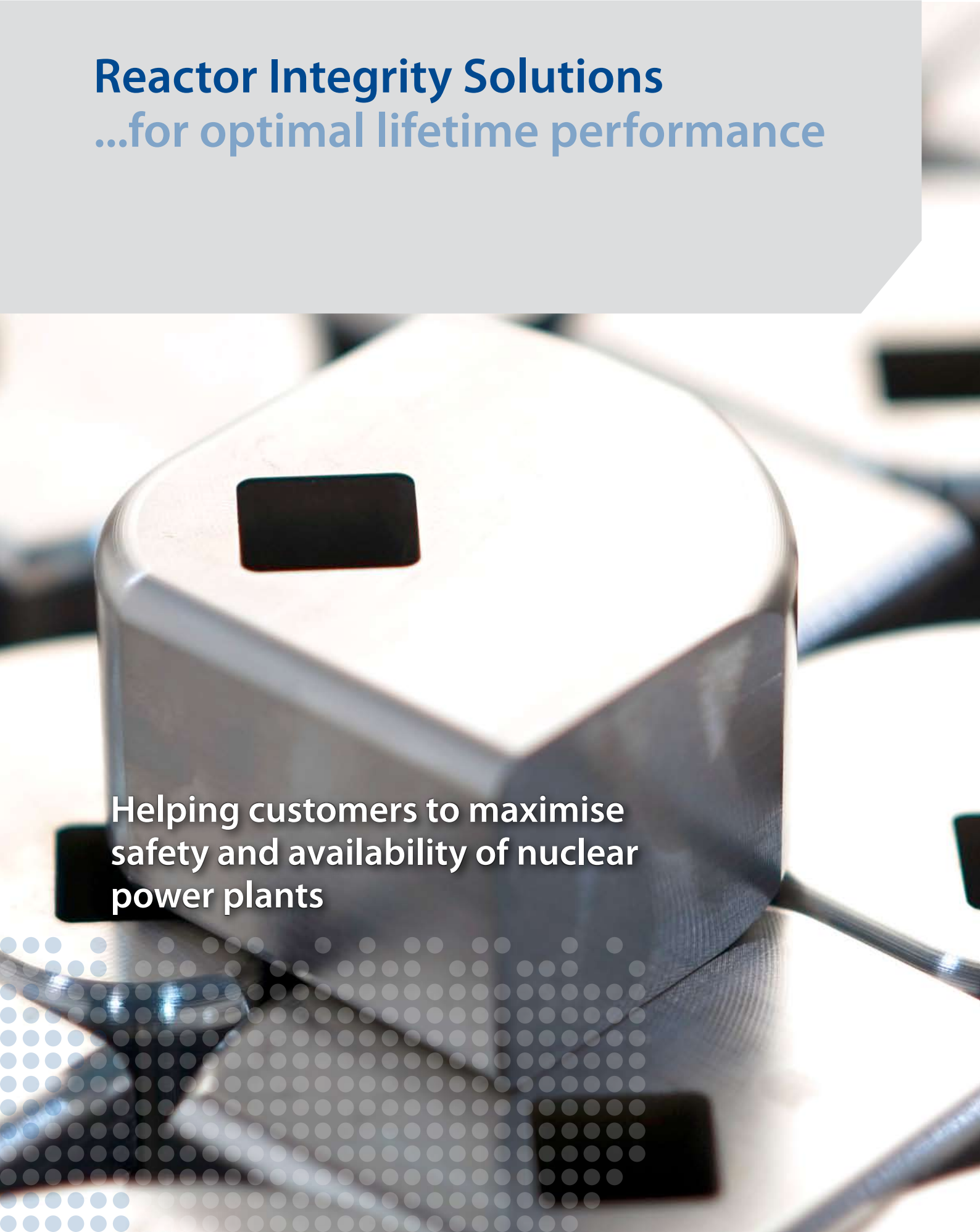
Rolls-Royce

Reactor Integrity Solutions

...for optimal lifetime performance



Helping customers to maximise safety and availability of nuclear power plants

Contents:

Tailored solutions for the lifetime of your reactor

Intelligent solutions to support demands for plant availability, predictability and long-term operation



With more than 50 years of experience in the design, build and operation of civil and naval nuclear plant, Rolls-Royce is ideally positioned to help customers optimise the future of nuclear energy by maximising the safety, availability and performance of nuclear plant while minimising unplanned outages.

