



JointTech

A Total Solution for Joint Leakage Problems

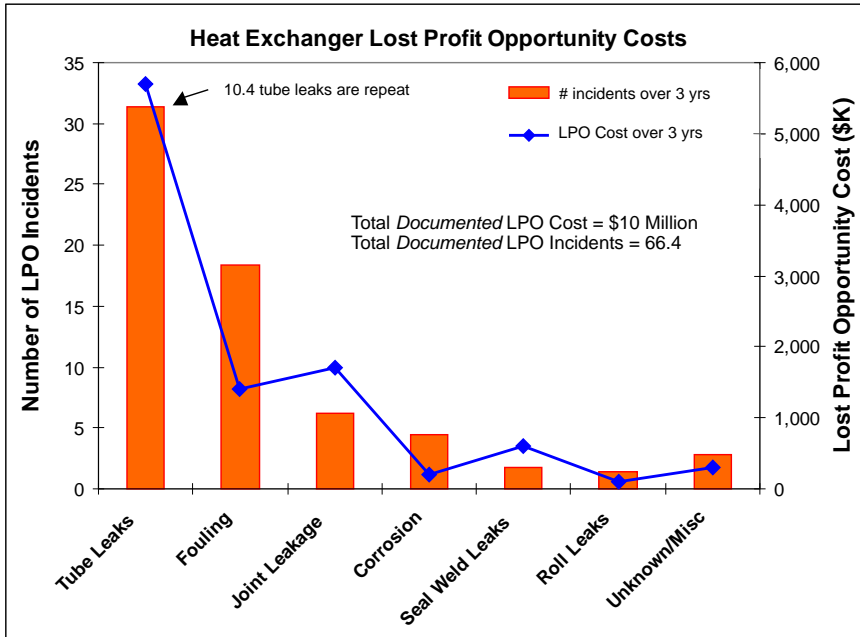


E²G Leadership in Advanced Joint Technology:

- Plant Joint Assembly & QA Procedures
- Plant Joint Integrity (100% Leak-Free) Program
- Gasket and Bolt-Load Selection
- Third Party Review of Joint Leakage Solutions or Assembly Procedures
- On-Site Support of Joint Integrity Program
- Full Joint Life-Cycle Training for all Levels of Plant Personnel
- Quick-Turnaround Leakage Solutions

Joint Economics: High ROI for Heat Exchanger Repair

Flange joint leakage is most common with high temperature joints, such as heat exchanger joints, and it can cost millions of dollars in lost opportunity costs if the plant must be shut down for repairs. However, eliminating heat exchanger joint leakage is also the most successful, cost-efficient solution to implement.



Joint Leakage is the second highest LPO (Lost Profit Opportunity) cost for heat exchanger and has the third highest LPO incident level for heat exchangers

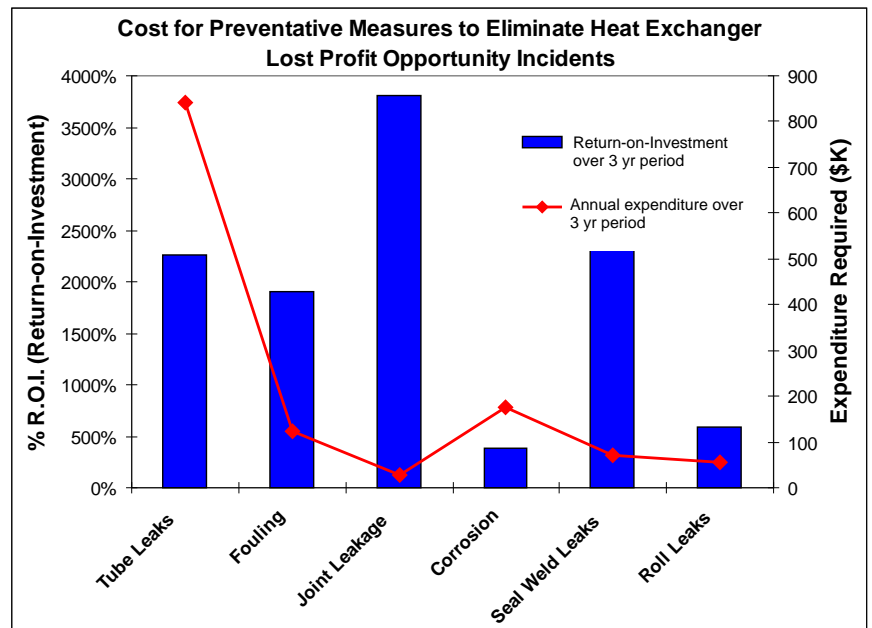
Notes:

