Quest Integrity, a TEAM company, is a global leader in the development and delivery of asset integrity and reliability management services. The company’s integrated solutions consist of technology-enabled, advanced inspection and engineering assessment services and products that help organizations improve operational planning, increase profitability, and reduce operational and safety risks. Quest Integrity has a solid and influential industry best practices since 1971.

### FTIS™ Advantage Comparison Table

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Project Management</th>
<th>Infrared Inspection Technique</th>
<th>3D-Ray (IR)</th>
<th>Manual Ultrasonic</th>
<th>Visual Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detects and quantifies pipe wall thinning occurring on the interior surface</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Detects and quantifies pipe wall thinning occurring on the exterior surface</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Detects and quantifies bulging on one side of the pipe circumference</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Detects and quantifies pipe wall thinning occurring on the exterior surface</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Detects and quantifies broad area corrosion damage</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Detects and quantifies broad area erosion damage</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Detects and quantifies pipe ovality</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Detects and quantifies bulging in radiated section of piping</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Detects and quantifies bulging in non-radiated section of piping</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Detects and quantifies bulging in raised surfaces (studded, finned, etc.)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Provides 3D and 3D color layout views of the entire furnace piping coil with inspection data overlaid immediately upon completion of inspection</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Provides 2D and 3D color layout views of the entire furnace piping coil with inspection data overlaid immediately upon completion of inspection</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Accurate axial positioning of flaw locations within each pipe segment</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

### FTIS™ ULTRASONIC INTELLIGENT PIG INSPECTION TECHNOLOGY

- ENGINEERING ASSESSMENT
- CONSULTING
- INTEGRATED SOLUTION SET FOR FIRED HEATER COILS – CONVECTION AND RADIANT SECTIONS
FIRED HEATER RELIABILITY AND ASSET INTEGRITY SOLUTIONS

Supporting clients in the refining and chemical industry, Quest Integrity is the global leader in fired heater tube inspections. Our advanced ultrasonic inspection technology, FTIS™, quickly and accurately inspects the entire piping coil, capturing data in both the connection and radiant sections. Combined with our advanced engineering and assessment capabilities, we deliver the optimal solution for your integrity management program.

**Solutions**
- **FTIS™** ultrasonic intelligent pig inspection technology
- **LifeQuest™** Header remaining life assessment data visualization, analysis and assessment software
- **Advanced engineering assessment of dents, gouges and crack-like flaws**
- **Failure assessment and root cause analysis**
- **Materials engineering and lab support**

**Benefits**
- **Reduced Operational Risk**
- **Enhanced reliability and reduced failure risk through connection, radiant and cross-over coil inspection**
- **Improves operator to make real-time decisions about coil readiness**
- **Improves maintenance accuracy**

**Cost-Effectiveness**
- **Extends life of fired heater coils**
- **Eliminates need for most conventional NDT methods**
- **Requires no scaffolding or heater loss entry**

**Time Efficiency**
- **Minimize offline status with time efficient inspections**
- **Travel at approximate speeds of 2 ft/s (0.6m/s) enabling inspection of 2,000 ft (610 meters) in 15 minutes and all coils in furnace in 1 day**
- **Generates field report typically within 24 hours of inspection completion**

**Damage Mechanisms Identified**
- Corrosion – broad area or localized
- Erosion – broad area or localized
- Mechanical damage (fretting)
- Diameter changes between interior and exterior wall thickness
- Galvanic cells (e.g., swelling, pitting, bulging)
- Axial and circumferential flaws
- Coke or scale build-up

**Features and Capabilities**
- **Provides 100% coverage of axial length in coils**
- **Provides 100% overlap of coverage for coil components utilizing 48 to 168 ultrasonic sensors**
- **Inspects header coils of any length**
- **Inspects pipe or tube diameters between 3–14 inches (76–355mm) NPS**
- **Negotiates unlimited short radius < 10° 180° return bends**
- **Travels and functions bi-directionally**
- **Negotiates plug headers (mule ears) without the need for modifications**
- **Provides exceptionally high quality data**
- **Determines axial positioning of flaw locations**
- **Calculates fitness-for-service and remaining life of coils utilizing LifeQuest header**

**Remaining Life Engineering Assessment**
- **Provides fitness-for-service and remaining life engineering assessments in accordance with API 579 and ASME FFS-1**
- **Performs analysis and assessment of heater components in accordance with Section 5 (Local Metal Loss) and Section 10 (Coke); includes Monte Carlo simulation to account for variability in future operating conditions**
- **Provides comprehensive assessment of current and future operating risk for each furnace tube utilizing 100% of inspection data**

**LIFE ASSESSMENT RESULTS**
- **Deterministic calculations of remaining life on foot-by-foot basis**
- **Flexibility for manual or automatic import of past operating conditions, inspection history and materials information for rapid assessment**
- **Final output of “system risk curve” displaying remaining life in hours versus probability of failure**
- **Acceptable level of risk, tube removal and turnaround planning determinable based upon results**
- **Combinable with heater performance monitoring and process modeling for extensive heater reliability management**
- **Costs 4-6% of coil repair or replacement, saving significant future downtime and maintenance costs**

**Engineering Assessment**
- **Level 2 and 3 fitness-for-service assessment of refinery in accordance with API 579/ASME FFS-1**
- **Finite element analysis for stress analysis, heat transfer and soil simulation**
- **Computational fluid-dynamics analysis of process vessels, heaters, boilers, heat exchangers and turbines**
- **Fracture mechanics analysis, including 3D finite element analysis simulation of components with cracks**
- **Failure analysis**
- **Corrosion engineering**
- **Remaining life assessment**
- **Ris e-based inspection/assessment**
- **Deep and high-temperature materials testing and database access**

**Inspection Reports**
- **Patented color 3D and 2D graphics illustrate most severe damage in intuitive format**
- **Patented 2D and 3D color plots of full seaparate header coil in “wall thickness” and “external profile” formats**
- **Minimum wall thickness readings in tabular format**
- **Computer-generated CAD drawing of piping coil layout with overlay of inspection results**
- **Data archival for future comparison**

**FTIS™** Heater Visualization and Assessment Software

**PLATFORM FOR DELIVERY OF FTIS INSPECTION AND REMAINING LIFE ASSESSMENT RESULTS**
- **Complete Analysis and Assessment Capabilities**
- **Flexible for manual or automatic import of past operating conditions, inspection history and materials information for rapid assessment**
- **Deterministic calculations of remaining life on foot-by-foot basis utilizing API 579**
- **Final output of “system risk curve” displaying remaining life in hours versus probability of failure**
- **Acceptable level of risk, tube removal and turnaround planning determinable based upon results**
- **Combinable with heater performance monitoring and process modeling for extensive heater reliability management**
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**LifeQuest™ Hardware and Software**

**Inspection of Fired Heaters with Plug Headers**

Fired heaters such as a Corner Heaters contain plug headers (mule ears) in order to allow access to the coils interior without cutting off a return bend. This access is sometimes necessary in order to achieve retrimination in the event that the coil becomes plugged and circulation is not achievable at the optimal flow rate. Historically, the presence of plug headers has posed a major challenge concerning fire tube inspection process due to difficulty in navigating the fittings. Advances in Quest Integrity’s furnace tube inspection System, or FTIS™, have increased the capabilities of the technology and extended the benefits of ultrasonic intelligent pigging to heater coils containing plug headers (mule ears) – without the need for radial inserts.

**Key Benefits**
- **Navigates plug headers (mule ears) without the need for modifications**
- **Eliminates the need to install radial inserts (slipper)