



## MAJOR PIPE RECALL: ENGINEERING ANALYSIS OF PRODUCTION DATA JUSTIFIES REPLACEMENT

In a major recall of installed pipes in a Middle East gas field, an ESi statistical analysis supported the initial premise that a large proportion of pipes failed to meet the technical specifications.

### SITUATION

ESi was retained to assist in an international arbitration dispute entailing the recall of approximately 5.5 km/3.5 miles of installed superalloy pipe used in the transport of untreated sour gas.

The pipes formed part of a complex multibranch piping system on two artificial islands that were part of a multibillion-dollar gas development project in the Middle East.

The client's decision to recall and replace all the pipe material was challenged as unnecessary and that a "test and replace" strategy could have been utilized to remove high risk material from the field.

ESi was tasked to assess the amount of pipe in the field that failed to meet the technical specifications and to determine if a "test and replace" strategy could have been utilized or if the complete recall was warranted.

**Practice:** Mechanical Systems

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#### Services Utilized

- Statistical Analysis
- ESi Laboratory
- Metallurgical Analysis
- Ultrasound Inspection
- Root Cause Analysis

#### About ESi

For over 30 years, ESi has leveraged its multidisciplinary team of engineers, scientists, and professional technical staff to investigate many major accidents and disasters. Our technical expertise, hands-on experience and state-of-the-art facilities, combined with diagnostic, analytical and physical testing capabilities create an ideal environment for quickly identifying and interpreting the facts of a case.

#### Contact ESi

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## SOLUTION

Initially, ESi efforts focused on statistical analysis of the production and test records associated with the manufacturing process's capability to manufacture pipe consistent with the technical specifications.

Material test data, inspection records, and process records were consolidated and then statistically analyzed to quantify the probable proportion of pipes failing to meet the technical specifications. This analysis required filtering through large data sets containing various production records and test results, to ensure unique and independent records were used in the analysis. Multiple requirements were considered in the analysis, so special care had to be taken to properly address the joint probability of the pipe failing to meet one or more of the requirements.

Results of this analysis indicated a failure to potentially meet multiple requirements of the technical specifications. To validate this hypothesis, ESi developed a sampling protocol for field returned units. ESi then used its accredited laboratory to test and identify about 100 full sized samples. Tensile test records of the material properties, such as yield and tensile strength, were consolidated and then statistically analyzed.

The analysis revealed a bimodal population in pipe strength, which in conjunction with the metallurgical analysis and ultrasound inspection of another large sample of retrieved pipes, verified a substantive deviation from the technical specifications.

## RESULTS

The ESi investigation of the manufacturing process revealed the intentional violation of required processes and controls. This resulted in the production of deficient pipe material that was covered up by the issuance of falsified certificates. The ESi investigation revealed and substantiated the details of these fraudulent activities and identified the methods used to falsify records and test reports. Dr. Pettinger also identified correspondence where key witnesses directed employees to alter production records and test reports, including the means used to obfuscate these activities.

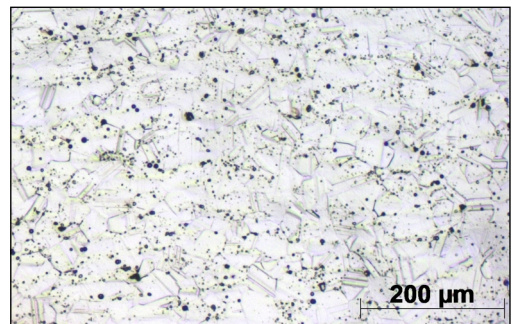
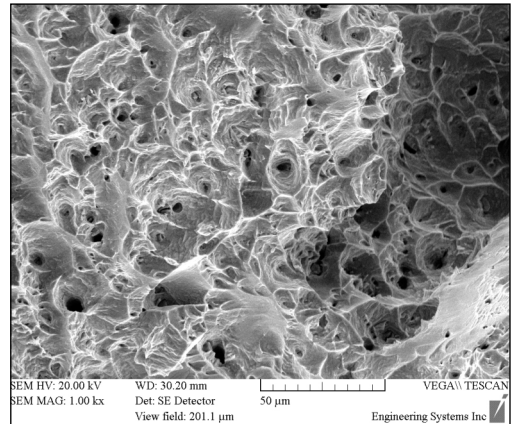
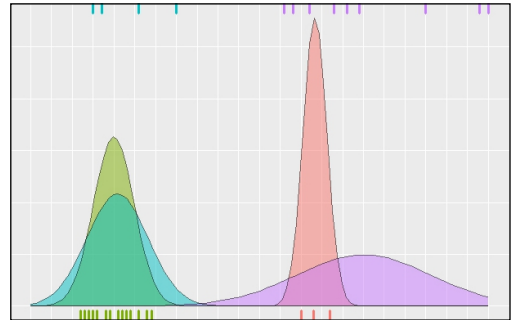
After submitting two extensive reports summarizing the findings, but prior to the testimony of ESi staff, the parties were able to settle the dispute with favorable terms for the client, allowing them to recover the costs of the recall.

ESi's statistical analysis of the data proved at a 95% confidence level that a substantial percentage of produced pipe material failed to meet the measurable contractual specifications. The large percentage of defective material, high risk application, and identified root causes proved that a substantial portion of the installed subject pipes failed to meet the technical specification in one form or the other.

The client's decision to recall all pipe material was justified and consistent with prudent engineering practices and the prevailing standards on recall decision management.

**WHY ESi.** The mechanical engineering practice group is comprised of consultants with backgrounds in:

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- Control Systems
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- Fluid Mechanics
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- Heat Transfer
- Process Piping
- Risk & Reliability Analysis
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- Stress Analysis
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- Thermodynamics
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