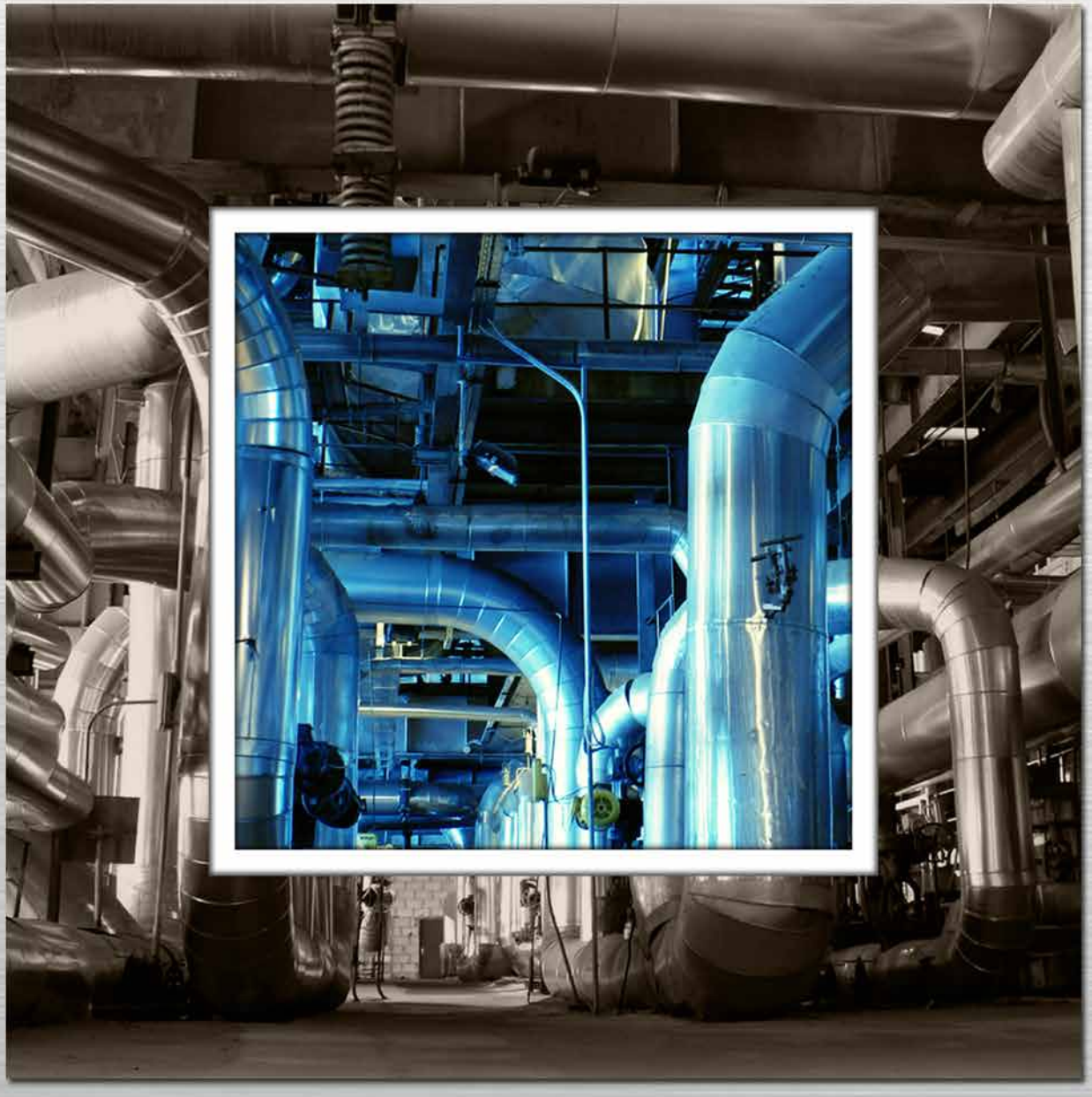
Power and Utilities



design • analysis • testing

STRESS ENGINEERING SERVICES INC.®

an employee-owned company

Stress Engineering Services helps define your risks and management options by integrating inspection, surveillance and testing techniques in an assessment based on the new API-579/ASME-FFS standard.

