Materials,
Technology & Innovation
We simplify complexities through our expertise, making what seems impossible, possible.

Make it sure, make it simple.
Leveraging our extensive know-how in the field of materials, technologies and innovation, we create value for our clients throughout the entire lifecycle of projects, from R&D to asset management including technological transfer from research projects to the best innovative solutions for the industry.

**Product & process development**
Thanks to our innovative thinking approach, we team up with our clients to face the technical and non-technical challenges of increasingly competitive markets. We support them in strengthening their technical know-how, giving them a vital competitive edge by improving the quality and sustainability of their products. We offer R&D projects and consulting services to support companies in process and product development, starting from the strategic evaluation of the technical scenario, to product design, process upscaling and market uptake, taking into consideration smart manufacturing technologies such as big data, analytics and additive manufacturing. Thanks to multidisciplinary teams and a deep knowledge of applications across all sectors we create value by cross-fertilising ideas between different markets, unlocking engineering productivity and driving value across production and the supply chain, providing innovative solutions for energy efficiency, special waste treatment and valorisation.

**Asset integrity management**
To maximise the availability and safety of large, high-value assets, our clients know they must invest in asset design, integrity and reliability assessments at each stage of the asset’s lifecycle. Thanks to the great experience gained over the years working for both material/component producers and end users we provide clients with a deep knowledge of typical in-service engineering requirements and how they can be affected by material and product performances. State of the art testing capabilities at both laboratory and real scale level allow us to validate the proposed AIM solutions.
We start by identifying the drivers that encourage a company to innovate. We analyse all possible evolution opportunities, giving them the required information to take a strategic decision, and work on the technological, market and business model aspects, to illustrate the technical and economic feasibility of their project and set up a strategy for intellectual property management.

**Innovation drivers analysis:** we set clients targets through a company assessment, organising brainstorming sessions, smart game-based workshops and interviews.

**Idea generation:** we develop evolution roadmaps showing all the opportunities for new business and explore different solutions, both in current and alternative markets.

**Landscape analysis:** we support our clients in understanding the competitive environment (positioning map) where they are positioned or are evaluating from four perspectives: IPR, technology, competitive network, market.

**Conceptual design:** support in the development of innovative product concepts, providing a set of block flow diagrams, sketches and preliminary 3D designs for further development activities.

**Market strategy:** we define a market strategy and business plan to help drive future strategy, monitor progress and acquire funds from potential investors.
Driving innovation

Main projects

LATEST INNOVATION AND EMERGING TECHNOLOGIES FOR ROCK FRAGMENTATION
Client: Confidential
Location: Confidential

Technology scouting and intelligence activities for the selection of innovative and effective technological opportunities for enhancing the drill & blast process including technology road mapping and evaluation of the most promising solutions, development of innovative conceptual designs, setting-up of a preliminary plan for development and integration of the identified technologies, detailed analysis of the most promising solution and confidential management of the identified providers.

IDENTIFICATION OF INNOVATIVE TECHNOLOGIES FOR THE RE-DESIGN OF A RIFLE RECOIL PAD
Client: Confidential
Location: Confidential

Analysis of technical requirements for the application and identification of innovative materials and structures with comparative analysis of the identified solutions, production of samples to be tested using a 3D polymeric printer and confidential management of the selected technology providers.

BUSINESS PLAN DEVELOPMENT FOR A HEALTHCARE SME
Client: Confidential
Location: Italy

Market analysis at a global level with the identification of main market segments, development of an ad-hoc penetration strategy, definition of the strategic paths for delivering the new product to the market and preparation of a complete business plan.

