



The
Equity
Engineering
Group, Inc.

Smart Technology for Aging Infrastructure



Engineering Services for the Oil Refining & Petrochemical Industries:

- **Risk-Based Inspection**
- **Fitness-For-Service (low & high temperature)**
- **Materials & Corrosion Consulting**
- **Advanced Thermal & Stress Analysis Using Finite Element Technologies**
- **Turnaround Support**
- **Mechanical Analysis & Design**
- **Pressure Relief System Consulting**
- **Mechanical Integrity & Inspection Programs**
- **Codes & Standards**

E²G: Focused on Your Plant's Profitability

The Equity Engineering Group, Inc. (E²G) is a recognized leader on aging infrastructure (fixed equipment) service and support for the oil refining and petrochemical industries. Our focus is to help clients improve plant profitability through proactive technologies that manage risk, maximize equipment operational availability, and control inspection costs.

Because our engineers have worked for major refineries and chemical companies, we understand the dynamics of a plant's operating environment and the pressures you face. We know your concern is for safety, reliability, and optimizing your plant's operating conditions for profitability and not needlessly inspecting, replacing or shutting it down. Unlike most consultants, we will help you make the practical decisions.

E²G can deliver our products and services conventionally, or through our Virtual Central Engineering (VCE) service. For companies without a large staff, VCE offers a team of technical experts on call to support your core resources.

We also create specialized software to assess fixed equipment, as well as engineering design and maintenance manuals.

Codes & Standards Activities

E²G devotes significant time to industry trade and professional organizations, chairing many of the volunteer committees where needs are discussed and codes and standards are set.

Few companies of our size dedicate as many hours to creating new standards and technical reference documents. One of our top priorities is effective technology transfer - to be the link between fast emerging technologies and our clients' immediate needs. Clients benefit because we incorporate these technologies into our consulting activities and software products before they're standardized practice.

E²G is the primary author for the following standards and has developed a strong international reputation for leadership in the following areas:

- API RP 579 - FFS Standard
- API Publ. 581 - RBI Base Resource Document
- API RP 520 - Sizing, Selection and Installations of PRDs
- ASME Division 2 re-write - New Pressure Vessel Design Code
- API 571 - Damage Mechanisms in the Refining Industry

We are involved with the Joint ASME/API FFS Standards Committee, NACE-STG 34 (Refinery Industry Corrosion), and a number of API CRE Committees.

Joint Industry Project (JIP) memberships include MPC Project Omega, MPC FFS, MPC Moly-Hy, PVRC Weld Residual Stress, and the Battelle Structural Stress project.

E²G is leading the effort for API to develop 21st Century technology for RBI implementation, and is the official marketer of the API RBI software.



E²G Support Services

Risk-Based Inspection (RBI)

- Program implementation and optimization
- Ongoing RBI program maintenance
- Consulting
- Consequence modeling probability of failure for vessels, piping and tankage based on damage mechanisms
- TML/CML optimization, circuit/system analysis
- Damage mechanism and susceptibility identification
- Risk/cost benefit based decision-making for process changes, inspection program modifications and equipment repair/replacement
- Identification of key variables driving probability

Metallurgical & Corrosion Engineering

- Equipment damage assessment, failure analysis and repair programs
- Corrosion monitoring and/or management programs using Materials Operating Envelope (MOE) approach
- Pinpoint damage mechanisms and potential areas of risk with VCEDamage software
- Specifications for heavy wall reactors, vessels and piping systems
- Assistance in understanding effects of crude slate changes
- Materials selection for grass roots, expansion, revamp and replacement projects

Pressure Vessels and Tankage

- Design of ASME Division 1 and 2 vessels
- Design of repairs and modifications
- Flanged joint design and bolting procedures
- Rerating of pressure vessels and tankage
- Localized PWHT evaluations
- Site-wide storage tank audits
- Remaining life and inspection plans for low pressure storage tanks

Rerating/Repairs

- NB R-Stamp holder license number R-6157
- Use of NB-23, API 510, 570, 653 to design and implement repairs
- Rerates and alterations to vessels and piping
- Determination of suitability for service for non-stamped equipment
- Use of materials expertise for repairs of difficult-to-weld materials (e.g. embrittled, laminations, etc.)

Fitness-For-Service (FFS)

- Leadership role and primary author in development of API RP 579 (FFS)
- Life extension of equipment
- Evaluation of general and locally corroded areas including pitting
- Assessment of crack-like flaws
- Heater tube remaining life assessments
- High temperature creep and creep crack growth assessments
- High temperature hydrogen attack
- Hot spots
- Dents, gouges and dent gouge combinations
- Blisters, HIC/SOHIC assessment
- Assessment of flow-induced vibration
- Fire damage assessment
- Blast effects modeling for fixed equipment
- Knowledge of world-wide FFS standards
- Fatigue assessment using ASME and PVRC approaches
- Heavy wall reactor health assessment
- Tank settlement evaluations

