy for medium and long term.

**Atlas 2 single cylinder research engine**
The single-cylinder research engine is offered as a product and as a test time at Ricardo’s UK large engine development facility. It provides a highly flexible, multi fuel capable tool to support faster delivery of products to market and at a considerably reduced cost.

Benefits and applications for the 300 bar engine:
- Heavy duty combustion system performance development
- Advanced combustion research
- Valve train development
- Aftertreatment control and development
- Variable air motion studies
- Fuel injection equipment development
- Component development
- Alternative fuels testing
- Simulation validation
- Function and durability tests

**Ethanol-boosted direct injection and split-cycle engines**
The challenges that marine industry is facing in terms of fuels-emissions-efficiency triad, could favour the research transfer from other industries to marine.

By means of successive research programmes, Ricardo is currently developing different technological concepts. In the field of new fuels and combustion, ethanol-boosted direct injection represents a good example of its potential benefits as an alternative approach. In the field of efficiency optimisation, split-cycle engine concept reduces significantly operating costs and has the potential to provide higher efficiency ratios than conventional engines.

Technology transfer is not new to Ricardo and could be a solution for your challenges. We are ready to support you in mitigating uncertainty.

**Waste-heat recovery with Organic Rankine Cycle (ORC) research**
We are actively involved in research programmes around the world. This enables us to keep our skills and knowledge up to date in the most disruptive technologies. A recent example is about Ricardo involvement in the creation of a research and training platform for the development and implementation of energy efficient and fuel flexible combustion technologies in order to improve efficiency and meet stringent emission standards in marine and light-duty automotive diesel engines. Specific tasks are assigned to Ricardo involvement relating to combustion engines and waste-heat recovery with Organic Rankine Cycle (ORC).
Ricardo’s strategic consultancy practice offers an extensive portfolio of corporate advisory services to help senior executive teams address high-impact issues and resolve operational problems at every stage of the value chain.

The majority of our consultants are qualified engineers with executive-level experience within the transport sector, whilst our environmental and energy advisers are at the forefront of policy creation and programme delivery for a range of governments and multinational organisations.

Unlike ‘pure’ management consultancy brands, this enables us to offer advice and analysis informed by direct industry and regulatory experiences.

Clients include transport operators, manufacturers and financial and government institutions, and our assignments range from acquisitions and post-merger integration support, through to designing business turnaround programmes, modelling of future transport trends and resource scarcity impact assessments.

In the marine sector specifically, we have helped clients undertake local market audits, challenge supplier costs structures, reform procurement programmes and review internal safety processes.

**Services include:**
- Business strategy
- Market entry
- Corporate sustainability programmes
- Economic impact assessments
- Commercial due diligence
- Regulation and policy
- Quality and High Value Problem Resolution (HVPR)
- Integrated cost reduction and operations improvement
- Mergers and acquisitions
- Low carbon technology assessments
- Regulatory compliance, planning and risk management
- Sale of non-core business units
- Modelling of future transport trends
- Resource scarcity impact assessments
Business Strategy

Systems and expertise

Resources and efficiency

Management

Operations and process

Strategic

tactical
cost

Economic

Management

Transport

Consulting

Business

Sustainability

Technology

Planning

Quality

Solutions

Policy

Scarcity

Environmental

Integrated

Scientist

Due diligence

Commercial

Regulatory

Impact

Engagement
Maximise efficiency and eliminate waste.

The Ricardo group

A global engineering, consulting and performance products business that specialises in transportation, energy and scarce resources.

Our work extends across a range of market sectors – such as passenger cars, commercial vehicles, rail, defence, motorsport, power generation and government – and we are proud to possess a client list that includes transport operators, manufacturers, energy companies, financial institutions and government agencies.

Through our multi-industry knowledge and deep technical expertise, we are uniquely positioned to handle our clients’ toughest strategic and operational challenges, with assignments that have included strategy development, cost reduction, safety management, regulatory compliance and environmental impact assessments.

Meanwhile our in-house engineering capabilities enable us to provide high-quality prototypes and low volume manufacturing of complex products and assemblies, including engines, transmissions, electric motors and generators, battery packs and fuel cell systems.

Yet across everything we do, in every assignment we undertake, we remain committed to the ethos of our founder, Sir Harry Ricardo, one of the most innovative mechanical engineers of his time, who, in 1915, set out on a mission to maximise efficiency and eliminate waste.
Asset health management
Effective implementation of Condition Monitoring System (CMS) and Condition Based Maintenance (CBM) will enhance the efficiency and effectiveness of maintenance regimes.

Preserving the environment
Movement of cargo around the globe generates pollution affecting the air, oceans, and rivers. Reducing emissions and improving fuel consumption is a major priority.

Helping you increase the resilience of assets
Ricardo can assist you with the development of CMS strategies, either in a holistic manner or for specific parts/equipment.

Addressing the slip
Ricardo can tailor a strategy to support you, whether it is immediate post-Tune up, or for a specific period of time.

On the same wavelength
For ferries, cruise ships and luxury boats, customers’ comfort is paramount. Noise and vibration should preferably be addressed during ship design and construction but it is not always the case.

In line with new technologies
Engineering studies for retrofitting engines from single- to multi-fuel, to reduce the environmental footprint and improve your fuel bill.

Shaping your environmental strategy
Compilation of modelled air pollutant and greenhouse gas emission inventories of vessels at national, regional and local level, and shore-side port operations at local level.

Unwanted emissions
Choosing the most cost-effective way to reduce exhaust emissions is essential in the marine industry.

Monitoring the comfort
NVH benchmarking and simulation, Transfer Path Analysis (TPA), Structural Dynamics Analysis and intake and exhaust noise simulation.

Retrofitting for success
From fuel system, lubrication system and cooling packs to emissions control technologies. Simulation of different running modes, validation, performance and durability tests.

NOx under control
Reduction of NOx emissions from all combustion engines is essential to improve air quality. Ricardo can tailor an exhaust NOx control with significant efficiency requirements.

Aftertreatment technology in your hands
Full range of services for exhaust emissions control implementation from initial specification and design through to control and calibration of the final solution.

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