KET4DUAL: STUDY ON THE DUAL-USE POTENTIAL OF KEY ENABLING TECHNOLOGIES
Client: European Commission / EASME / Executive Agency for Small and Medium Sized Enterprises
Location: Belgium

Identification of highly relevant dual-use areas of innovation for cross-cutting key enabling technologies with analysis of possible synergies between these innovation areas and previous FP7, Member State and European Defence Agency activities.
With our experienced, creative multi-disciplinary team of engineers we transform an idea into an engineered concept using the most advanced numerical codes and design tools. Product design is optimised by FEM (Finite Element Method), CFD (Computational Fluid Dynamics) analyses and virtual testing considering complex physical phenomena and advanced materials in the following fields: structural mechanics (FEA), vibrations and fatigue analysis, CFD, thermal management, impact and crash analyses, coupled multi-physics. We use lifecycle thinking instruments to support strategic decisions through the assessment of economic and environmental impacts, paving the way for product certification.

**Prototyping & testing**
We support clients in prototyping the developed design and testing it in a relevant environment using rapid prototyping with 3D printing machines, design of experiment to optimise test campaigns, material testing & prototyping and process development and validation (both from laboratory scale to full scale) demonstrator setup combining mechanical and mechatronic skills and prototype and small series production.

**Scaling-up**
We provide with guidelines towards industrialisation allowing clients to fill the gap between prototype production and series manufacturing. Our approach uses a step by step analysis of the production chain to identify strengths and weaknesses of the process under examination including an assessment of environmental footprint and social implications.
From ideas to engineering concepts

Main projects

FEM DYNAMIC ANALYSIS ON ELECTRIC MOTORS
Client: Confidential
Location: Italy
Provision of a Finite Element Response Spectrum analysis carried out on an electric motor subjected to a dynamic load (earthquake). The electric motor model was composed of four main components (shaft, motor housing and two shields) and the shields were connected to the motor housing through bolted connections while the shaft was connected to the shields through two supports where bearings were housed. The numerical analysis was conducted using an FEM approach.

INNOVATIVE BENCHMARK TECHNOLOGY FOR AIRCRAFT ENGINEERING OPTIMISATION
Client: European Commission (FP7-Aeronautics and Air Transport)
Location: Belgium
Development of numerical platform and strategy (www.rbf4aero.eu) allowing aeronautical design engineers to run cross-solver applications by using their own numerical models and computing platforms. The numerical platform allows for multi-objective and multi-disciplinary optimisation (MOO/MDO), CFD optimisation through adjoint-morphing coupling and ice growth simulation.

DESIGN OF THE UPSCALED PROCESS FOR NCC-FOAM PRODUCTION
Client: European Commission
Location: Belgium
NCC-FOAM EU PROJECT - G.A. 604003 including design of the unitary processes and of detailed process flow diagrams with material streams, supporting services and primary equipment such as pumps, compressors and reactors / vessels, definition of the material flow rates for the various streams according to the desired plant capacity using material and energy balance calculations and analysis of parameters such as temperatures and pressures.

ECOLAUNCHER - FUNCTIONAL ECOLOGY TO REDUCE LAUNCHERS IMPACT ON DEEP SEA
Client: ESA / ESTEC
Location: The Netherlands
Quantification of the impact of Vega and Ariane 5 launcher components on deep sea ecosystems and the provision of a basis and recommendations for future work through functional ecology; a branch of ecology that studies the roles and functions played by biological organisms in ecosystems to understand the specific impact of launcher materials on ocean ecosystems. The project is part of the ESA Clean Space Initiative, which promotes an eco-friendly approach to space activities.
Our renowned engineers provide a wide range of performance assessment services across all industry sectors, including laboratory and full-scale testing, type approval testing, and electrical, mechanical and materials testing in accordance with international industry standards or specific client requirements. We also provide independent design verification of products and third-party witnessing of manufacturing processes, factory acceptance testing and commissioning activities. Our expertise includes the assessment of electrical, electronic, mechanical, metallurgical, ceramic and polymeric materials.

For the Oil & Gas sector, our technicians and engineers are leading experts in numerical modelling and full-scale testing methods that aid in predicting the future performance of steel pipeline materials with anomalies such as dents, wrinkle bends, flaws in seam welds and vintage girth welds. We have over 40 years’ experience in assessing fracture control on steel gas pipelines according to API 5L and ISO 3183 standards using state-of-the-art models and experimental validation by fracture propagation testing in full-scale conditions. We are also highly qualified for testing and qualification of threaded premium connections for tubing and casing.