Over the past five decades our nuclear capability has expanded and developed as nuclear technologies have advanced. Today, our expertise in the technologies that are driving forward the nuclear, aerospace, defence, marine and energy industries worldwide stands ready to work with customers to achieve outstanding operational excellence… far into the future.

Our comprehensive suite of engineering services support critical investment projects and meet customers demands for plant availability, predictability and long-term operation.

We have developed some of the most innovative solutions to enable the early identification and full characterisation of defects and the fastest resolution, minimising costly downtime. Our advanced technologies deliver solutions that allow access to the most remote and sensitive locations. Our technical expertise includes advanced in-service monitoring, inspection and repair. Our efficient non-destructive materials sampling and insitu repair techniques meet the most stringent regulatory demands.

Reactor Integrity Solutions

A comprehensive portfolio of reactor services and solutions, helping customers to achieve optimal lifetime performance

DEFECT AVOIDANCE

- Plant monitoring
- Reactor chemistry services
- Equipment health management
- Care and maintenance advice

COMPONENT REPAIR

- In-situ component maintenance and repair
- Solution development
- Special purpose machinery
- Reverse engineering
- Active component refurbishment and repair
- Prototyping and testing
- Training & implementation

INTEGRATED SOLUTIONS

- Fleet implications
- Gated review process
- Implementation planning
- Solution selection
- Project management

DEFECT CHARACTERISATION

- Inspection services
- Material sampling
- Metallurgical analysis
- Defect modelling
- Manipulator design
- Remote operations
- Risk based ISI

COMPONENT ANALYSIS/DESIGN JUSTIFICATION

- Safety case engineering
- Analysis beyond ASME requirements:
  - CFD
  - Stress
  - Thermal
- Mechanical component design, verification and validation
- Design justification and substantiation
- Residual lifetime assessment

Rolls-Royce offers tailored engineering solutions in support of the total lifetime management of your critical asset investment.

Defect Avoidance

Protecting component and plant integrity through world-class monitoring and maintenance solutions



- Plant monitoring
- Equipment health monitoring
- Reactor chemistry services
- Care and maintenance advice

Rolls-Royce offers a comprehensive monitoring package to determine actual plant state, repair strategies and safety case justification.

Nuclear operators face increasing challenges of ageing plant. Preventative maintenance programmes are necessary to maintain safety and plant integrity, and the long-term availability of components.

Rolls-Royce offers a comprehensive monitoring package to determine actual plant state, repair strategies (including difficult to access areas of the plant) and safety case justification.

We have extensive expertise in plant monitoring solutions that enable the constant monitoring of plant parameters and integrity of components.

Equipment health management is a key tool that can help utility operators move to a more predictive and proactive management of assets. Rolls-Royce has extensive equipment health management expertise gleamed from its aerospace and energy business. Equipment health management applies a set of mathematical models and techniques to monitor equipment and detect anomalies. This allows remedial action to be undertaken prior to functional failures occurring, while minimising spurious alerts.

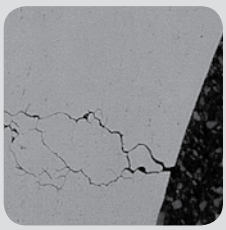
Rolls-Royce has more than 50 years of specialist knowledge in the fields of nuclear materials, chemistry and corrosion and offers technical services across the reactor lifecycle, from design to plant life extension (PLEX).

