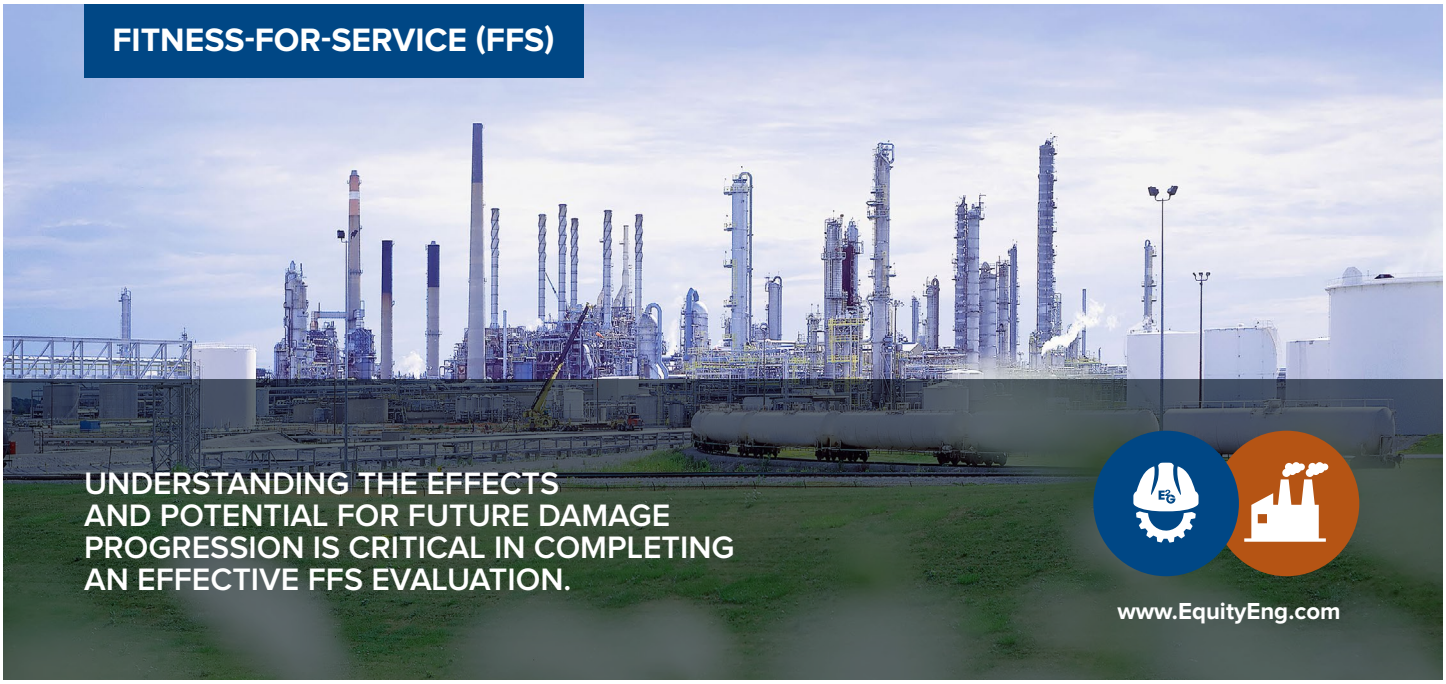
FITNESS-FOR-SERVICE (FFS)



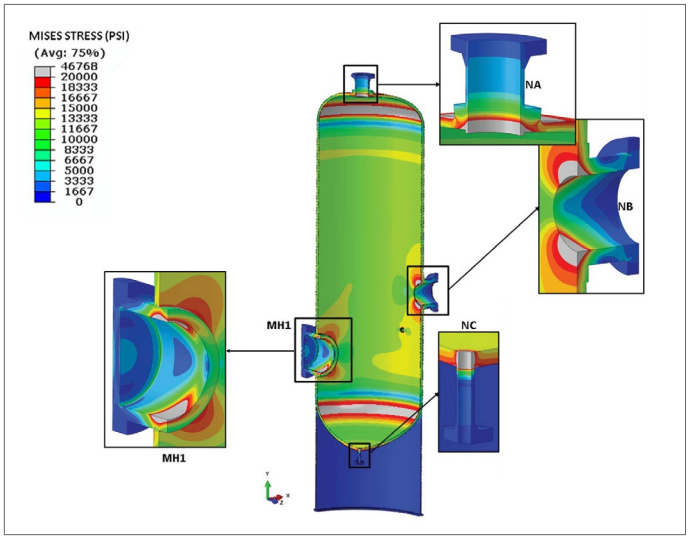
INDUSTRY LEADERSHIP

E²G|The Equity Engineering Group, Inc. is internationally recognized in the refining and petrochemical industries as a leader in aging infrastructure services and support. Our engineers pioneered the advancement of FFS technologies and were the lead investigators of the international standard API 579-1/ASME FFS-1 *Fitness-for-Service*. The document has rapidly become the FFS standard of choice for other industries such as pulp & paper, fossil utility, food processing, and non-commercial nuclear. In addition to our involvement in the development and continuous advancement of FFS technology, E²G was the lead investigator of API 571 *Damage Mechanisms Affecting Fixed Equipment in the Refining and Petrochemical Industry.* Understanding the effects and potential for future damage progression is critical in completing an effective FFS evaluation.