RINA is a leader in testing for plastic petrol pipes used in a range of different fuel applications. Mechanical, low and high temperature, fuel contact, weathering, electrical and pressure tests are carried out on a manufacturer's range of pipe and fittings. To exclude potential contamination permeating through the pipe wall, we conduct permeation testing on water pipes at our in-house intrinsically safe fuel test facility in the UK, and our rigorous methodology gives both the manufacturer and user full confidence in the test results.
Performance assessment

Featured project

**PREMIUM CONNECTION QUALIFICATION TESTING**
<Client: Tenaris  
Location: Italy>

Qualification of Tenaris top class premium connections for the oil & gas market according to stringent standards (i.e. ISO 13679 and API RP 5C5 testing protocols) due to the highly demanding performance levels required. RINA qualified components by carrying out complex full-scale testing activities to manage high pressures, high temperatures and cyclic mechanical loading on samples up to 20” diameter and 5m long, with an independent third party inspector witnessing the tests.

Main projects

**GEOGRID LIFE PREDICTION**
<Client: Tensar International  
Location: United Kingdom>

Tensar produces a geogrid product which is used to maintain the structural integrity in coastal protection. The geogrid needs to be capable of maintaining its tensile strength ‘as-new’ for 50+ years and RINA was engaged to perform a long-term ageing assessment. Samples were tensile tested, placed in synthetic seawater, aged for 12 months, and the tensile tests were repeated. Using the Arrhenius model, a life prediction for the material was calculated and results determined it would last well in excess of the 50+ years specified.

**TYPE TESTING OF A SINGLE CORE 11 KV XLPE CABLE**
<Client: Confidential  
Location: United Kingdom>

Our client’s customer requested an independent type-test of a single core 11 kV XLPE insulated cable to verify the manufacturer’s compliance with BS 7835. A subset of testing to IEC 60502-2 and BS 7835 was conducted on aged and unaged samples including conductor and screen resistivity, bend test, partial discharge, insulation and sheath mechanical properties, insulation hot set test, flame test and acid gas. Tests were selected on their significance to long term cable life.

**RAILWAYS BUMPERS ASSESSMENT AND CERTIFICATION**
<Client: Confidential  
Location: Italy>

Railways buffers are widely used to absorb crash energy. Our client wanted to start production of a new product and certify it for the rail transportation authority. RINA made a preliminary assessment of the product characterising the energy response curves provided under various operating conditions in terms of speed and angle of impact and used the results to improve the performances of the buffer before final testing.

**TENNIS BALL PERFORMANCE TESTS**
<Client: Confidential  
Location: Italy>

Tennis balls are produced for different courts as well as new types of games on the market. RINA was asked to evaluate the basic properties of the balls before and after ageing. A special testing programme was set up in order to strain the balls and to verify geometrical properties and bounce performances.
In today’s global market, innovation is the key factor for competitiveness. Thanks to our multidisciplinary approach, we can support clients across the entire innovation process, from concept to industrial application, including new product development, production optimisation, quality improvement through Industry 4.0 technologies with highly interconnected plant automation systems. To improve the environmental impact of processes we provide solutions for waste and water treatment and emission reduction. We are continuously requested to develop solutions for the steel manufacturing cycle, for a future where energy and resource savings, low CO2 emissions, tailor made performance steels and advanced control and monitoring devices for safer workplaces and processes all contribute to a truly sustainable life.

The RINA recommended quality mill approach is to finalise alloy design and relevant processes in order to obtain target microstructure. Such an approach requires know-how in terms of metallurgical modelling tools to quantitatively predict microstructure evolution as a function of key process parameters as well as final mechanical properties as a function of relevant microstructural features.

