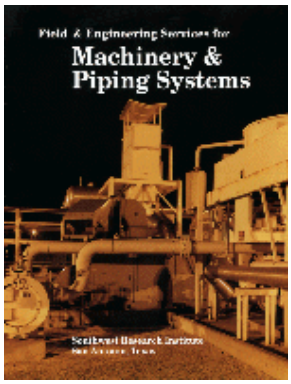
Field and Engineering Services for Machinery and Piping Systems

机器设备及管道系统的现场及工程技 术服务



For more than 50 years, Southwest Research Institute (SwRI) has helped industry develop and operate reliable and safe plant machinery. SwRI has a proven reputation as a leader in fluid mechanical systems design and operation. The Institute provides on-site and remote services that are:

- Client-focused
- Problem-responsive
- Solution-oriented
- Cost-effective

五十多年来 ,美国西南研究院已经帮助工业界开发了用于站场运行中的可靠性和安全性的机器设备 , 作为一个技术领先者 , 在流体力学系统的设计及运行行业获得了尊敬。西南院能够提供现场及远程的技术服务：

- 用户关注的技术
- 问题的响应（解决）
- 指导性的解决方案
- 费用成本分析

Combining consultations, extensive field studies, and comprehensive laboratory, analytical, and computer-modeling capabilities, SwRI engineers rapidly and economically:

- Characterize the problem
- Diagnose the cause
- Predict the consequences
- Assess alternate designs
- Recommend solutions

联合咨询、延伸的现场研究、综合实验室、分析能力、计算机模型能力，美国西南研究院工程师可快速经济地完成以下方面的工作：

- 问题的描述
- 故障原因诊断
- 结论预测
- 替代性设计的评价
- 推荐解决方案

The Institute has solved thousands of machinery- and dynamics-related problems for the following industries:

- Gas transmission
- Gas distribution
- Oil and gas production
- Oil refining
- Gas processing
- Chemical processing
- Fertilizer production
- Paper manufacturing
- Marine and offshore
- Power generation

美国西南研究院为以下工业界解决了成千上万的机械和动力问题：

- 天然气输送工业
- 天然气分输工业
- 石油及天然气开发工业
- 石油炼制工业
- 天然气处理工业
- 化学处理工业

- 化肥生产工业
- 造纸工业
- 海洋及滩海工业
- 电站

Vibration Control

Data Acquisition and Analysis

Excessive machinery and piping vibrations reduce machinery service life and production. SwRI engineers measure, analyze, and control machinery and piping vibration, using well-developed techniques and instrumentation to provide:

- Pressure pulsation assessments
- Vibration assessments
- Dynamic strain severity measurements
- Near-field noise levels
- Impact and shaker testing
- Laser shaft alignment evaluation
- Mechanical response characteristics
- Modal and failure analyses

振动控制

数据采集和分析：

过度的机器设备及管道振动会减少机器的服务年限及正常的生产 ,美国西南研究院工程师测量、分析及控制机器及管道的振动 , 使用已开发的优良的技术和仪器提供如下技术服务：

- 压力脉冲评价
- 振动评价

- 动态应变严重性评价
- 现场噪音等级
- 冲击及摇动测试
- 轴对准激光评价
- 力学响应特性
- 模型及失效分析

Flow-induced Noise and Vibration Analyses

SwRI measures and evaluates flow-induced vibration problems rapidly and effectively. The Institute has solved these vibration problems on a wide range of systems including:

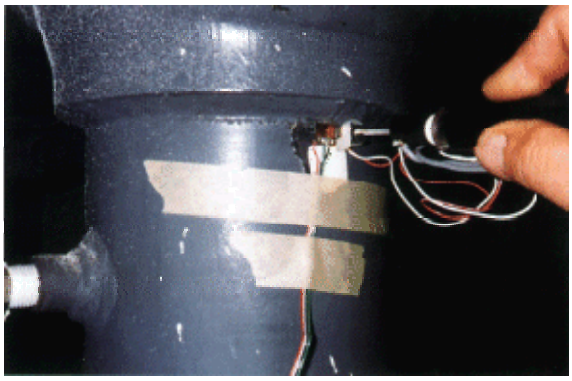
- High-energy piping
- Safety, check, and let-down valves
- Heat exchangers
- Process towers
- Flare lines
- Surge control piping
- Machinery internals
- Furnaces
- Offshore platforms and structures
- Compressor casings

