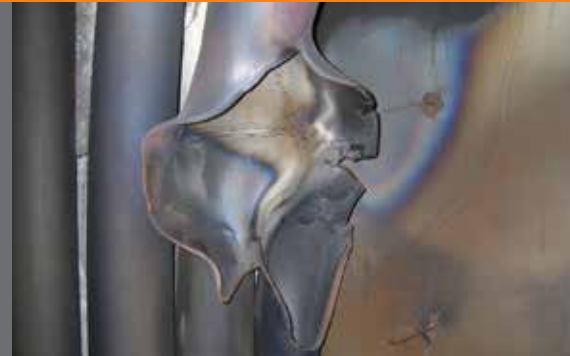


# ROOT CAUSE FAILURE ANALYSIS



## BACKGROUND

Failures can have catastrophic outcomes, including major economic costs, tragic human loss and sometimes public embarrassment. Understanding the causes is necessary to prevent future failures. Our technical specialists investigate the modes of failures and their root causes.

Our investigations often include examination of design issues, materials of construction, manufacture, fabrication and operating conditions and practices.



## EXPERIENCE

Failure investigations include:

- Rotating equipment such as gas or steam turbine blades, hot gas path items and gearboxes
- Aircraft wheels, propellers, rotor blades, frames and fasteners
- Steam reformers, HRSG and boiler tubes and headers
- Titanium and stainless steel heat exchangers
- Overhead power line components and trolley bus and railway catenary systems
- Pumps, compressors, shafts and crackshafts
- Geothermal energy plants
- Underground pipes
- Gas cylinders and valves

Applicability:

- Industrial plants
- Fossil power plants, hydro power plants, geothermal energy plants, refineries, petrochemical plants, process plants, underground services
- Transport: aircraft, automotive, railway
- Regulatory authorities
- Buildings and structures

## BENEFITS

- Experience in a wide range of failures
- Independence and confidentiality
- Knowledge of a wide range of analysis and testing equipment and procedures
- Back-up of an extensive range of analysis and testing equipment
- Large international network of specialists
- Global operation with one of the largest materials consultancy organizations within Australasia and South East Asia
- Leading-edge research facility with renowned specialists



## SOLUTIONS

For failures with a safety or regulatory consequence, our engineers and metallurgists are skilled in conducting comprehensive Root Cause Failure Analysis (RCFA).

In addition to developing detailed technical explanations and supporting evidence for failures, we also help to determine and eliminate defects in design and operational practices to prevent the recurrence of similar failures. The analysis may include determining fitness-for-service and prediction of remaining service life.

Our specialized capabilities include:

- On-site evaluations
- Fracture mechanics analysis
- Finite element stress analysis
- Product testing
- Corrosion assessment
- Root cause failure investigations
- Metallurgical assessments and materials testing of new, used and failed components and equipment
- Fatigue failure reconstruction and analysis
- Forensic examination
- Preparation of expert testimony with supporting evidence for use in mediation, arbitration or litigation
- Defect assessment, structural integrity and fitness-for-service
- Remaining life assessment of assets with detected cracks or other damage
- Mechanistic corrosion assessments
- Failure-related materials research and support testing

Typical examples of Root Cause Failure Analysis involving a wide range of specialized expertise:

- Detailed condition assessment of components including blades, vanes, combustors and their respective coatings
- Detailed metallurgical failure assessment to identify damage mechanisms such as creep, thermal fatigue and stress corrosion cracking
- Local and general oxidation and hot corrosion rates
- Extensive database of alloy material properties
- High resolution electron microscopy and chemical analysis
- Inspection and operation history, including data trending
- High temperature mechanical testing in our laboratory
- Critical stress calculation by analytical or finite element solutions
- Remaining creep life determination of gas turbine blades