Services include:

- Equipment heath management
- Materials selection, validation and predictive models
- Development of chemistry specifications and modelling tools
- Detection of negative effects to ensure safety margins are not reduced significantly
- Monitoring of effects before loss of integrity and plant availability become a concern
- Dedicated interface with plant owner for plant management
- Operational plant support

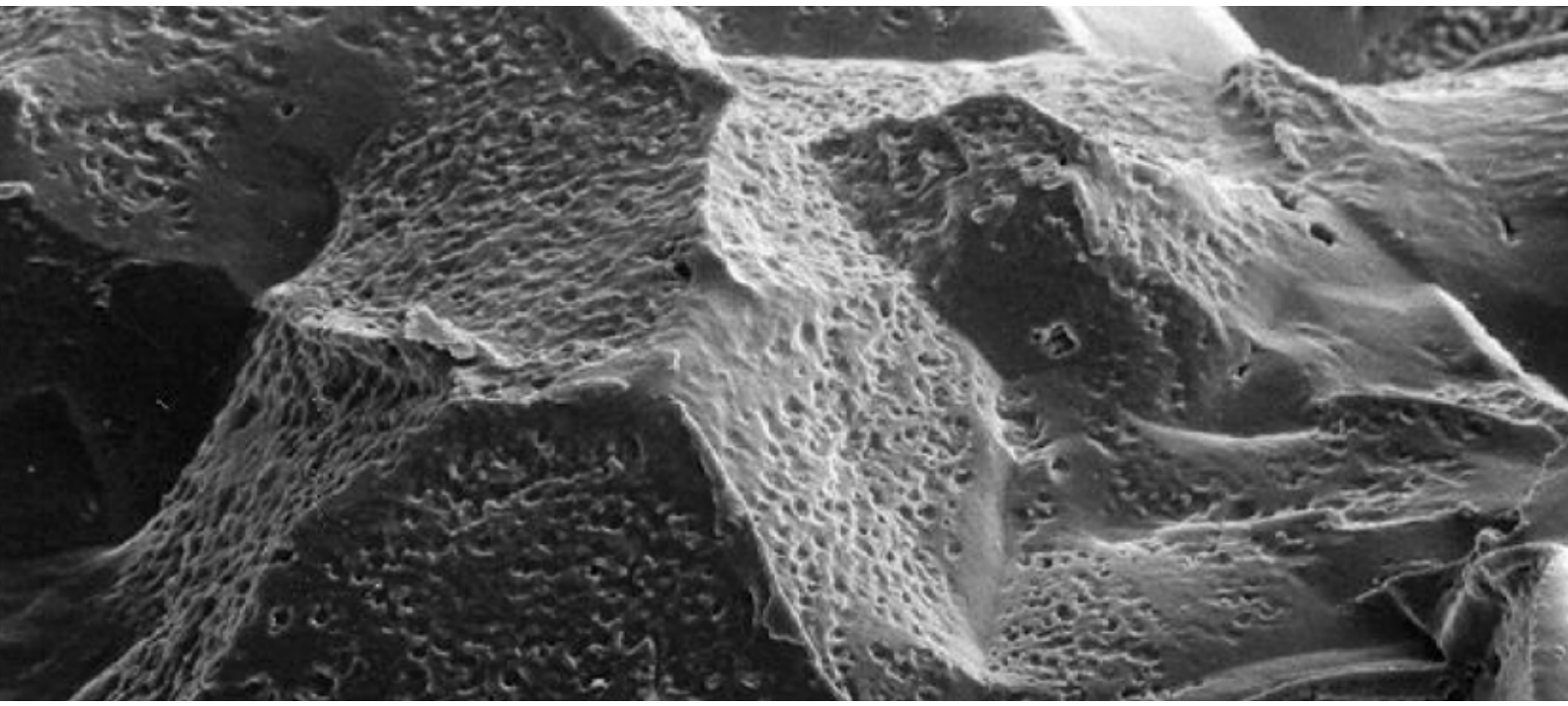
Defect Characterisation

The fastest inspection and sampling techniques to minimise costly downtime

- Inspection services
- Material sampling
- Metallurgical analysis
- Modelling
- Manipulator design
- Remote operations

Whether meeting requirements planned well in advance or providing a rapid response to emergent problems, we will work with you to achieve minimised downtime and optimal performance.



Rolls-Royce has extensive expertise in inspection, ageing management, technical support and analysis techniques. The inspection techniques we deploy are unique to our customers because no two challenges are quite the same. We address considerations such as components, materials and the space envelope as well as much more.

