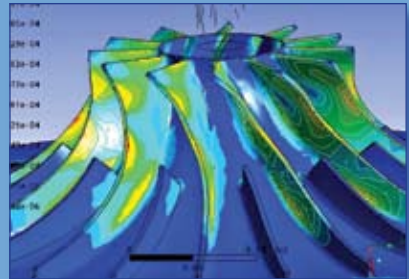
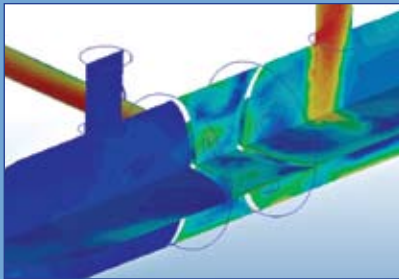
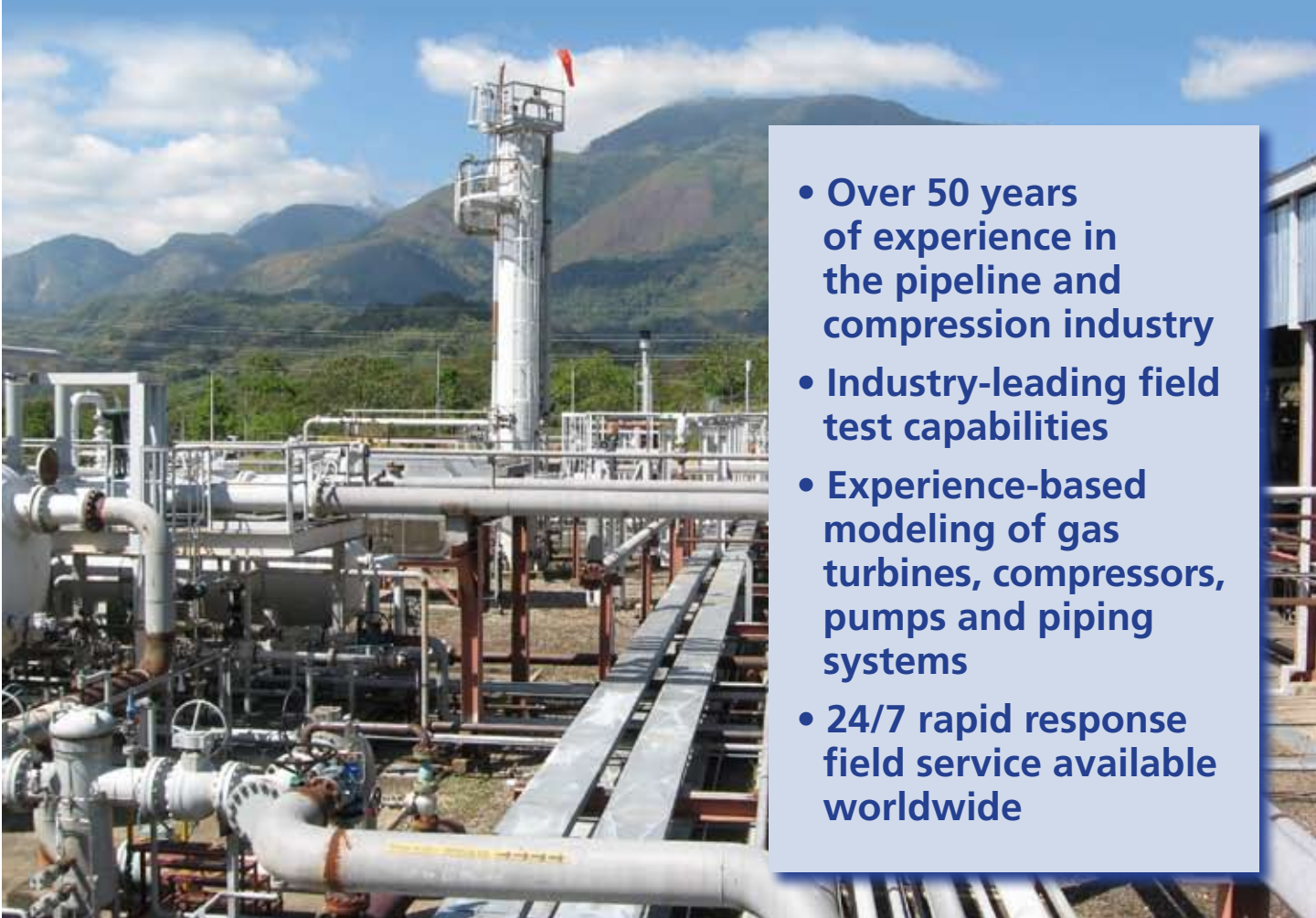


# Engineering Services for the Pipeline & Compression Industry



- Over 50 years of experience in the pipeline and compression industry
- Industry-leading field test capabilities
- Experience-based modeling of gas turbines, compressors, pumps and piping systems
- 24/7 rapid response field service available worldwide