Navigating Between Risk, Consequences & Cost

Having better information on current risks, and how these risks impact operational and engineering options, makes rational and defensible decision-making possible. With the publication of API 579/ASME-FFS the job of assessing FFS and risk has been largely converted to an organized and objective activity. By its very nature there will always be unique problems that need special guidance. Because these documents are guides and not recipe books, interpreting them, implementing them, and filling in the holes where they leave decisions to the user are an area where the experience provided by the staff and resources of Stress Engineering Services (SES) can be a major factor in achieving the desired results.

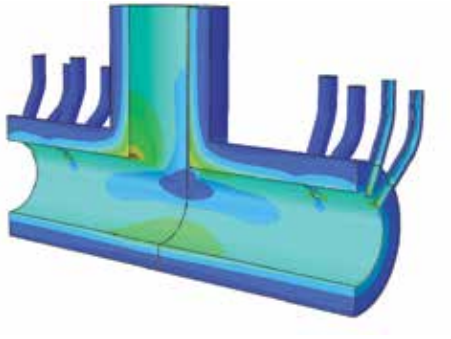
New Approaches to Problems of Plant Integrity

Demand for power is growing faster than the resources now available, and ensuring safety while balancing cost and risk is more important—and more difficult—than ever. Scheduling outages and inspection is often the key to avoiding unplanned downtime. Both unnecessarily conservative and optimistic estimates of time between inspections can be costly. Fortunately, with the help of comprehensive materials data, advanced analytical, inspection, testing and monitoring techniques, we can now:

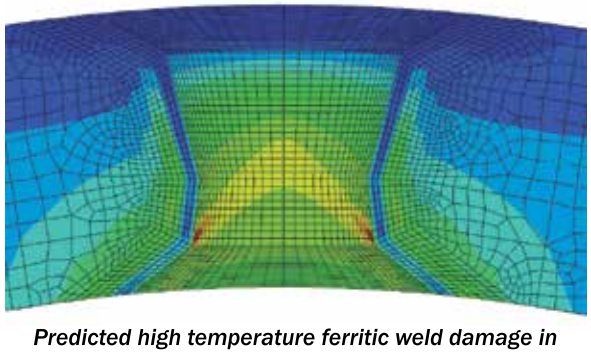
1. Estimate the failure risk of damaged plant until repairs are possible.
2. Recommend measures such as monitoring and optimized temporary temperature reductions to minimize risk.
3. Base decisions to repair, replace or run on data analysis and defensible criteria.

Understanding is the Key

The keys to good FFS and related activities are a better understanding of component load histories, combined with the necessary tools and experience to make accurate predictions about the effects of these histories on component integrity. These tools are available today in the form of advanced methods of flow simulation,



structural analysis and surveillance, as well as much improved models of the material damage caused by cyclic loading, and exposure to high temperatures and corrosion. Risk-based approaches are available to make allowance for the significant scatter in material properties. Using these tools in combination can lead to significant improvements in reliability as well as the economics of plant operation.



Predicted high temperature ferritic weld damage in weld metal adjacent to HAZ

Unique FFS Expertise & Experience

SES is a 200 hundred strong engineering consulting company that has been in business for nearly 40 years, serving a wide range of industries related to primary energy production from all sources including oil, gas, coal and nuclear fuels. The company's expertise is built on teams of experienced structural analysts, instrumentation engineers, fluid dynamics engineers, metallurgists and materials and welding engineers, as well as extensive component testing facilities, including non-destructive testing and data acquisition capabilities all of which are employed both in-house and on-site.

As part of its connection with industry, SES personnel are active participants in the regulatory process, serving on ASME Code and API groups tasked with developing standards of good practice, as well as engaging in development work aimed at improving assessment methods for the future.