流动引起的噪音及振动分析

美国西南研究院能够快速高效地测量和评价流动引起的振动问题 ,我们也能够解决以下这些多个方面的系统问题：

- 高能量管道
- 安全、检查和下泄阀门
- 热交换器

- 工艺塔器
- 放空管线
- 管道喘振控制
- 炉子
- 滩海平台及结构
- 压缩机外壳



Institute engineers use a frictional strain gauge to accurately locate high dynamic strain. This screening tool minimizes the time needed to resolve unscheduled maintenance shutdowns.

美国西南研究院工程师使用一种摩擦应变仪精确地确定了高的动态应变，解决未计划的维修关断时，这种工具减少了所需的时间。

Strain and Fatigue Testing and Analysis

Using their extensive expertise in identifying potential failure locations and installing strain gauges for fatigue diagnosis, Institute engineers have developed a set of industry-recognized strain and vibration criteria. SwRI staff members routinely install strain gauges on hot piping while the system is still on-line. Strain testing has been used for:

- Thermal and dynamic stress measurement
- Mechanical response testing and modal analysis of turbine blades and impellers
- Safety and reliability screening of machinery and piping
- Dynamic stress screening using portable strain gauges
- Failure analysis

应变及疲劳测试及分析

利用美国西南研究院工程师宽广的专业领域,已经开发出了一套工业认可的应变和振动的准则,技术人员最初将其应用在鉴别潜在的失效位置和疲劳诊断的应变仪方面，在热力管道上，且系统一直在线运行，应变测量可用于以下方面：

- 热应力和动应力测量
- 力学响应测试及透平叶片、推进叶轮的模型分析
- 机器设备和管道系统的筛选的安全性及可靠性
- 使用便携式应变仪的动应力连续测量
- 失效分析

Testing and Modeling

Rotordynamic Analysis

SwRI has conducted analyses of rotating equipment and machinery for more than 35 years. The Institute offers the following services to ensure optimum rotordynamic performance:

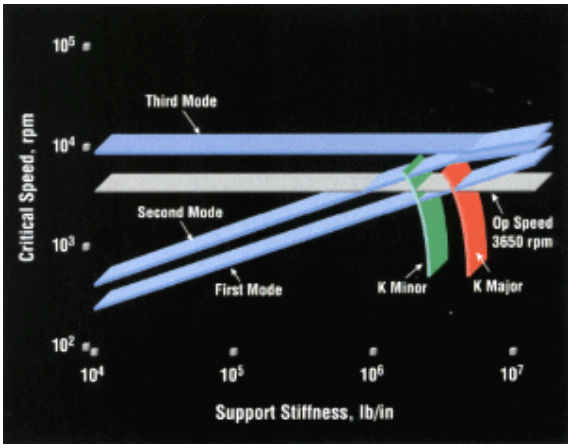
- Independent design audits
- Undamped lateral critical speed determination
- Damped unbalanced response prediction
- Bearing stiffness and damping calculation
- Stability (logarithmic decrement) calculation
- Steady-state torsional critical speed calculation
- Transient torsional calculation
- Coupling selection
- Cumulative fatigue prediction
- Forced response analysis
- Custom model preparation

测试及模型

旋转动力分析

美国西南研究院已经开展了 35 年的旋转设备和机器的分析，能够提供以下方面的服务，以保障旋转动力性能的优化：

- 独立的设计校核
- 使横向临界速度不衰减
- 平衡响应衰减的预测减
- 轴承硬度及衰减设计
- 稳态扭转的临界速度的计算
- 瞬态扭转计算
- 样品选择
- 累积失效计算
- 强迫响应分析
- 常规模型准备



This map depicts undamped critical speeds as a function of support stiffness. Calculated bearing performance parameters are often superimposed on the map to help avoid coincidence of lateral critical speeds and excitation energy.