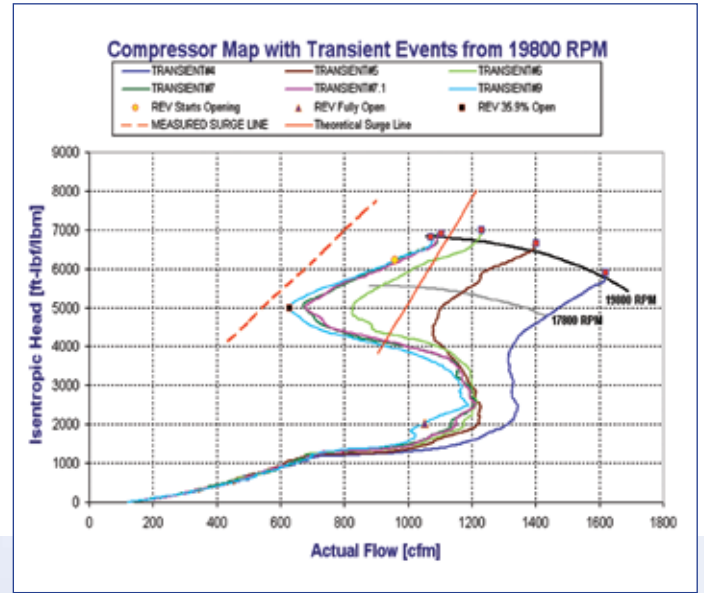


### Machinery Troubleshooting

- Diagnose machinery and piping system vibration problems
- 24/7 response team for field testing
- Accurate vibration, pulsation and performance measurement
- Advanced instrumentation and diagnostic tools

### Root Cause Failure Analysis

- Multidisciplinary forensic investigation of failed plant systems and machinery
- State-of-the-art materials and corrosion analysis laboratories
- Identification of failure mechanisms using advanced engineering analysis tools
- Code and standards compliance verification



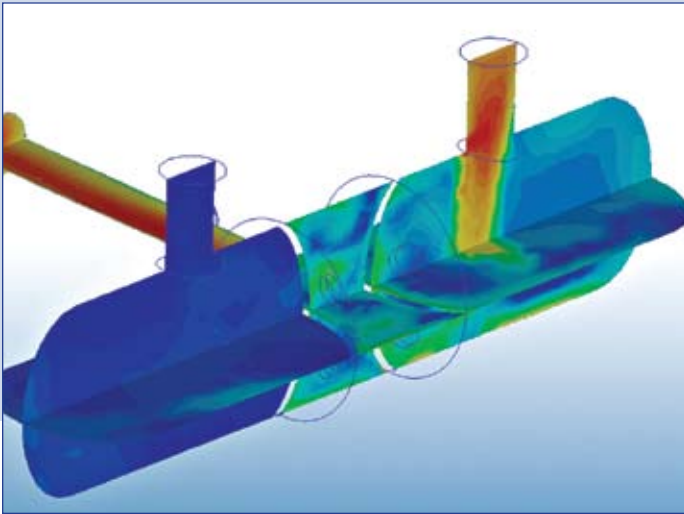
### Field Performance Testing

- Power and efficiency measurements of compressor, turbines and pumps
- Test performed to ASME PTC-10, PTC-22 and PTC-46 requirements – industry-accepted guidelines for field testing
- Calibrated instrumentation for lowest uncertainty
- Condition monitoring tools

### Transient Surge Analysis

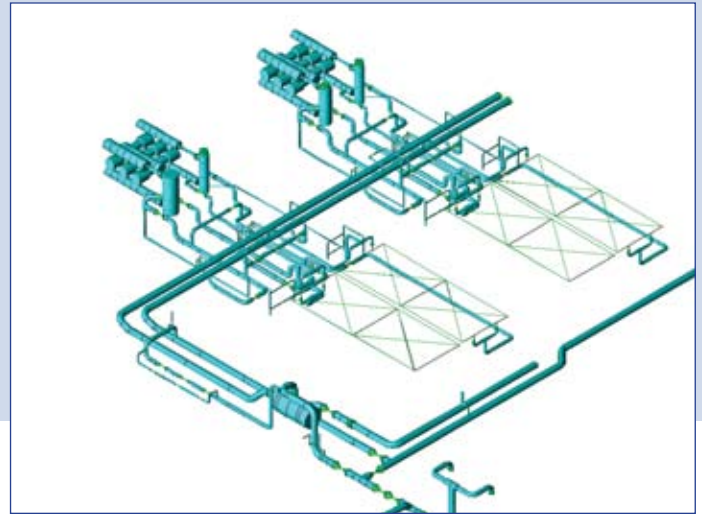
- Simulation of complex centrifugal compressor stations operation sequences
- Evaluation of startup, normal operation, stops and emergency shutdowns
- Risk analysis and recommendations for surge avoidance
- Validated transient surge models using closed loop, natural gas test data