RINA’s offering is a ‘through process’ organised in suites, with each one covering all available technical assistance, modelling tools, automation, labs and pilot plants, from product development back to raw materials selection. With over 20 state-of-the-art laboratories and pilot plants we can reproduce complete industrial cycles and our experts can implement innovative solutions directly in our clients’ plants.
Material and product development & process

Featured project

GOES PRODUCTION TECHNOLOGY
Client: Confidential
Location: Europe

Design and development of a new production method to manufacture Grain Oriented Electrical Steel (GOES) used to build electric transformer cores. The new technology has been designed across the entire processing route from steel making (thin slab casting) to finished strips at a final thickness down to 0.23mm. The client successfully implemented the new technology and is now producing all GOES products up to the ‘top grades’.

Main projects

FORGING & HEAT TREATMENT OPTIMISATION OF LARGE DIE BLOCKS
Client: Confidential
Location: Italy

RINA supported several Italian forge masters in the process optimisation for forging reduction ratio (ingot casting, forging, heat treatment) including conventional and ESR melting. Both forging and quenching have been optimised with FEM support and by using our database material properties, taking into account individual forge master equipment constraints.

RECOVERY OF NICKEL FROM WASTE
Client: European Commission / Thyssen Krupp / Acciai Speciali Terni
Location: Europe

During the production of austenitic steel, large amounts of waste acid and neutralisation sludge accumulate in the pickling process which contain dissolved or combined nickel extracted from the value-added chain in the waste disposal. Together with chromium, nickel is one of the most expensive and most important alloying elements in austenitic stainless steel alloys. In this project, two processes for nickel recovery from waste acid and neutralisation sludge were successfully developed and their efficiency was investigated at pilot scale.

RF SENSOR DEVELOPMENT FOR CASTING MACHINE
Client: European Commission
Location: Europe

An innovative measuring system that uses radio frequency technologies for mould powder thickness and levels of molten steel in the mould of a continuous casting machine of long products. The system allows a dynamic measurement of the powder thickness with previously impossible accuracy and a measurement of steel level with greater range and higher speeds than the solutions currently available, all without the use of any radioactive source. The continuous measurement of the powder thickness represents a breakthrough technology.

DAINOX BRIGHT™
Client: Confidential
Location: Italy

Together with DANIELI, RINA developed Dainox Bright™, a process technology able to obtain cold rolled stainless steel strips with an enhanced surface quality, whilst maintaining capacity and operative costs of conventional A&PLs thanks to a dramatic reduction of the oxidation process during annealing. Chemical pickling treatment is reduced, which in turn creates an important cost saving and reduces the volume of waste solution to be neutralised.
Thanks to our comprehensive knowledge of materials and extensive laboratory capabilities, ranging from nanoscale to full scale, our specialists can provide a broad range of material selection services for specific technological applications. We can identify operating envelopes for diverse industrial applications, addressing enhanced safety in real operating conditions and also focusing on cost saving, and we conduct testing to qualify materials and provide experimental evidence of resistance against damage mechanisms, including those related to operation in very severe environments and extreme loading conditions. This allows our clients to achieve significant cost savings by using less expensive materials but still guarantees an adequate level of safety as well as launching demanding projects using materials under non-standards conditions. A recent approach offered by additive manufacturing (AM) uses integrated computational materials engineering in which microstructural and mechanical analysis is integrated with process parameters, modelling data and tomography defect analysis.

AM is defined as “the process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies, such as traditional machining”, and is rapidly expanding in a number of industrial sectors, providing design freedom and environmental / ecological advantages. It involves complex physical phenomena including melting / solidification and vaporisation, heat and mass transfer. RINA can map available AM methods and track technological trends and gaps, helping our clients select or design proper alloy compositions to achieve qualified components.
Additive manufacturing

The process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies, such as traditional machining.

Main projects

CHEMICAL INHIBITORS COMPATIBILITY TESTS
Client: Confidential
Location: Italy

Verification of chemical inhibitors and scale inhibitor compatibility with different materials such as steel, plastic and polymers that can interact with inhibitors. The tests were carried out according to Nace standards and the materials were exposed to temperature, pressure and to a specific inhibitor solution for a representative time duration. After exposure, a post-test analysis was carried out to highlight any alterations.