该模型描述了作为支座硬度功能的临界速度情况，计算轴承性能参数通常是有层理的图形，帮助设备避免侧向临界速度和激励能量的一致性。

Dynamic Structure Analysis

Using integrated field and modeling techniques, SwRI engineers assist in cost-effective designs of machinery components and foundations. The Institute offers expertise in:

- On-site shaker testing (10,000-pound capability)
- Foundation and structural response
- Structural design audits
- Machinery tie-down assessment
- Foundation crack growth evaluation
- Vibrational modal analysis
- Soil dynamics analysis
- Skid and structural deflection testing

动力学结构分析

使用综合的现场及仿真技术,美国西南研究院工程师展开了机器零部件和基础的费用—效率的设计，美国西南研究院提供的专业范围如下：

- 现场振动测试（10,000 磅的能力）
- 基础及结构响应
- 结构设计校核
- 机器锁紧评价
- 基础裂纹生长评价
- 振动模型分析
- 土壤动态分析
- 台架及结构偏转测试

A SwRI field engineer monitors the condition of rotating machinery using an SwRI-developed data acquisition system.

美国西南研究院工程师使用一套数据采集系统监测转动机器的状态

Diagnostics and Balancing

Excessive vibration and unstable balance can lead to early component failure, reduced capacity, and equipment inefficiency. In addition to sophisticated data acquisition, test, and diagnostic equipment that detects and resolves vibration and balance problems, SwRI has developed software and expert systems to provide state-of-the-art monitoring and diagnostic capabilities, such as:

- Sub- and super-synchronous vibration analysis
- Oil whip and oil whirl instabilities detection
- Impeller and diffuser stall diagnosis
- Torsional vibration analysis
- Surge detection
- In-place, normal speed, and multiplane, multispeed, and multishaft balancing
- Rotor and resonance balancing
- Remote monitoring acquisition and data transmittal instrumentation
- Weight correction calculation

诊断及平衡

过度的振动及不稳定平衡能引起零部件的过早失效,使排量及设备的故障率降低,另外,复杂数据的采集、设备测试和诊断,能检测及解决振动和平衡问题,美国西南研究院开发了软件和专业系统,为以下方面提供一流的监控及诊断能力:

- 欠同步和超同步振动分析

- 油膜涡动和油膜振动检测
- 叶轮及扩散器诊断
- 扭转振动分析
- 喘振检测
- 现场工作，标准速度、多叶片、多速度及多轴平衡
- 转子及响应平衡
- 数据远程监测采集及数据传输仪器的使用
- 重量的正确计算

Flow Measurement Diagnostics

SwRI maintains world-class natural gas flow measurement research and calibration facilities. Institute staff members solve metering problems by providing assistance in the following areas:

- Square root error measurement
- Gauge line pulsation and error quantification
- Pulsation effect determination
- Upstream piping-induced flow distortion resolution
- Meter calibration and proving techniques
- Transmitter processing evaluation
- Flow measurement station design and audits
- Entrained liquid detection and evaluation
- Lost and unaccounted for flow determination and resolutions

流体测量诊断

美国西南研究院维护着世界级的天然气流体测量研究及校核装置,我们的技术人员通过在以下技术领域解决计量方面的问题：

- 平方根误差测量

- 计量管线振动和偏差量化
- 振动效果确定
- 上游管道引起的流量偏差因子
- 计量校核及验证技术
- 传感器过程评价
- 流量计量站设计及校核
- 液体夹带检测和评价技术
- 流体测定及再次解决方案中的损失和无法解释性

The Institute operates the Gas Technology Institute's Metering Research Facility, located at SwRI. This facility enables engineers to measure the performance of new and existing gas meters over a range of typical and extreme conditions.

由西南院运营的天然气技术研究院的计量研究设施，位于美国西南研究院院内，这套设施能够使工程师测量新开发的及现有天然气流量计的性能，进行较大范围内典型工况及极端工况的测量。

Performance Optimization

SwRI is an industry leader in developing and implementing performance and diagnostic analyses of reciprocating compressors, pumps, and engines. Using the Institute's computer-based multichannel cylinder performance acquisition and analysis software, SwRI engineers:

- Analyze horsepower and capacity versus output
- Detect and identify mechanical and system faults
- Identify valve dynamic faults
- Estimate valve leak severity
- Generate performance maps and operating charts

- Measure and calculate energy balance

性能优化

在开发和执行往复式压缩机、泵、发动机的故障诊断及性能分析方面，美国西南研究院是业界的领导者，使用美国西南研究院的计算机技术为基础的多通道气缸性能的数据采集和代代相传软件，工程师可以开展以下工作：

