Quest Integrity™

CHALLENGE CONVENTION

Fired Heater Reliability and Asset Integrity Solutions

+ FTIS™ ULTRASONIC INTELLIGENT PIG INSPECTION TECHNOLOGY
+ ENGINEERING ASSESSMENT AND 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 industries, 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, collecting data in both the convection 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™ Heater 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

- Improves heater reliability and decreases failure risk through convection, radiant and cross-over coil inspection
- Enables operators 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 box entry

Time Efficiency

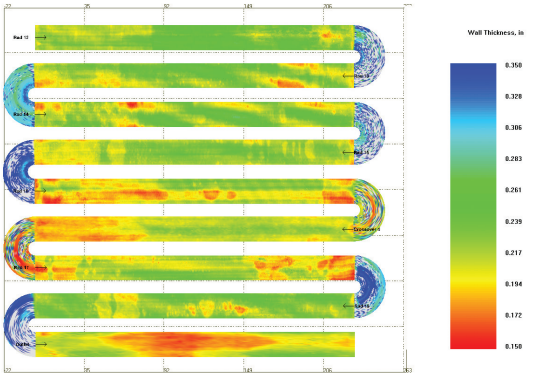
- Minimize offline status with time efficient inspections
- Travels at approximate speeds of 2 ft/s (0.6m/s) enabling inspection of 2,000 ft (610m) coil in 15 minutes and all coils in furnace within 1 day
- Generates field report typically within 24 hours of inspection completion

Damage Mechanisms Identified

+ Corrosion – broad area or localized
+ Pitting – broad area or localized
+ Erosion – broad area or localized
+ Mechanical damage (fretting)
+ Deformations (e.g. swelling, ovality, bulging)
+ Carburization (through indirect detection)
+ Axial and circumferential flaws
+ Discriminates between interior and exterior wall thinning
+ Coke or scale build-up

Features and Capabilities

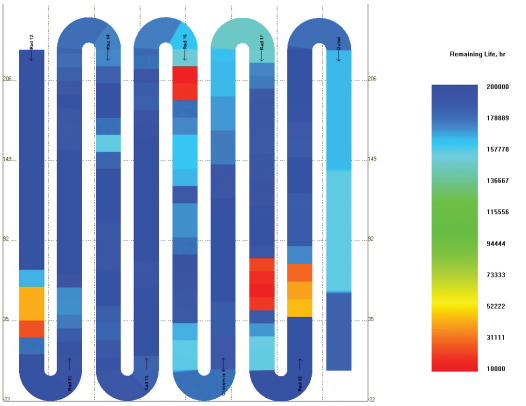
- Industry-leading resolution and flaw detection capabilities
- Inspects heater coils of any length
- Travels and functions bi-directionally
- Inspects full range of pipe or tube diameters-typically 2–14 inches (51-356mm) NPS
- Negotiates unlimited short radius x 1D 180° return bends and plug headers (mule ears)
- Negotiates coils attached to common headers, eliminating the need for costly modifications
- Captures and reports location of flaws detected
- Calculates fitness-for-service and remaining life of coils utilizing LifeQuest Heater



Inspection data is viewed using LifeQuest Viewer

Remaining Life Engineering Assessment

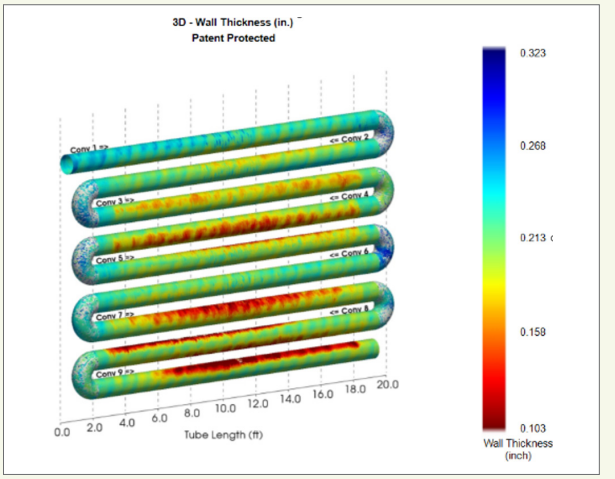
- Provides fitness-for-service and remaining life engineering assessments in accordance with API 579 and ASME FFS-1/2007
- Performs analysis and assessment of heater components in accordance with Section 5 (Local Metal Loss) and Section 10 (Creep); includes Monte Carlo simulation to account for variability in operating conditions
- Provides comprehensive assessment of current and future operating risk for each furnace tube utilizing 100% of inspection data



