



ThinkTank

Fitness-For-Service and Risk-Based Inspection for Tanks



E²G Leadership in Tank Assessments:

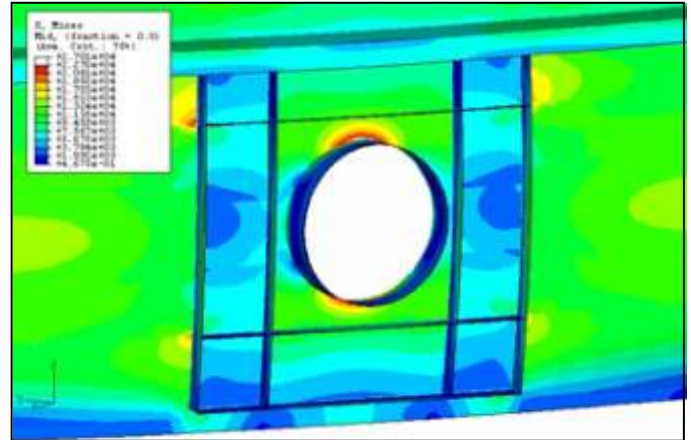
- Integrated FFS and RBI Capabilities
- Specialized Tank Settlement Evaluations
- Hydrotest Exemption Analyses
- API RBI of Tankage
- Aboveground Storage Tank FFS Tool Set
- Specialized Assessments of Refrigerated & Liquefied Hydrocarbon Gas Tanks

E²G's ThinkTank Assessments Improve Your Bottom Line

ThinkTank FFS Assessments improve plant or terminal reliability by:

- Utilizing FFS techniques to avoid expensive tank outages and extend tank life
- Providing cost effective designs for tank repairs
- Employing AST settlement expertise to avoid costly releveling and design foundation repairs
- Performing FFS Assessments in lieu of costly or impractical hydrotests
- Performing frangible rook assessments

A predictive analysis ensures tank availability
An acid storage tank was built out of Monel, but used external carbon steel bands to reduce the required Monel thickness. The tank included an aluminum and fabric dome roof that would gain weight as polymers from the product adhered to the fabric. The tank had general shell thinning and there was some concern with the increasing roof weight load. Due to the tank's unusual geometry, Level 3 API 579 FFS analyses were required. We were able to determine the minimum required thickness for each of the tank's shell courses and a maximum permissible roof weight, so that the Owner knew when repairs or roof cleaning were required. The figure (right) is of local stresses at one of the reinforced manways.



Stresses at Manway of Banded Acid Tank Nozzle

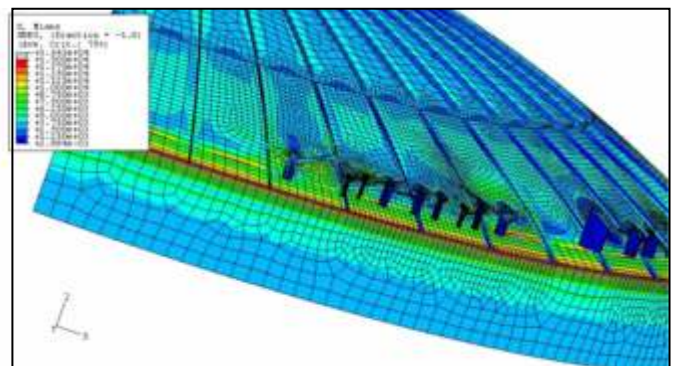
E²G's RBI & Tank Design expertise optimizes your inspection program by:

- Utilizing the new Version 7.0 API RBI Tank Module to plan inspections and avoid more frequent, internal inspections based on older practices
- Providing a tank inspection plan for your plant or terminal that employs your tank inspection resources where they are needed most

E²G combines its FFS and RBI expertise to optimize tank inspection plans for refrigerated products such as ammonia and liquefied hydrocarbon gases. Our methodology uses:

- Finite Element Analysis (FEA) stress analyses to determine where to focus inspection
- FFS calculations to examine stress corrosion cracking, fatigue damage, and remaining life
- Risk Assessment tools based on API RBI Version 7.0, including enhancements to consequence modeling developed by our engineers

Pinpointing risk areas focuses inspection planning
Ammonia storage tanks are subject to an initiation or acceleration of Stress Corrosion Cracking (SCC) if opened to the atmosphere for internal inspection. By performing an in-depth evaluation that included FFS and RBI Assessments, we developed inspection plans for ammonia tanks (and spheres) and their associated equipment that emphasized non-intrusive inspection techniques and focused inspection where it was needed most to manage risk. The figure (right) shows stresses in the domed roof of an ammonia storage tank.



Stresses in a Roof of a Domed Ammonia Storage Tank

Why Owners Choose E²G for Tank FFS & RBI

Industry leaders

The Equity Engineering Group, Inc (E²G) is the recognized leader on services and support for aging infrastructure. Our company pioneered the use of Fitness-For-Service (FFS) technologies applied to Aboveground Storage Tanks (AST), developing the standards upon which the technology is based. As project manager of the API's Risk-Based Inspection (RBI) User Group, we've developed new Version 7.0 API RBI software which includes a comprehensive AST module. E²G's engineers have also been involved in the development of AST bottom and shell settlement procedures found in API RP 653, *Tank Inspection, Repair, Alteration, and Reconstruction*.