SARCO2B
Client: National Grid / Eni / Europipe / EPRG / DNV GL
Location: Italy

RINA was requested to set up a test to evaluate the pipe material ductile fracture propagation behaviour in case of failure of a high-pressure CO2 transportation pipeline. A real pipeline (210 m long made by 24"OD, 16mm WT steel) was filled with 60 tons of supercritical CO2 and 2 tests were successfully carried out assessing the compliance of the pipeline gas transportation material and improving the knowledge in this innovative area of study.

QUALIFICATION TEST OF NICKEL SUPERALLOYS FOR TURBINE BLADES
Client: Confidential
Location: Italy

Qualification tests at high temperatures (up to 1050°C) performed on CMSX4 and CMSX10 single crystal alloys. The test programme comprised creep, tensile, low cycle fatigue (LCF) and thermo-mechanical fatigue (TMF) tests. In particular the cycle time for TMF was analysed aiming to simulate the real transient conditions in aircraft engines. Clockwise and counterclockwise diamond cycle types were applied on bare and coated specimens to investigate their influence on the fatigue limit.

NEW ALLOYED MATERIAL QUALIFICATION
Client: Confidential
Location: Italy

RINA was asked to use our know-how to design and execute a specific testing campaign for assessing the new performances of a product to be used on the upstream Oil & Gas market against the severe operating conditions of interest for the final customers.
Our excellence in fracture mechanics, fatigue, stress analysis, material performance, mechanical testing and non-destructive inspection enables us to offer ECA services at the highest levels to assess imperfections typically originated during welding. Our clients attain significant cost savings and enhanced safety by gaining awareness of the possible effect of actual imperfections and their acceptability which helps them define a cost effective inspection and repair plan during installation and operation. Analyses are performed in compliance with recognised procedures such as BS7910 and API579 as well as procedures specific for the oil and gas offshore sector (DNV-OS-F101 and RP-F108). We make use of the most advanced approaches which allow relaxing the over-conservatism level and, consequently, we better define the rejection / repairing rate with respect to best workmanship criteria. We also provide component specific input data for these studies through state of the art testing (fracture mechanics testing on SENB and SENT specimens for CTOD and J-integral evaluation, low and high cycle fatigue testing, stress corrosion testing) and stress analysis to properly take into account all the loading scenarios, even when special conditions (for instance those driven by large displacement and strain applied) are considered.

Our specialists can perform non-linear numerical analyses for working out the applied driving force as well as large- and full-scale tests (segment testing, full scale four point bend testing) to validate the ECA final outcomes. Aggressive environments which might cause severe material damage (for instance due to the presence of H2S and CO2) are also taken into account both in the calculation and through testing. Finally, we can act as independent third-party to review ECA calculations carried out by other companies.
ECA services

Fracture mechanics  Fatigue  Stress analysis  Material performance  Mechanical testing  Non-destructive inspection

Main projects

FUGITIVE EMISSIONS MONITORING AND ESTIMATION  
Client: Confidential  
Location: Italy

ECA calculations to determine the maximum tolerable defect size of offshore sealines conveying oil & gas rich in hydrogen sulphide during both laying and operation. RINA was engaged to review the ECA calculations made by the project contractor, repeating them in order to check the numerical results and recommending calculation modifications where necessary.

ECA FOR OFFSHORE LINEPIPE BUCKLE ARRESTOR GIRTH WELDS  
Client: Confidential  
Location: Italy

RINA was asked to perform specialised fracture mechanics testing accompanied by devoted ECA analysis for determining the maximum tolerable defect sizes in the welded joints for the installation of offshore pipelines equipped with arrestors for preventing buckle propagation phenomena. Final validation testing was performed in order to prove of the ECA calculation results and reliability of the outcomes provided to the client.