1. Results are average LPO cost for one refinery over the period of 3 years.
2. Data compiled from operating history of five refineries.

Joint Leakage requires the lowest expenditure to eliminate LPO incidents and has the highest ROI (Return-on-Investment) and highest likelihood of success of all heat exchanger LPO categories

Notes:

1. Tube Leaks - based on bundle replacement at an average cost of \$120K for a 10yr life
2. Fouling - based on increased chemical cleaning at \$20K per incident and 50% efficiency
3. Joint Leak - based on \$7.5K per incident (joint machining, new gasket and improved bolting procedure) and an initial \$40K investment in improved bolting QA procedures and personnel training
4. Corrosion - based on component (shell, bundle) replacement at an average cost of \$120K for a 10yr life
5. Seal Weld Leaks - based on bundle replacement / improvement at an average cost of \$120K for a 10yr life
5. Roll Leaks - based on bundle replacement / improvement at an average cost of \$120K for a 10yr life



"That bolting procedure you gave us was great, it saved our crew over one shift for that exchanger alone and the unit came up on time, with no problems! Can we use that procedure on all the joints from now on?"

Boilermaker Foreman from Canada

JointTech Assessments Improve Your Bottom Line

Steam Generator Tubesheet Joint Leak: Expert knowledge provides a \$200 solution

A joint had been problematic since the exchanger was installed. Leakage was expected within days after unit start-up and subsequent to any unit trip. There were periodic costs associated with the need to re-tighten the joint, or the manufacture of a special leak-sealing clamp, or unit shutdown for replacement of gasket. In addition, there was an on-going maintenance cost for pulling the exchanger bundle, weld build-up and re-machining of flange faces on most unit shutdowns.

Over the lifetime of the exchanger, prior to solving the leak, the total cost, including previous failed solutions, is conservatively estimated at over \$300K. Bolting contractors had recommended higher bolt loads, lower bolt loads and better bolting patterns. However, none of these proposed solutions were successful because they didn't address the root cause for the leakage.

The client requested an FEA model of the joint, including transient thermal analysis. To verify the FEA model, an analytic analysis was also performed. Both methods indicated the primary root cause of the leakage was gasket failure due to differential radial movement. A secondary root cause, excessive operational flange rotation, was also highlighted as impacting the gasket selection process. The analysis indicated that a simple change of gasket type and higher bolt loads to counteract gasket relaxation levels would easily resolve the leakage issue. The client purchased a new gasket (\$200) and the leakage problem was eliminated.

The JointTech difference:

- Identification of root cause for joint leakage through advanced analysis and practical knowledge of gasket behavior, rather than suggesting standard solutions that could make the problem worse.
- Knowledge of the effects of flange movement (rather than gasket stresses) on gasket behavior and joint leakage.
- Use of analytic methods to get a quick answer and verify the FEA results.
- Complete joint life-cycle knowledge (design, assembly and operation) leading to a more comprehensive recommendation for problem solving.
- Advice on bolting contractor assembly procedures.



Crude Leak from a Tubesheet

Coker Slide Valve Joint: Root cause analysis plugs a \$250K per day leak

A refinery client installed a new flanged 72" diameter valve on the bottom head of their coker. Upon unit start-up, the joint leaked, resulting in a fire. The unit was subsequently brought down for an extended outage (\$250K per day lost production) to determine the cause. The client's flange reliability expert asked us to determine the root cause of the leaking by performing a transient thermal analysis of the joint. The client suspected that a hotspot at a near-by inlet nozzle was contributing to leakage and that differential radial growth of the flanges could be causing bolt yield.