Technical excellence

Along with developing RBI technology and software, our engineers were also the principal developers of the landmark API RP 579, *Recommended Practice for Fitness-for-Service* and RP 571, *Damage Mechanisms Affecting Fixed Equipment in the Refining Industry*. These documents form the basis for most FFS assessments performed in the U.S. as well as in many other countries. Our expertise in both FFS and RBI allows us to apply the right resources to meet your tank needs, and in unique situations, we can focus the combined effort of both our FFS and RBI tools on your tank concerns.

Cutting-edge client servicing

E²G's ThinkTank™ service provides the link between developing technologies and our clients' multifaceted tank problems. We helped write the standards, so we know how to use these technologies to their fullest potential. And because we've worked in plant environments, we know you need practical recommendations in a short time frame. Unlike most consultants, we'll help you make the practical decisions.

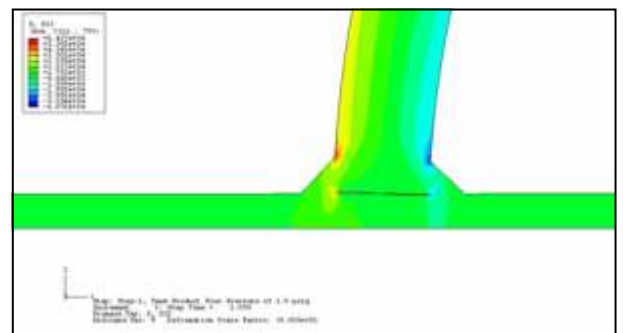
VCESage software

The ThinkTank suite of software modules is a part of E²G's proprietary VCESage™ analysis program. These modules provide tank FFS tools that inspectors and engineers use to evaluate many types of common tank damage.

Implementing ThinkTank at your Plant or Terminal

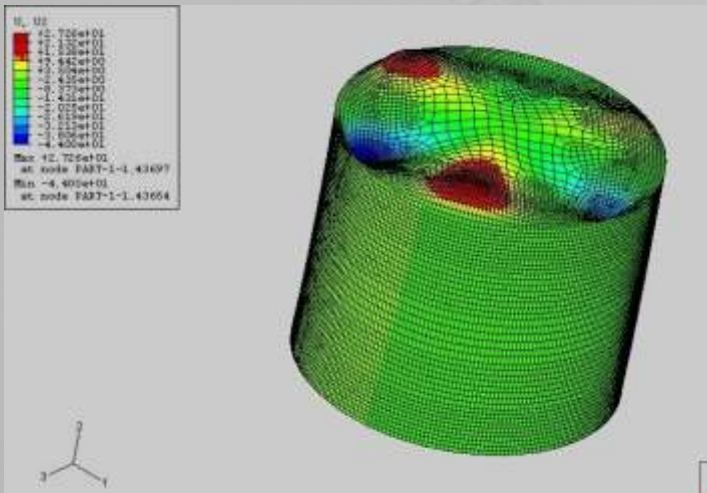
The suite of ThinkTank Assessments can be implemented at your site or on a corporate level, depending on the type of assessment needed. As an example, in the implementation of a comprehensive refrigerated tank assessment, the work process is as follows.

- Review inspection, maintenance and operations data for the tank(s)
- Perform a design review of the tank and its piping, and determine damage mechanisms
- Perform FEA of the tank(s), flexibility analyses of piping, and appropriate FFS analyses for the damage mechanisms
- Perform a RBI Assessment of the tank(s) and the associated piping and pressure vessels to evaluate likelihood and consequence of various failure scenarios
- Evaluate the tank's foundation design and pressure relief design
- Develop an inspection plan for the tank(s) and associated equipment based on the RBI and FFS results
- Design repairs for specific damage, as needed
- Continue to update (evergreen) the inspection plan based on new inspection data over time

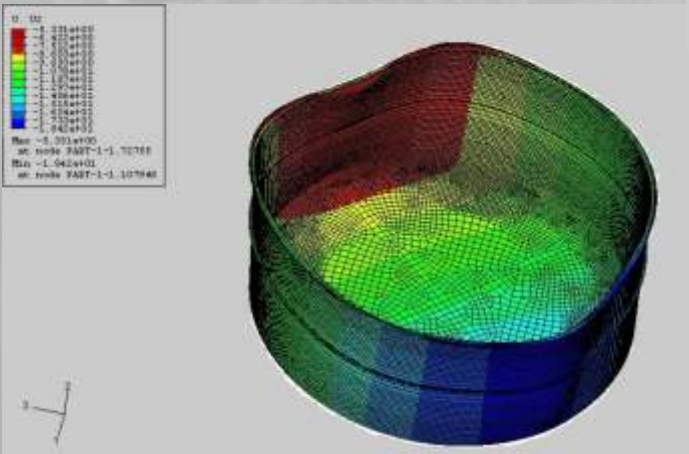
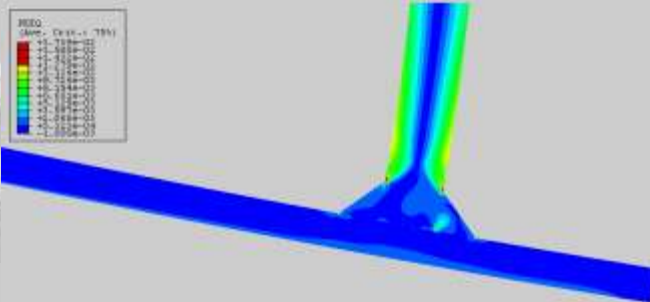


Stresses at Corner Joint Used for Hydrotest Exemption

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.



Plots from FEA Stress Analysis of Storage Tank Settlement



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