ECA FOR OFFSHORE GIRTH WELDS  
Client: Confidential  
Location: Italy

A oil & gas client proposed two pipelines joined by a girth weld in the middle. Since the girth weld should have been carried out in the mill with at least the same quality of a lay-barge made girth weld, RINA was asked to determine the optimal testing plan and ECA analysis. Testing and ECA methodologies were set up according to the demanding installation and operation scenarios.

ECA FOR ONSHORE GAS PIPELINE  
Client: Eni  
Location: Italy

The aim was to verify whether the use of high-grade steel could affect pipeline tolerability resistance with respect to pipe body and girth welds defects. Experimental activities were carried out at real scale accompanied by ECA calculations in order to assess high-grade steel pipeline resistance in presence of various types of defect, considering environmental damaging effects. The results allowed application limits of high-grade steels for high-pressure gas transmission to be defined.
Our spectrum of mechanical, corrosion and electrical engineering knowledge and experience enables us to offer a broad range of fitness for service technical services, from on-site field support and defect assessments to complex finite element simulations to support any condition assessment programme. The assessment procedure evaluates the remaining strength of equipment in its current condition, which may be degraded from its original condition. Common degradation mechanisms include localised, pitting and crevice corrosion, hydrogen attacks, embrittlement, fatigue, high-temperature creep, and mechanical distortion, and a component of interest may contain flaws or other damage, or it may be subject to more severe operating conditions than the original design anticipated.

The typical outcome of a fitness-for-service assessment is a ‘go / no-go’ decision on continued operation or mitigation recommendations. Procedures are complex and require state-of-the-art analytical, metallurgical, mechanical tests and multidisciplinary engineering analyses with a combination of physical testing and interpretation thereof identifying principal affecting damage mechanisms under the prevailing operating conditions. Test results can also be used for a theoretical calculation of a component’s fitness for prescribed design specifications. Often, irreversible damages to the equipment also mean an alteration of the original design and production specifications is required, such as a lower rate of production or reduced stress condition.
Featured project

FITNESS FOR SERVICE OF COKE DRUMS
Client: Confidential
Location: Spain

RINA carried out an FFS assessment on cracks in coke drums, covering finite element analysis, and detailed stress analysis for critical loads including hydrostatic pressure, self-weight and thermal loads. Critical defect sizes and crack growth by fatigue were estimated using API / ASME FFS-1 579 guidelines. The critical defect dimensions were calculated and crack growth curves were predicted using a cyclic stress profile.

Main projects

CCGT RAPID INPECTION AND FITNESS FOR SERVICE
Client: Confidential
Location: United Kingdom

Our client runs a 515 MW combined cycle gas turbine (CCGT) power station in the UK, operating since 1994. Non-destructive testing identified defects in the high-pressure steam downcomers. We mobilised immediately for field replication and performed an onsite metallurgical characterisation of the defects, providing an assessment of critical defect size and potential fatigue crack growth and supporting a technical safety case for 12 months’ operation and 3,000 starts.

LNG OFFLOADING LINES AND TANKS
Client: Confidential
Location: Italy

RINA analysed the FFS state of existing LNG plant offloading lines and tanks to verify their suitability for a more intensive use as requested by the client. Their safety against any relevant failure mechanism (embrittlement, fatigue etc.) was been successfully verified and the FFS analysis results allowed the client to increase the frequency of loading / unloading twenty times whilst maintaining a suitable level of safety.

REGASIFICATION PLANT DAMAGED COMPONENTS
Client: Confidential
Location: Northern Europe

RINA was asked to perform an FFS analysis on components of a regasification plant that had suffered a fire, in order to assess whether they could be still safely used and, if so, according to what prescription. RINA's FFS analysis results defined a monitoring plan to allow the safe service of the components and preventing costly interruptions to production lines.