Our novel and highly efficient non-destructive materials sampling and in-situ repair techniques have satisfied the most stringent regulatory requirements and have supported extended operational lifetimes. Rolls-Royce has developed some of the most complex engineering solutions for advanced in-service inspection and repair techniques that allow access to remote and irradiated locations. Whether meeting requirements planned well in advance or providing a rapid response to emergent problems, the same level of quality and attention to detail is applied.

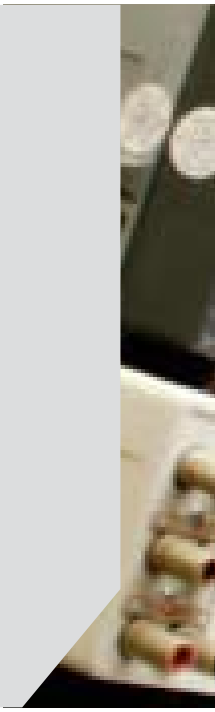
Applications include:

- Visual inspection (including metallurgical methods)
- Materials sampling
  - Scoop sampling
  - Boat sampling
  - Core sampling
- Phased array ultrasonic inspection
- Ultrasonic inspection
- Eddy current inspection
- Computed radiography inspection
- Surface detection inspection and metallurgical replication
- Underwater replication
- Electromagnetic interference monitoring
- Irradiation damage analysis (3D atom probe)
- Noise and vibration examination
- Alternating current field measurement
- Alternating current potential drop
- Defect Modelling

Component Analysis/Design Justification

Complete product life cycle solutions helping customers maintain the highest level of plant performance



- Safety case engineering
- Analysis to ASME and RCC-M requirements and beyond
  - CFD
  - Stress
  - Thermal
- Mechanical component design, verification and validation safety
- Design justification and substantiation
- Residual lifetime assessment
- Risk based ISI

Engineering analysis expertise to help customers justify the on-going structural integrity of their facilities.

Rolls-Royce provides complete reactor lifecycle solutions from initial concept design through to testing and provision of through life technical support. Our analysis expertise includes design optimisation, operating parameter assessment and modelling of abnormal events. We operate and support a number of licensed sites and our expertise in design, analysis and specification development delivers design solutions which meet with site licensing compliance.

Our engineering analysis capability is second to none in disciplines including materials, metallurgy and mechanical design of reactor cores, criticality analysis and design, stress and thermal analysis. These techniques are specifically required to monitor and analyse the ageing mechanisms within the plant in order to justify the ongoing structural integrity.

Systems and components are designed to meet safety functional requirements defined by the nuclear, environmental and conventional safety cases. The designs are subject to robust substantiation through calculation, modelling and validation testing, commensurate with their safety significance. The full product lifecycle is supported from front-end design to in-service support and assessment of existing systems, including obsolescence support.

We have managed lifetime extensions to more than 50% of the UK's submarine fleet and have developed a robust methodology for justifying and managing continued long-term operations incorporating:

- Baseline data review
- Components and systems assessment
- Risk based balance of investment
- Risk based in-service inspection

We have a broad range of industry standard design and analysis tools, and the design capability to meet ASME-N and RCC-M codes for nuclear and non-nuclear applications.

Services include:

- Structural integrity
- Thermo mechanical knowledge
- Finite element analysis
- Fatigue
- Vibration
- Acoustics
- Fracture mechanics
- Robust design, optimisation and probabilistic
- Seismic dynamics
- Impact and shock analysis
- Non linear material damage
- Residual lifetime assessment