Analysis indicated that the joint was severely under-designed for the thermal loading, and design modifications were suggested to rectify this problem. The thermal transients seen during operation were causing significant reductions in gasket stress, and operational flange rotation caused excessive re-distribution of the gasket stresses. The inlet nozzle was also shown to be a secondary factor in causing leakage and a thermal-sleeve design was proposed to eliminate this problem. The analysis confirmed that bolt yielding due to differential growth was not an issue. Subsequent design modifications made by the client incorporating our findings have eliminated the leakage concerns.

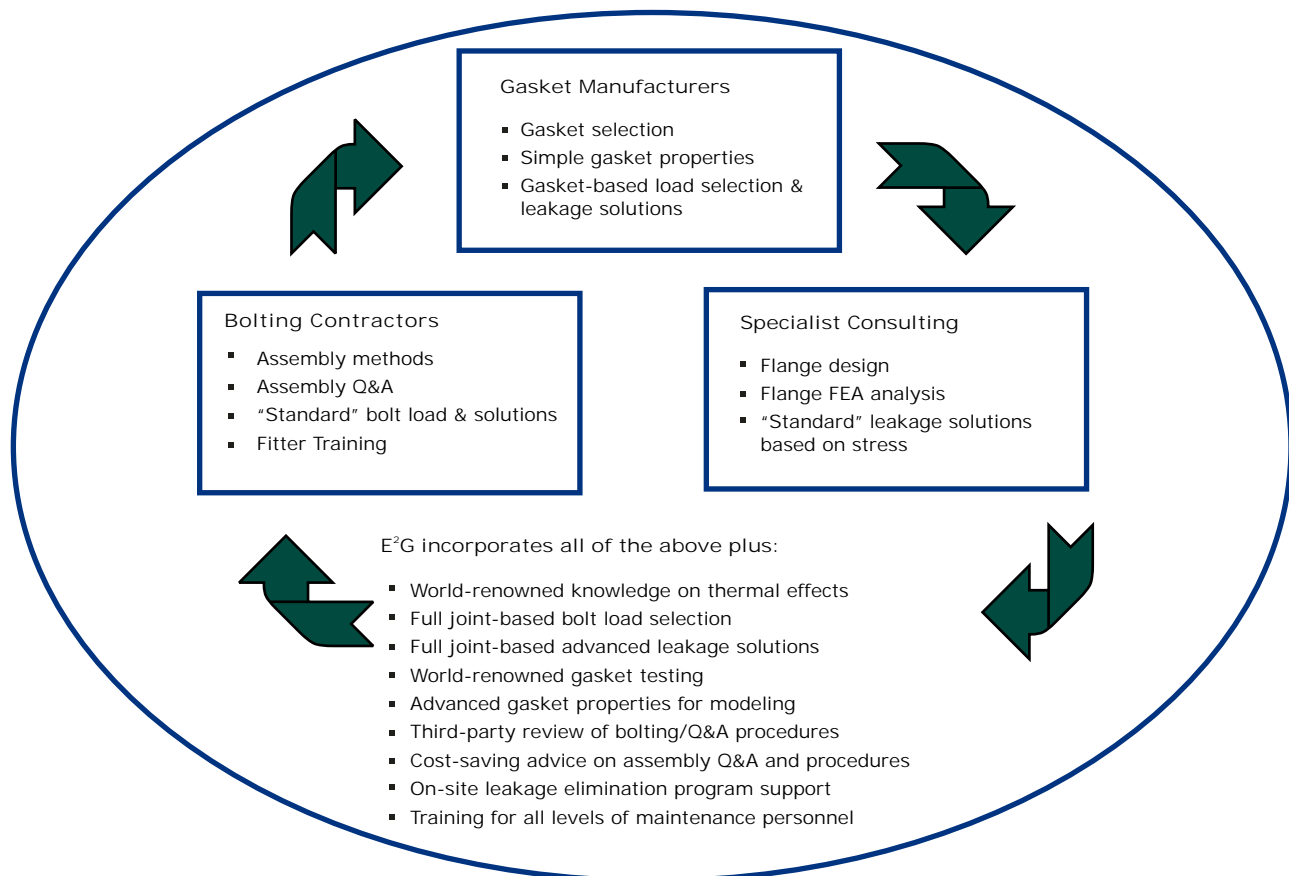
The JointTech difference:

- Identification of possible root causes through advanced analysis and thorough knowledge of the impact of thermal transients on gasket sealing.
- Ability to work with the client to eliminate possible causes in a practical manner.