A 2-D view of API 579, Remaining Life based on Part 5 and Part 10 damage mechanisms

Inspection Reports

+ Patented 2D and 3D color plots of full heater coil in “wall thickness” and “internal profile” formats
+ Minimum wall thickness readings and deformations in tabular format
+ Feature (flaw) locator sheets for every reported minimum wall thickness reading and deformation
+ Reporting by damage type (internal, external, pitting, fretting, bulging, etc.)
+ Viewer software containing 100% of the inspection data
+ Data archival for future comparison



3D Convection Coil Layout – damage patterns are illustrated in 2D and 3D graphics

LifeQuest™ Heater Visualization and Assessment Software

PLATFORM FOR DELIVERY OF FTIS™ INSPECTION AND REMAINING LIFE ASSESSMENT RESULTS

Complete Analysis and Assessment Capabilities

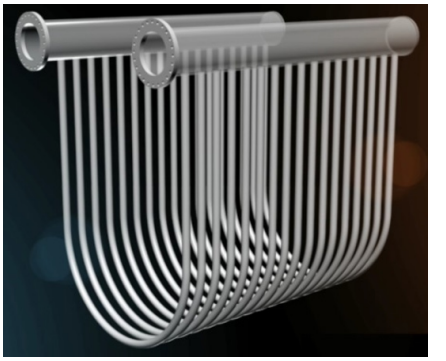
- Flexibility for manual or automatic import of past operating conditions, inspection histories and materials information for rapid assessment
- Deterministic calculations of remaining life on foot-by-foot basis utilizing API 579
- Final output of “system risk curve” displaying remaining life in hours 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
- 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 weld 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
- Risked-based inspection/assessment
- Creep and high-temperature materials testing and database access

**2D and 3D modeling covered under U.S. Patent No. 7,542, 874; China Patent No. ZL200580017873.2; South Africa Patent No. 2006/09598; Canada Patent No. 2,568,174; Mexico Patent No. 269892; Australia 60/576,276; Russia 2392658.*

Plug Header



Common Headers (Manifolds)

Inspection of Fired Heaters with Plug Headers and Common Headers

Fired heaters containing plug headers (mule ears) and common headers (manifolds) have historically posed a major challenge to the in-line inspection process due to the difficulty in tool navigation.

Advances in Quest Integrity technologies now make it possible to inspect coils and piping welded to plug and common headers with little to no heater modifications, enabling a complete and quantitative mapping of each coil’s/pipe’s wall thickness and geometry.

Key benefits:

Plug Headers

+ Navigates headers without the need for modifications
+ No radial inserts (slippers) required

Common Headers

+ Navigates headers with little to no modifications
+ Allows for high quality cleaning and inspection

FTIS™ Advantage Comparison Table

Capabilities	FTIS™ Intelligent Pig (UT)	Tethered Inspection Technique	Infrared (IR)	X-Ray (RT)	Manual Ultrasonic (UT)	Visual Methods
Detects and quantifies pipe wall thinning occurring on the interior surface including pitting damage	✓	✓		✓ radiant section only	✓ radiant section only	
Detects and quantifies pipe wall thinning occurring on the exterior surface including fretting and pitting damage	✓	✓			✓ radiant section only	✓ radiant section only
Detects and quantifies bulging on one side of the pipe circumference	✓					✓ radiant section only
Detects and quantifies pipe swelling (360° of pipe circumference)	✓					✓ radiant section only
Detects and quantifies broad area corrosion damage	✓	✓		✓ radiant section only	✓ radiant section only	✓ radiant section only
Detects and quantifies broad area erosion damage	✓	✓			✓ radiant section only	✓ radiant section only
Detects and quantifies pipe ovality	✓					✓ radiant section only
Inspects 100% of piping coil convection section	✓					
Inspects 100% of piping coil radiant section	✓	✓		✓ radiant section only	✓ radiant section only	✓ radiant section only
Inspects convection section piping containing raised surfaces (studded, finned, etc.)	✓					
Provides 2D and 3D color layout views of the entire furnace piping coil with inspection data overlaid immediately upon completion of inspection	✓					
Accurate axial positioning of flaw locations within each pipe segment	✓		✓ radiant section only	✓ radiant section only	✓ radiant section only	✓ radiant section only

Quest Integrity 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 is built on a foundation of leading edge science and technology that has innovated and influenced industry best practices since 1971.

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