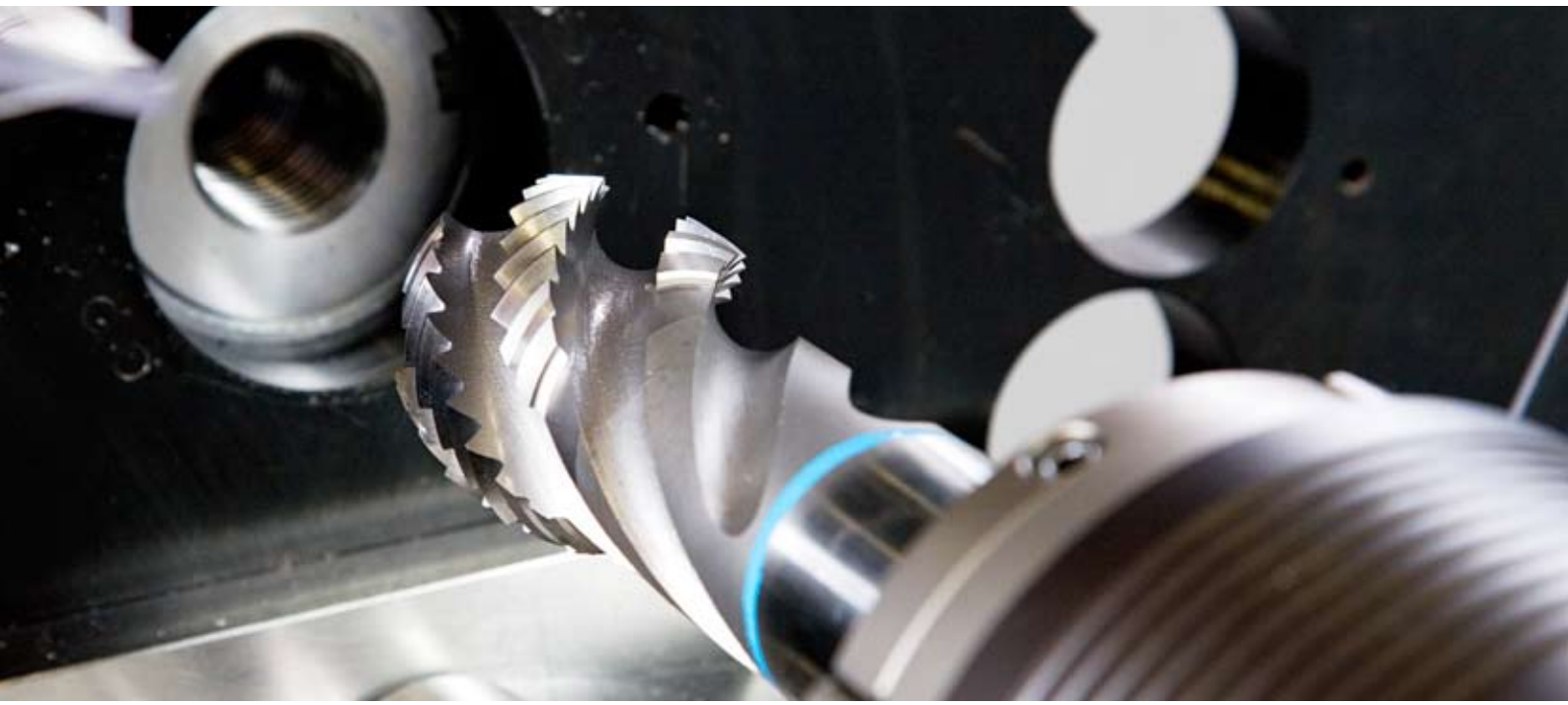
Component Repair and Refurbishment

Tailored solutions developed and deployed with speed and precision




- In-situ component maintenance
- In-situ component repair
- Solution development
- Special purpose machinery
- Reverse engineering
- Active component refurbishment
- Component repair
- Prototyping and testing
- Implementation
- Pre-prepared techniques

Helping customers proactively manage nuclear plant repairs and providing the mobility to respond rapidly to emergent repair work.



Often, refurbishment options offer customers a cost-effective alternative to new components. Rolls-Royce offers a comprehensive suite of repair and refurbishment capabilities for nuclear plant.

With extensive experience in support of both civil nuclear reactors worldwide and the UK's naval nuclear submarine programme and, Rolls-Royce is experienced in a range of in-situ repairs, active refurbishment of contaminated and active equipment and the replacement of failed, worn or obsolescent parts.

Replacement components may be built to print or reverse engineered to meet original requirements and modern standards.

Our facilities are designed to handle the receipt, strip, inspection, assembly, testing and dispatch of active nuclear components including main coolant pumps and reactor pressure vessel heads.