Turnaround Support

- On-site and emergency turnaround support
- Pre-turnaround (TAR) "smart planning" - FFS analysis, repair/replacement feasibility and necessity review, equipment replacement specifications and parts upgrading opportunities, re-design, stress analysis
- Work on-site as part of problem-solving team
- Perform code calculations and FFS assessments
- Design repairs
- Bolting procedures and gasket selection

Capital Project Consulting

- Project audits
- Preparation of design specs for new equipment
- Assistance in specialized equipment issues
 - FCCU slide valves and expansion joints
 - High pressure reactors
 - Reformer MOV's
- New fabrication inspection
- Review of specification requirements and fabrication drawings
- Design calculation review
- Modification plans for existing equipment

Piping

- ASME B31.1, B31.3, B31.4 and B31.8 Code compliance
- Linear and non-linear piping stress analysis
- Evaluation of piping loads on equipment
- Buried piping systems
- Expansion joints
- Specialty valve design and selection
- Development of piping classes
- Gasket and packing selection

Pressure Relieving System Design

- Pressure relief studies
- Risk-based PM interval assessment
- Pressure relief device sizing and selection
- API RP 520, 521 and 2000
- Flare Header Modeling
- DIERS methods including two-phase flow sizing
- Heat exchanger tube rupture analysis

Welding

- Welding procedures and specs
- Weld repair of new and existing equipment
- Welder training and supervision
- Field supervision for implementation of repairs
- Hot tap design

Finite Element Analysis (FEA)

- Thermal and stress analysis
- Plasticity and creep analysis
- Fatigue analysis
- Structural stability analysis
- Fracture mechanics
- Advanced material modeling

Heat Transfer and Fluid Flow

- Heat exchanger design and troubleshooting
- Heat exchanger tube vibration analysis
- Process integration (Pinch) technology
- Steady state fluid analysis including two-phase flow
- Transient fluid analysis including slug flow, surge and water hammer assessments
- Consequence modeling and evaluation for atmospheric releases of flammable and toxic fluids
- Computational Fluid Dynamics Modeling (CFD)

Civil/Structural Engineering

- FEA of structural systems
- Steel and concrete structure code design
- Foundation design and grouting requirements for equipment
- Settlement analysis of tankage
- Wind, seismic and blast design assessments
- Steel and concrete stacks
- Fired heater tube and pipe supports

E²G Training Programs

E²G is the exclusive API subcontractor to develop and deliver training programs for RBI (API 580/581), FFS (API 579) and Pressure Relief System Design (API 520). Our newest API-sponsored course offering is on "Damage Mechanisms Affecting Fixed Equipment in the Refining Industry API 571."

E²G is uniquely qualified to instruct these courses. We know these technologies because we developed them, and we understand how to apply them through our experience as ex-owner/operators and our work with people in the plants.

Hundreds of plant engineers, inspectors and managers have gone through our training programs which are offered both in the U.S. and internationally several times a year. On-site courses are also available.

- Official API-sponsored FFS, RBI, Pressure Relief, & Damage Mechanism courses
- VCESage software
- Welder training



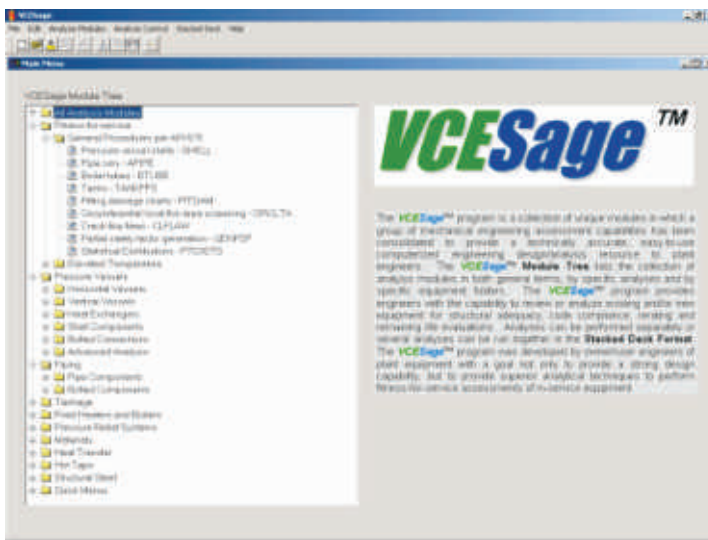
E²G Software Technology

E²G offers proprietary software that helps optimize the life of in-service equipment. We can also custom design engineering software for special purpose needs.

VCESage

Considered a benchmark program, VCESage™ is a collection of program modules that provides an accurate, easy-to-use computerized design/analysis resource. The various modules give engineers the capacity to review and/or analyze existing and new equipment for structural integrity, code compliance, rerating and remaining life evaluations. The modules include:

- Fitness-For-Service
- Pressure vessel and heat exchanger code calculations
- Remaining life assessments
- Storage tank design
- Heater tube life extension
- Expansion joint design
- Wind loading on towers and stacks
- Hop tap design
- Heat exchanger tube rupture evaluation
- Insulation heat transfer
- Sizing and selection of steam tracing and relief valves
- Quick Menu Modules that require less input for analysis