Extraordinary Challenges - an SES Specialty

A common theme underlying much of SES business is dealing with problems that fall on the edge—and sometimes over the edge—of standard engineering practice, where simply coloring inside the lines does not get the job done. The difference in complexity between design requirements and many plant failures illustrates the point. Dealing with such problems is unavoidable if complex systems are to be kept up and running. Examples of work carried out by SES that is relevant to power generation include:

- Simulating the operating cycle of a bolted flange in a high temperature piping system, to determine the time to leak, and to work out a tightening schedule to control leakage in the future.
- Remaining life assessment of power plant piping in creep, fatigue and FAC service.
- Development of a creep/fatigue assessment procedure for Heat Recovery Steam Generator (HRSG) power plant harp modules.
- Assessment of potential Code violations in an offshore turnkey HRSG prior to sale.
- Investigation of exhaust gas flow induced vibration in HRSG modules.

- On-line analyze-as-you-go assessments of intricately formed downcomer piping being designed and replaced in the narrow windows of time provided by a plant shutdown.
- FFS assessment of underclad cracks in a pressurized water reactor vessel.
- Installation and on-line monitoring of strain gages on a commercial nuclear power plant.
- Creep buckling analysis of blocked superheater tubes in a HRSG.
- Evaluation of brittle weldments in the steel liner of a nuclear plant concrete containment vessel.
- Failure analysis of cracked fossil fuel gas ducts due to P-embrittlement.
- FFS assessment of underclad cracks in a pressurized water reactor vessel.
- Redesign of a Tee joint in a hot reheat steam piping system during a scheduled shut down, to replace a component leaking from a through-crack.
- Analysis of Hot Tap Tee connection.
- Optimized downrating for extended life of superheaters and reheaters.
- Failure analysis of main steam, hot reheat and cold reheat piping.
- Life prediction of welded joints.

Common themes illustrated by these examples are:

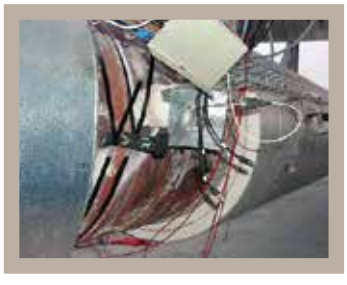
- Rapid response and deployment of up-to-date resources to deal with emergency situations.

- Assessment of material damage in complex components having complex operating histories.
- Combination of analytical, experimental, metallurgical and data acquisition capabilities.

Codes and Standards

As well as dealing with problems that fall outside the envelope of normal operation, SES staff also actively participate in the development of industry standards, such as the continuing evolution of ASME Codes and Standards, notably Sections I, III and VIII, the piping Standard B31.3, as well as contributing to the development of Joint ASME/API Fitness-for-Service Standard API 579-1/ASME FFS-1.

Technical Capabilities



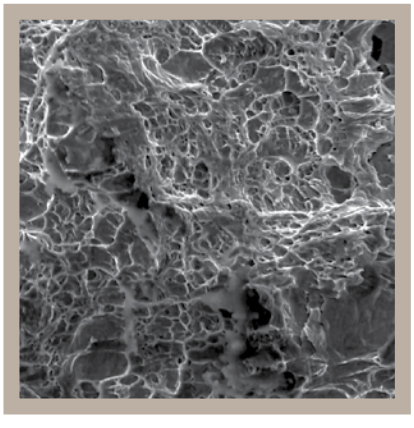
SES capabilities are best illustrated by using examples, as well as tools used in solving problems in the field. Applications cover a wider spectrum than the power industry, but many of the skills and much of expertise acquired in other industries are relevant to problems in power. The benefit of this 'cross fertilization' with a variety of industries has proven invaluable in solving problems related to power plant operation.

Water Chemistry SES has experience in utility systems raw water treatment, cooling water treatment and wastewater management. We can provide performance monitoring and vendor valuations for cost control, current program evaluations, prepare specifications for re-bidding these programs, and assist in evaluating new treatment bids. SES also has experience in re-use of municipal waste water for cooling towers and general plant water balance issues to include optimizing recycle of streams to plant scrubbers, cooling towers and other possible options.