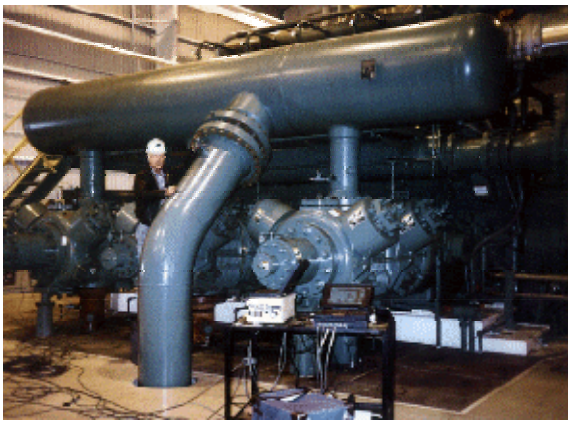
- 输出功率及排气量的分析
- 检测并确定力学及系统故障
- 确定阀门动态故障
- 评估阀门泄漏的严重程度
- 总体性能图及运行工况图
- 能量平衡的测量和计算

Experienced in centrifugal compressor startup diagnostics and troubleshooting, Institute staff members routinely:

- Assess compressor performance
- Detect and prevent surges
- Diagnose and analyze pulsation, noise, and vibration

在离心式压缩机启动故障诊断及故障解决方面，美国西南研究院技术人员拥有例行的经验

- 压缩机性能评估
- 喘振测量和预防
- 脉冲、噪声、振动的诊断及分析



SwRI engineers field test a reciprocating compressor using an SwRI-developed PC-based data acquisition system to analyze horsepower and capacity and to identify and correct system performance problems.

美国西南研究院工程师使用自主开发的计算机数据采集系统进行现场测试并分析往复式压缩机的功率及排量,从而确认并更正系统存在的问题。

Additional Services

The Institute, with 12 technical divisions cooperating in multidisciplinary approaches to solving problems, carries out research, development, engineering, and testing in areas ranging from applied physics to training systems and simulators. Additional services of interest to the machinery and piping industry include:

更多的技术

美国西南研究院拥有 11 个技术分院，多学科的综合解决工业问题，在该领域完成研究、开发、工程、测试等服务，从应用物理到培训系统、模拟等方面，更多的管道设备及管道工业服务包括：

Failure Analysis

- Systematic component failure analysis
- Material assessment
- Corrosion damage evaluation and prediction

失效分析

- 系统部件失效分析

- 材料评价
- 腐蚀伤害评价及预测

Fracture Analysis

- High-temperature life prediction and failure analysis
- Fatigue life analysis
- Environmentally assisted cracking
- Probabilistic life assessment

裂纹分析

- 高温寿命评价预测和失效分析
- 疲劳寿命分析
- 环境造成的开裂
- 不确定性寿命评价

Decision Assistance

- Maintenance optimization
- Decision maintenance analysis

辅助决策

- 维修方案优化
- 维修决策分析

Dynamic Monitoring

- Turbomachinery vibration control
- Combustion turbine balance
- Turbine alignment, distortion, and thermal gradient monitoring

动态监控

- 透平机械振动控制
- 燃烧透平平衡
- 透平轴对准、变形及热力梯度监控

Nondestructive Evaluation

- Automated ultrasonic flaw detection and sizing
- Intergranular stress corrosion cracking detection
- Dye penetrant and wet fluorescent magnetic particle testing
- Magnetostrictive sensor corrosion pit detection

无损检测评价

- 自动超声波缺陷检测及预测尺寸
- 晶粒间应力腐蚀裂纹检测
- 染色的渗透剂和磁性颗粒物测试
- 磁致伸缩传感器腐蚀针孔检测

Training and Instruction

- Training systems and simulators
- Measurement workshop and short courses

培训及教育

- 培训系统及模拟器
- 度量教室及短期培训课程

更多的信息请您联络美国西南研究院北京代表处李金武 ,北京朝阳区东三环北路 8 号亮马河大厦 1 座 1303 室 ,电子邮箱 : jinwu.li@swri.org 手机 :13911774667, 电话 : 010-65906391-805,传真 : 010-65906392