



# ENGINEERING SERVICES

## INDUSTRY LEADING ENGINEERING EXPERTISE

MHI Compressor International (MCO-I) utilizes over a hundred years of engineering expertise and proven design manuals when servicing all equipment. Our state-of-the-art service center, Pearland Works, is equipped with the latest in reverse engineering measurement tools, used by trained engineers and technicians. We work in close partnership with the hundreds of steam turbine and compressor design engineers in Hiroshima to bring our advanced technology to your machinery.

Our standard approach is to gather dimensional data, construction details, and material information in order to understand the original design intent. We then apply our proven designs within the existing envelope—injecting our Mitsubishi technology into any manufacturer's equipment.

## REVERSE ENGINEERING SERVICES

### Aerodynamic Design

- CFD
- Internal re-rates and re-rotoring
- Steam turbine
- Centrifugal compressor

### Complex Finite Element Analysis

- Structural redesign
- Harmonic analysis
- Thermal analysis

### Rotor Dynamics

- Analysis
- Stability improvements
- Bearing design

### Design Experience

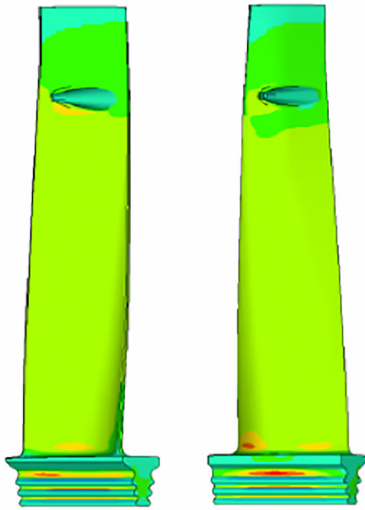
- Standard component designs
- Manufacturing process standards
- Broad fleet history

### Site Evaluations & Diagnostics

Recommendations and evaluations for preventative maintenance, modernization, and upgrades



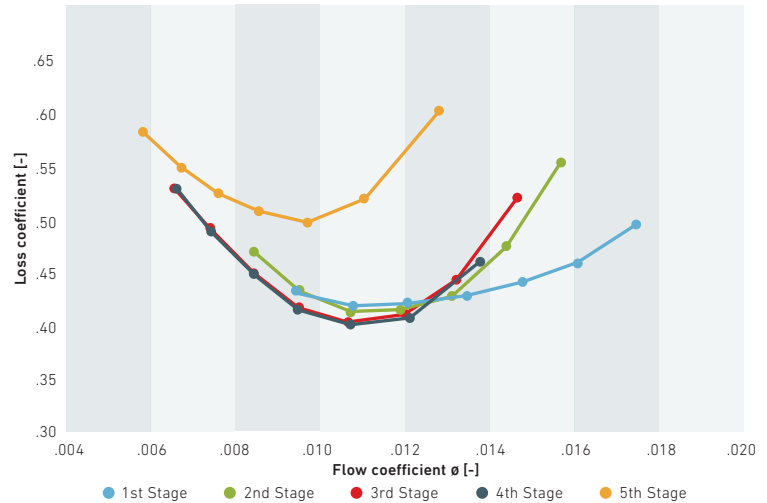
## SERVICE EXAMPLES



### Blade Analysis

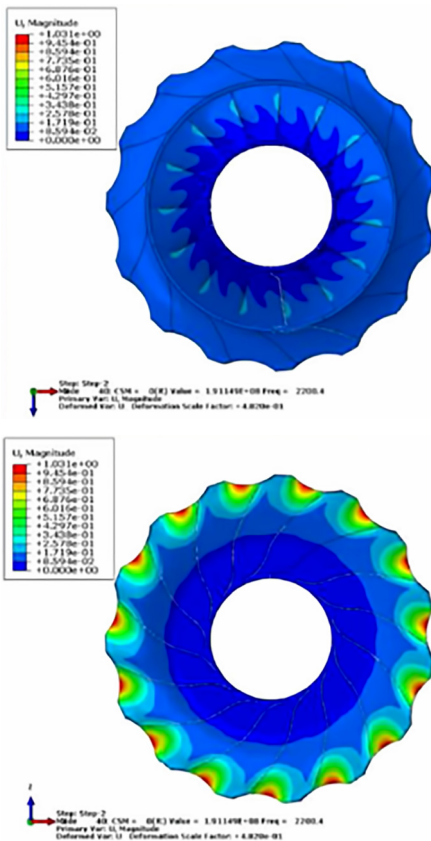
- Reverse engineer existing blade
- Analyze loads on the blade—report failure point identified by customer
- Redesign based on MCO standards—material and configuration—to reduce harmonic excitation

ROTOR VANE LOSS COEFFICIENT



### Aerodynamic Evaluation

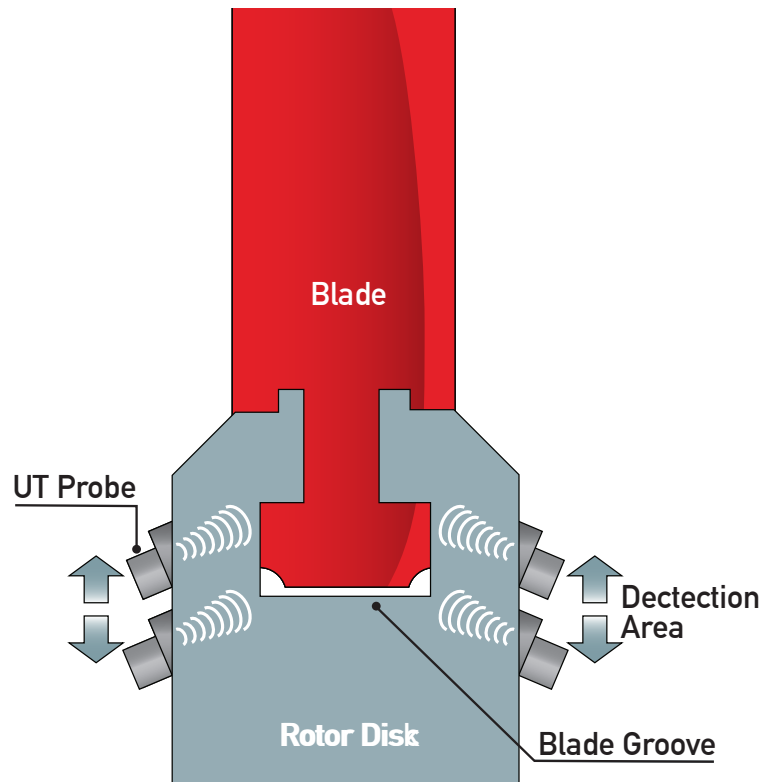
- Model the customer's compressor rotor and diaphragms
- Perform 3D CFD analysis of performance on the original configuration
- Perform 3D CFD analysis on newly proposed configuration
- Analyze additional performance cases (different flows etc) at the new configuration



### Root Cause Failure Analysis and Structural Redesign for a Compressor Wheel

#### Project Scope

- Perform root cause failure analysis on repeat failed impeller
- Model impeller and review structural loads
- Redesign to eliminate high stresses
- Modify existing impeller



### Stress Corrosion Cracking

#### Project Scope

- Identify cracks in T-slot roots using ultrasonic inspection methods (phased array)
- Redesign blades for a fir tree root, reducing stresses by around 30%
- Use state-of-the-art sub arc welding machines to re-weld the disc followed by axial entry milling to convert to fir-tree roots.