API RBI User Group Software

The new RBI software is an integrated tool with stand-alone modules including fixed equipment, heat exchanger bundles, atmospheric storage tanks, and pressure relief systems. Developed through the API consensus standards process, it combines documented technology, industry best practices and owner/user experience. This user-friendly software can be used to:

- Estimate risk values for equipment
- Prioritize equipment based on measured risk
- Design and optimize inspection programs
- Identify, measure and manage risk of equipment failure

VCE Damage Mechanisms

With a technical basis in API RP 571 and WRC 489, this software is a quick reference guide for identifying and understanding the potential damage mechanisms that can cause costly equipment failure. Designed for inspection and maintenance personnel, VCEDamage Software™ provides:

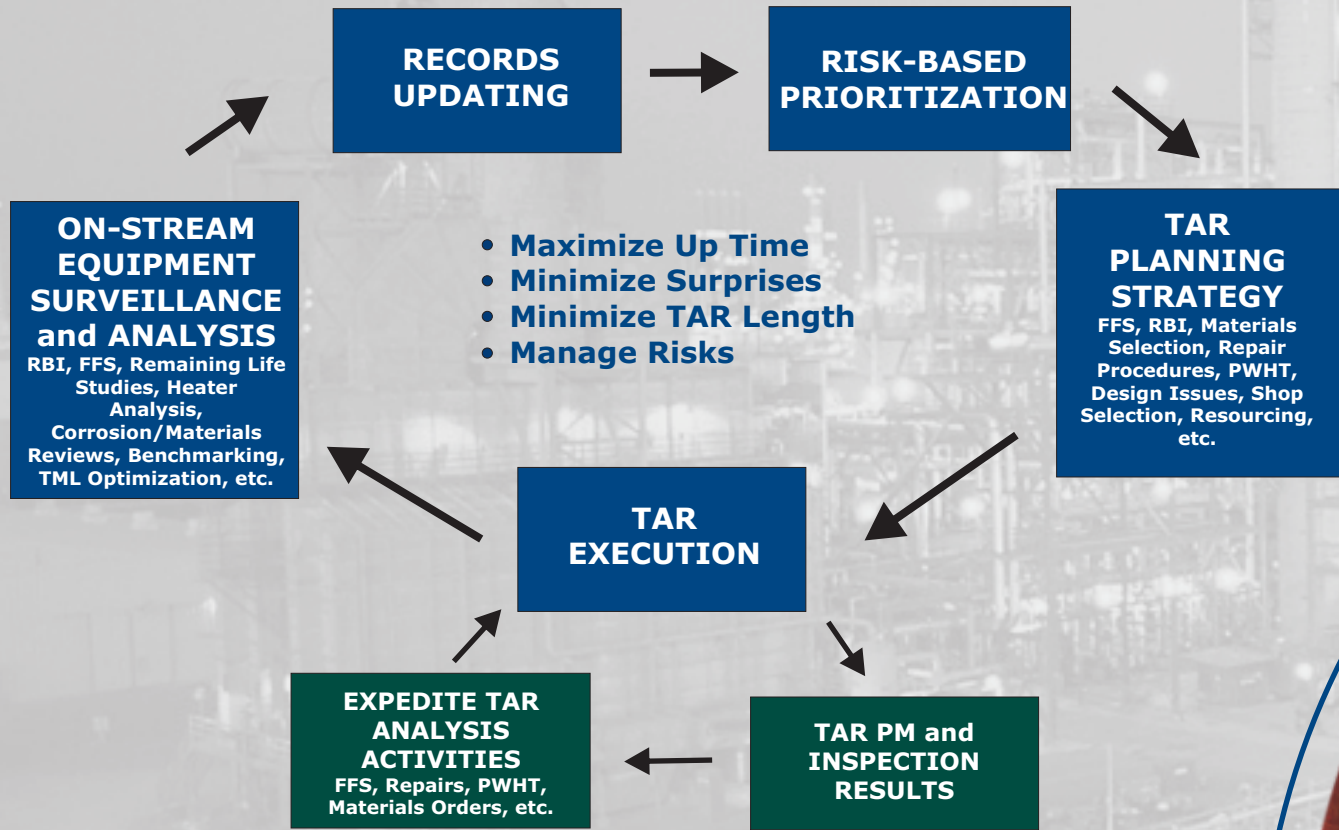
- Guidance through the damage mechanism selection process
- Help in selecting the best inspection method for each kind of damage
- Simplified Process Flow Diagrams (PFDs) that show where damage is likely to occur in a process unit

VCEPractices

Time-tested by owner/users, this is a complete management system consistent with PSM requirements, not just a collection of individual practices. Built on industry best practices, the system details how to design, build, buy, commission, maintain, monitor, test, inspect, repair and modify equipment. The system can be customized to your site with on-call support from E²G technical experts.

The Equity Engineering Group, Inc. is the recognized leader on aging infrastructure service and support for the oil refining and petrochemical industries. E²G experts help improve your plant's profitability by supplying state-of-the-art products and services that ensure equipment operational availability, control inspection costs and avoid costly shutdowns.

E²G: FOCUSED ON PLANT PROFITABILITY
Turnaround (TAR) & On-Stream Support



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