Our dedicated nuclear rig development and test laboratory facilities are specifically designed and utilised in support of our civil and naval nuclear programmes.

Applications include:

- Transition weld full repair
- Aqua and chemical cleaning
- Post-weld heat treatment
- Non-destructive examination / remote visual inspection
- Metallurgical support
- Obsolescence management
- Equipment calibration and asset configuration control
- Integrated pressurised test loop for the testing of NSSS equipment
- System and equipment interface test rigs

An integrated approach

...committed to your success

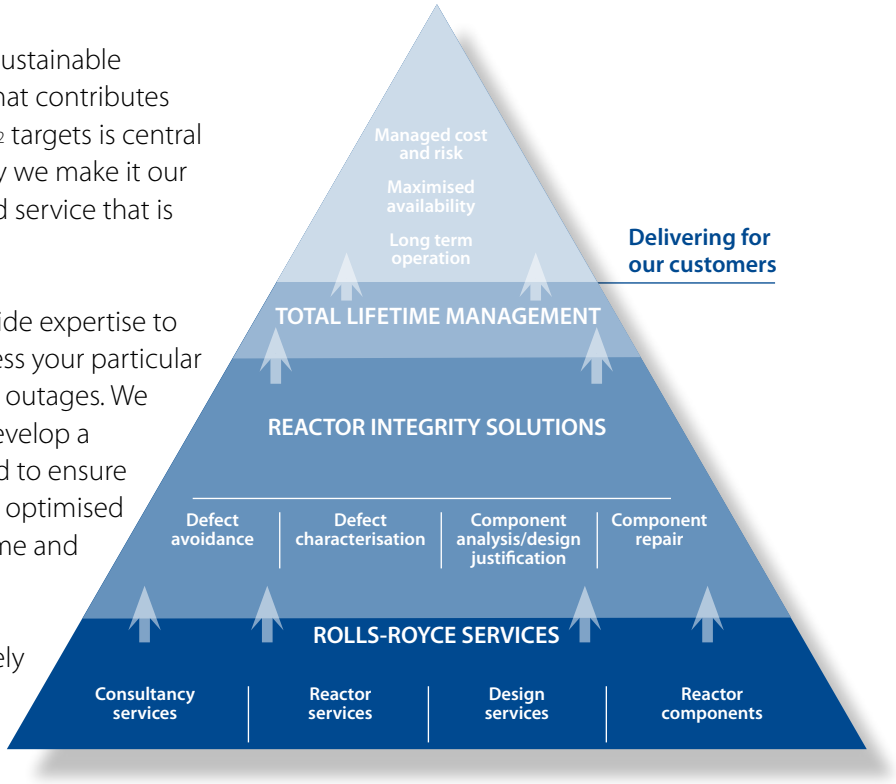


We understand that ensuring safe, sustainable and reliable electricity generation that contributes significantly to achieving global CO_2 targets is central to your business strategy. That's why we make it our business to offer a truly value-added service that is tailored to your needs.

Rolls-Royce can draw on its worldwide expertise to develop bespoke solutions to address your particular needs for planned major and minor outages. We can also work closely with you to develop a lifetime management plan designed to ensure that your critical asset investment is optimised for the duration of its planned lifetime and beyond.

And the real added value you can rely on from Rolls-Royce is our ability to draw upon our group-wide capability of multi-disciplined engineering excellence to deliver a flexible, responsive and integrated approach to address your emergent, unplanned needs.

When you face unexpected operational challenges, we can deliver a technically viable and fully validated solution that will minimise costly downtime and get your plant operational as quickly as possible.



With Rolls-Royce, you can be assured of higher quality and greater value from a partner you can trust...

A responsive solution to address your individual needs:

Initial Multidisciplinary Team mobilised to:

- Contain
- Quantify
- Evaluate
- Inform

Concurrent Engineering to minimise plant down-time:

- Safety Case
- Design/Justification
- Development of Tools & Techniques
- Implementation Plan & Training
- Specialised Support

Justify continued Through Life Operation:

- Safety Case
- TLMP

Minimised downtime and optimal operational performance for the customer

24hrs 7 days a week response service so your emergent challenges are addressed immediately...

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