Installation of Pipe Hanger Load Monitor

Operations Support and Monitoring The SES team includes on-site capability to support activities typically handled in a laboratory or office setting, such as Field Metallographic Replication (FMR), mechanical sample collection and field microscopy. In addition to material and welding support, SES offers installation and data analysis of strain gages, thermocouples and Acoustic Emission (AE) systems with field technical support as required.

Material Science and Engineering SES employs a large group of metallurgists and material scientists with experience of all aspects of material behavior from conventional structural steels, through advanced alloys for high temperature applications to ceramics, plastics and other non-metallics. This expertise includes modeling complex material behavior under extreme operating conditions for the purpose of predicting component response and failure.

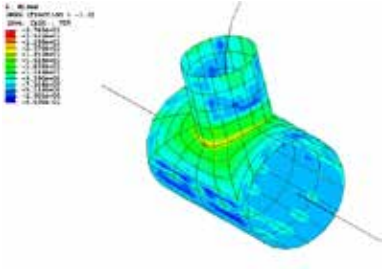


WELDING Stress Engineering Services (SES) has a long standing involvement in the design and continuing operation of large welded structures, and the effect of welded joints on component reliability. SES is involved in a major ASME/EPRI project to develop practical approaches to high temperature weld design and life prediction.

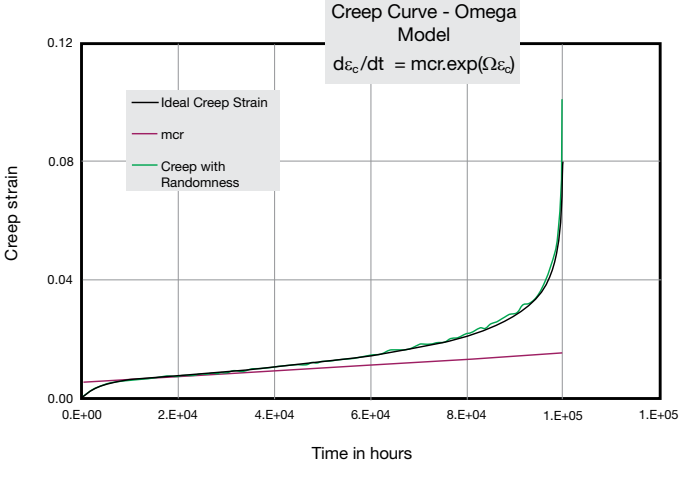
TRAINING SES provides customized in-plant training courses aimed at helping plant operators become familiar with the recommendations and complexities of API 579/ASME-FFS. SES also offers courses in plant cycle chemistry focused on helping chemists, engineers and operators know what conditions can cause long-term damage to equipment, along with how to correct abnormal conditions.

ENGINEERING COMPUTATION SES ranks among the leaders in the practical application of advanced computational techniques to the assessment of component performance and life. Much of the work done by SES in this field consists of the difficult, nonlinear problems which lie beyond the scope of standard component analysis. Typical problems include forced vibration of process equipment and piping, damage and cracking under cyclic load and high temperature, buckling and instability of components with complex geometries, and combined fluid/solid evaluation of flow induced vibrations of HRSG components, tube bundles and other plant equipment.

MODELING Development of realistic and effective models for failure prediction is critical. Usually both complex material behavior and extreme operating conditions are involved. SES understands these issues and the need to tailor model complexity in order to provide answers.



MANUFACTURING SUPPORT SES operates one of the largest component testing labs in the world, used by manufacturers of pumps, valves, seals, pipes and pipe fittings, for design development and performance testing. A data acquisition team supervises the collection of data on in-house experiments, travel on-site to monitor existing equipment, and participate in commissioning new installations.



ABOUT STRESS ENGINEERING SERVICES

Stress Engineering Services, Inc. is an employee owned professional engineering consulting company. Founded in 1972, Stress Engineering successfully completes over 1,500 projects per year for more than 700 clients worldwide.

Our staff covers a score of engineering disciplines including mechanical, civil, electrical, metallurgical, materials, water chemistry, theoretical and applied mechanics. Over 80% of our engineers hold advanced degrees, most are licensed P.E.'s, and the average engineer has more than 15 years experience.

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