SUPERIOR CLIENT SERVICE

E²G is focused on applying the appropriate level of technology to make practical decisions that impact our clients' objectives regarding safety and economics. We offer superior client service in part due to our continuing involvement and leadership in developing FFS technology and API/ASME standards. Our consulting services reputation of providing the highest level of value to clients was built on the following:

- Providing practical and cost-sensitive solutions to challenging FFS problems
- Utilizing advanced FFS techniques to extend equipment life
- Designing effective temporary or permanent repairs
- Optimizing inspection based on detailed remaining life evaluations
- Reducing shutdown time
- Providing quick turnaround in emergency situations



Stress Analysis Results for Subsequent Critical Flaw Sizing and Fatigue Life Prediction

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For More Information:
P. 216.658.4765
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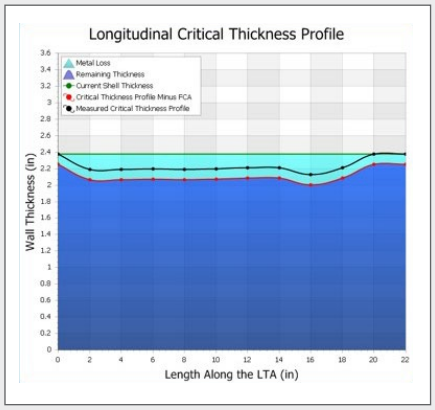
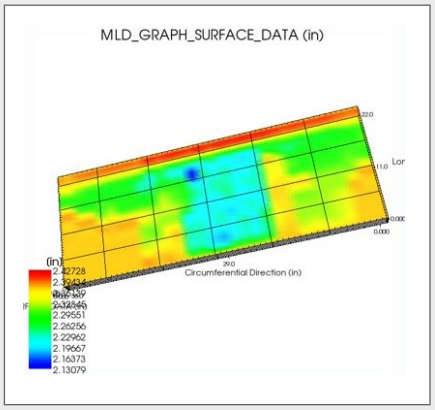
The Equity Engineering Group, Inc.

A FULL RANGE OF FFS EXPERIENCE

E²G has evaluated all types of damage that occur in the oil and gas industry on a wide variety of equipment, including pressure vessels, process piping, transmission pipelines, hydroprocessing reactors, storage tanks, heat exchangers, furnaces (casing, tubes, and stacks), and mechanical components of specialized equipment.

The traditional use for FFS has been in a reactive mode to assist with critical run, repair, or replace decisions once flaws or damage are discovered during equipment shutdown inspections or on-stream inspections. However, FFS technology can be used proactively in order to extend equipment life and optimize inspection intervals and inspection tasks based on results from detailed remaining life evaluations that are developed through rigorous engineering evaluations focused on the specific damage mechanisms of concern. E²G has extensive experience completing FFS evaluations at all stages of the equipment life cycle.

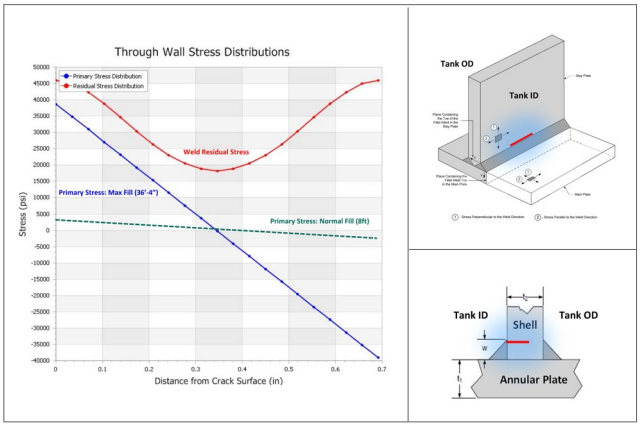




Thickness Mapping for Evaluation of Wall Loss Due to Corrosion

OUR EXPERIENCE INCLUDES THE ASSESSMENT OF THE FOLLOWING DAMAGE MECHANISMS:

- Brittle Fracture and Minimum Pressurization Temperature (MPT) evaluations
- General wall loss corrosion and local thin areas (LTAs), including pitting
- Dents, gouges, and dent-gouge combinations
- Distortion, bulges, weld misalignment, out-of-roundness, edge settlement
- Low temperature hydrogen damage such as laminations, blisters, HIC (Hydrogen Induced Cracking), and SOHIC (Stress Orientated Hydrogen Induced Cracking) damage
- HTHA (High Temperature Hydrogen Attack)
- Crack-like flaws (such as environmental or mechanical damage or fabrication defects), including explicit weld residual stress simulation as appropriate
- Fire Damage Assessments
- Hot spots
- Creep and creep fatigue
- Thermal and mechanical fatigue, including state-of-the-art welded joint fatigue and strain based fatigue methods
- Mechanical vibration of piping systems or equipment, including field data collection
- Blast loading and other dynamic effects



Analysis Results for Storage Tank Critical Flaw Sizing and Hydrotest Exemption

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