Looking at the "Total Joint" for 100% Leak-free Status

Extensive knowledge of joint sealing technology, plus advanced analysis techniques, gives E²G the edge on resolving joint leakage problems. By looking at the "big picture", the JointTech approach can decrease workload and reduce maintenance costs on the joint.

The Total Joint Picture



Compared to competitors, who offer "black box" consulting solutions and are often limited to their own experience with problems, JointTech offers:

- The correct solution for the root cause, first time, every time -- no plant- based experimentation or wasting of maintenance budget.
- A proven track record in solving difficult joint leakage problems.
- Consideration of all components and the full joint life-cycle to determine the root cause and optimal solution.
- A link between the highly technical and practical, incorporating both to achieve an effective solution.
- Extensive reality-based testing -- knowledge of current test procedure limits and how to apply their results
- Knowledge of gasket-type performance as well as performance differences between gasket manufacturers.
- Extensive testing and implementation of assembly procedures and lubricants -- practical advice on what to use and where, not focused on only one "perfect" way of doing things.

With the JointTech solution, E²G experts will show you how to achieve "100% Leak-Free" status -- and along the way improve personnel safety, receive EPA credits, eliminate costly leak-sealing/joint clamping operations and keep your plant running smoothly.

JointTech: Solving "Unsolvable" Joint Leakage Problems

No one should accept the lost dollars from joint leakage or expensive assembly procedures as normal operating costs. Every joint can be sealed permanently with the technology available today. But most standard solutions don't consider the "total joint" when assessing problems, providing only assembly-focused, gasket-focused or analysis-focused solutions.

The JointTech™ solution incorporates knowledge in *all* the areas required to effectively identify the root cause of a leakage problem:

1. Actual gasket behavior and modes of failure
2. Effects of temperature on gasket, bolts and operational loads
3. Real-world assembly procedures, methods and parameters
4. Advanced analysis methods, including FEA with advanced gasket properties

The Equity Engineering Group, Inc. (E²G) has in-depth operational experience with flanged joint specification and operation. Internationally recognized in the refining and petrochemical industries as a leader on aging infrastructure services and support, E²G pioneered the development of advanced Fitness-For-Service technologies (API RP 579, API RP 571) -- documents that form the basis for most FFS assessments performed in the U.S. today. JointTech was created by E²G's Dr. Warren Brown, a renowned expert on flanged joints and practical solutions to real-world joint leakage issues. It is the only program of its kind on the market today.