*SwRI has designed and analyzed more th*



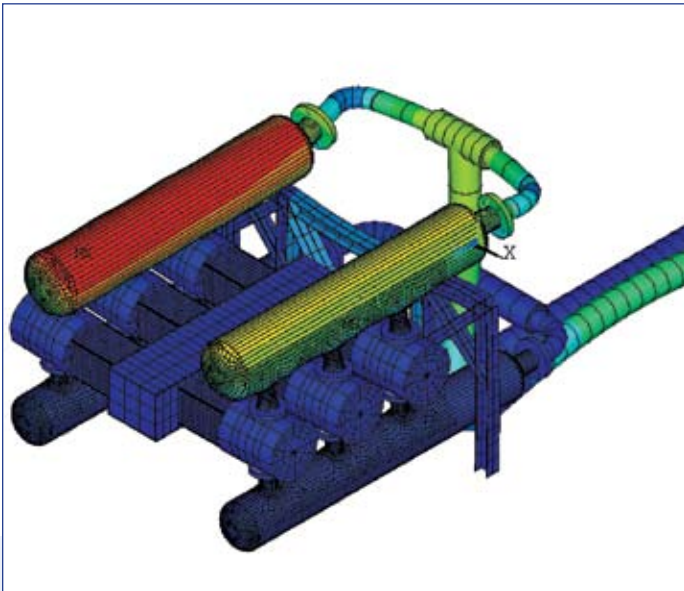
### Pulsation/Acoustic Analysis

- API 618 reciprocating compressor and station piping analysis for pulsation control
- Industry leading time and frequency domain analysis tools
- GMRC and SwRI proprietary low loss pulsation control devices and bottle designs
- Optimized design approach for reduced capital cost and highest compression efficiency



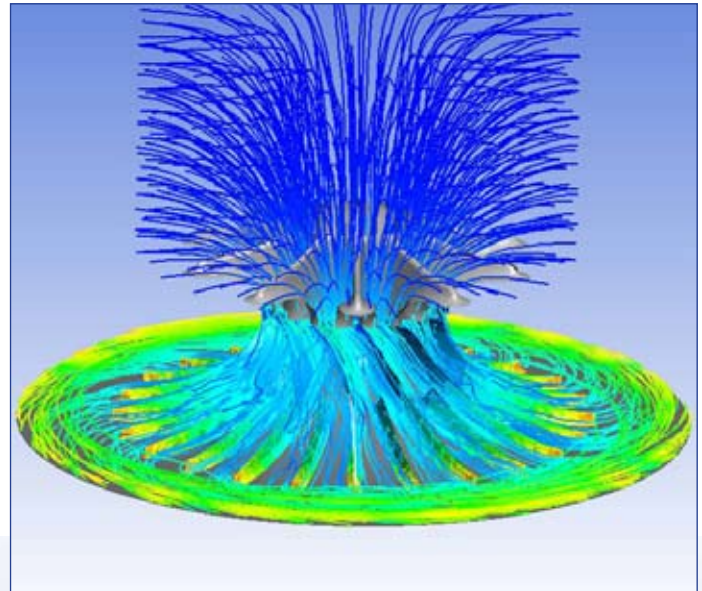
### Mechanical Piping and Skid Analysis

- 3-D finite element analysis and piping thermal stress analysis per API 618
- From single compressors to entire platform modules
- Coupled foundation, skid, rotordynamic and FEA analysis
- Determination of dynamic stress amplitudes, frequencies and mode shapes



### Plant and Pipeline Flow Simulation

- Transient and steady state simulation of gas, liquid and multi-phase flows
- From simple compressor stations to large pipeline networks
- Compressor, pump and valve selections for optimized performance and safe operation
- Transient valve flow for flow-induced vibration, water-hammer and blow-down analysis



### Rotordynamic and Torsional Analysis

- Lateral, torsional and coupled rotordynamic analysis
- Prediction of critical speeds, transient and steady-state rotor response
- Determination of stress/cumulative fatigue for remaining life analysis
- Advanced analysis techniques including fluid-structure interaction and skid/foundation effects

*an 12,000 compressor stations worldwide*



*Southwest Research Institute is an independent, nonprofit, applied engineering and physical sciences research and development organization using multidisciplinary approaches to problem solving. The Institute occupies more than 1,200 acres and provides more than 2 million square feet of laboratories, test facilities, workshops and offices for more than 3,000 employees who perform contract work for industry and government clients.*

**S**outhwest Research Institute has helped develop and operate reliable, safe compression machinery for more than 50 years. The Fluids Engineering Department solves pulsation, machinery, and dynamics-related problems for the pipeline and compression industry with more than 12,000 compressor stations designed to date. SwRI has a proven reputation as a problem solver in the design and operation of fluid mechanical systems, combining custom consultations, extensive field studies and analytical and modeling capabilities.



*Benefiting government, industry and the public through innovative science and technology*

*We welcome your inquiries.*

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