OFFSHORE HEAVY WALL THICK LINEPIPE
Client: Confidential
Location: Italy

A joint industry project was launched by the client involving oil & gas and engineering companies and aimed at verifying the behaviour of a heavy wall pipeline when subjected to combined loading. RINA was asked to perform full-scale FFS testing and non-linear numerical analysis in order to determine the working window limits to maintain the pipeline in operation even under the worst operational conditions possible.
We provide a systematic, phased approach to condition assessment, tailored to each client’s needs: from the initial asset life management strategy, reviews of plant design, operation and maintenance, through to effective inspection planning, fitness for service, remaining life assessments, and strategies for future asset management. Equipment failure requires a quick and expert response, and our team is adept at gathering forensic evidence and establishing the root cause of a failure, providing clear advice to prevent similar events in the future.

Determining the root cause of failure can be key to avoiding further costly mistakes, affecting both business performance and hard-earned reputations. RINA’s asset specialists and laboratory facilities help manufacturers, operators and other stakeholders understand why the failure occurred, the contributing factors, and provide information to prevent similar future events from taking place. We utilise our knowledge, expertise and analytical facilities to undertake forensic investigations and carry out root cause analysis of equipment from plant to component level.

We routinely support manufacturers, owner operators, insurers, loss adjusters, lawyers and stakeholders across all business and industrial sectors with single or joint expert witness testimony, preparation of legal arguments, site and laboratory based investigations, root cause analysis, capability on static, rotating, electrical and electronic equipment and access to advanced analytical techniques with guided support from an expert operator (e.g. SEM-EDX).
Systematic and tailored services

Main projects

**GAS TURBINE CONDITION ASSESSMENT**
*Client: Confidential*
*Location: Middle East*

Analysis of the service-run components of a 100 MW gas turbine, to review their condition and assess the potential for further safe and reliable operation of the machine. Our work included destructive examination of the blades, full stress analysis and fracture mechanics assessment. Using thermal analysis and analytical models we assessed their condition and the effect of refurbishment and repairs on operating properties.

**FAILURE INVESTIGATION OF X2 SAFETY CAPACITORS**
*Client: Confidential*
*Location: Scandinavia*

Identification of the root cause of the failures of polypropylene capacitors. The Scanning Electron Microscope (SEM) identified that capacitance loss was due to oxidation of the aluminium / zinc layer, and ion-chromatography identified free chlorine ions, which contributed to accelerated corrosion. Further analysis detected defects in epoxy filler allowing moisture ingress. We recommended batch sampling to help with component selection to avoid future failures.

**REMOTE CONDITION MONITORING**
*Client: The Carbon Trust*
*Location: United Kingdom*

The Carbon Trust was investigating remote condition monitoring on offshore wind farms to detect degradation prior to any sudden failure where such systems are required for online monitoring due to the remote locations. RINA assembled a multi-skilled team including power, asset and modelling consultants who identified a risk reliability cost model and techniques to monitor the condition of electrical components.

**DATA CENTRE FIRE INVESTIGATION**
*Client: Confidential*
*Location: United Kingdom*

Provision of a root cause and forensic engineering analysis of a fire in a data hall which caused damage to equipment and critical loss of service affecting a multinational bank. Through our onsite and laboratory investigations, together with fault simulations on suspected equipment, we concluded that a luminaire installation error caused the fire and that by inspecting all the remaining lamps the risk of reoccurrence was eliminated.
RINA consists of the parent company RINA S.p.A., the holding which controls the main sub-holdings RINA Services S.p.A. and RINA Consulting S.p.A. In order to ensure compliance with the applicable recognition, authorization, notification and accreditation rules, including those relevant to the management of impartiality, RINA has adopted a governance and organizational model. According to this model, the sub-holdings are subject to direction and co-ordination by the holding in the finance, administration, strategic, organizational, managerial and business continuity fields, while technical and operational decisions remain under the exclusive responsibility of the sub-holdings and their controlled companies. The strict separation of duties in the governing bodies and the impartiality risk assessment, which identifies and manages the impartiality and conflict of interest threats coming from the company relations, ensure compliance with the applicable impartiality rules.