Jet Fuel Leak from Exchanger Joint

Meet Dr. Flange

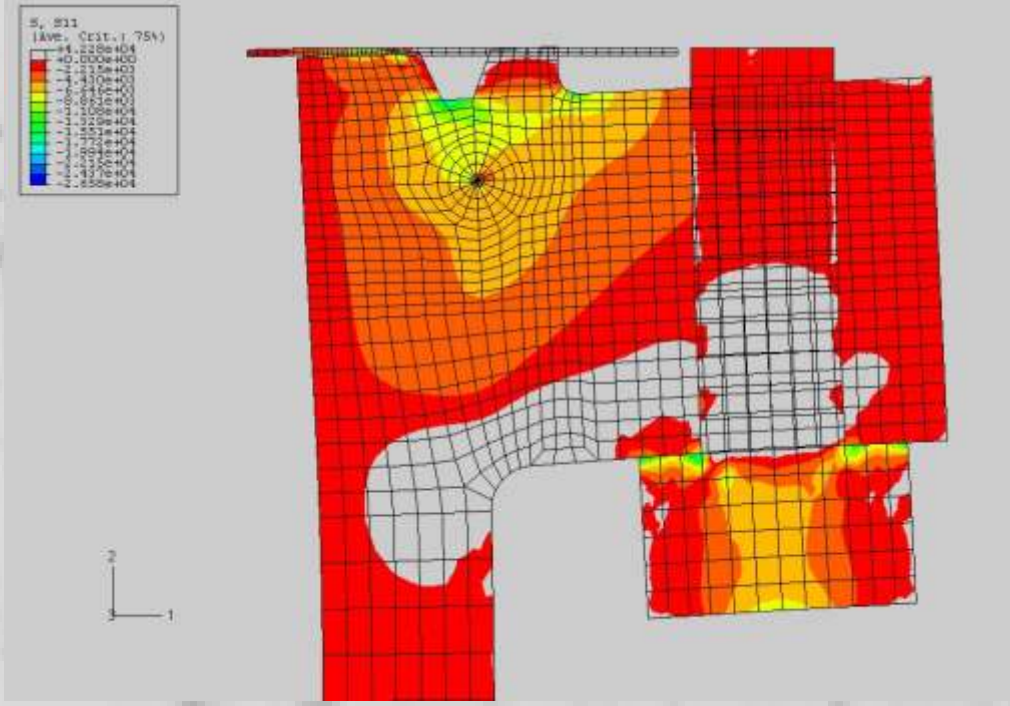
Warren Brown, Ph.D. has consulted on problematic flange leakage issues with most major refining companies in the U.S. Along with hands-on experience, Dr Brown brings a wealth of knowledge to E²G in improving and innovating on Industry Best Practices. He has been extensively involved in the research and implementation of leading-edge work on flange design, the effects of temperature on joints, gasket selection and joint assembly. He has pushed the envelope on Industry Best Practices in the field of joint assembly and his work has led to improved leakage performance of joints, while actually reducing the effort required for joint assembly by 50%.

He is actively involved with both the PVRC and ASME committees on bolted flanges and presented three sessions at the 2001 PVRC training conference on Bolted Flange Technology. His work was the basis of four innovative and useful sessions at the 2005 PVRC training conference on "Best Practices for Flange Assembly and Maintenance".

Dr. Brown has published over 14 peer-reviewed papers on joint design and operation, and has three Welding Research Council Bulletins in publication. He has also worked with a major refining company in the development of their joint integrity program, which has resulted in the 100% leak-free operation of flanged joints at participating refineries within 2-3 years of implementation. The cost benefits of such a program, which eliminates unnecessary shutdowns or leak-sealing operations, are easily demonstrated.

Within the industry, there are few who understand the limitations of current technology in gaskets and bolting, and this inhibits their ability to push the boundaries of current best practices beyond ASME PCC-1. With a knowledge of the limitations of all joint components, coupled with specific practical knowledge based on field and laboratory research, E²G is uniquely placed to offer clients not only current industry best-practice, but also future industry best-practice.

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.



FEA Stress Plot of Cracked RTJ Flange

RTJ Groove Cracking on Exchanger Flange: Fast analysis avoids costly turnaround delay

A refinery client found severe cracking in several RTJ flange grooves during a routine inspection of their VGO unit feed/effluent exchangers. Replacement of the flanges or repair of the cracking was not possible within the turnaround time frame, and would have led to a costly delay in start-up and associated lost production costs. E²G was called in to analyze the cracking to determine if it was possible to use RTJ replacement gaskets and to confirm the Fitness-For-Service of the flanges without repairing the cracking. E²G quickly performed advanced FEA modeling of the flanges and determined that it was acceptable to operate without repairing the cracks. Thus, the client was able to complete the turnaround without any delay. In addition, the unit has been running successfully for over seven years since the Analysis was performed, with no further issues associated with RTJ groove cracking.

The JointTech difference:

- Quick turnaround on advanced analysis techniques.
- A practical solution that considered all aspects of joint operation and minimized the cost of the turnaround.

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