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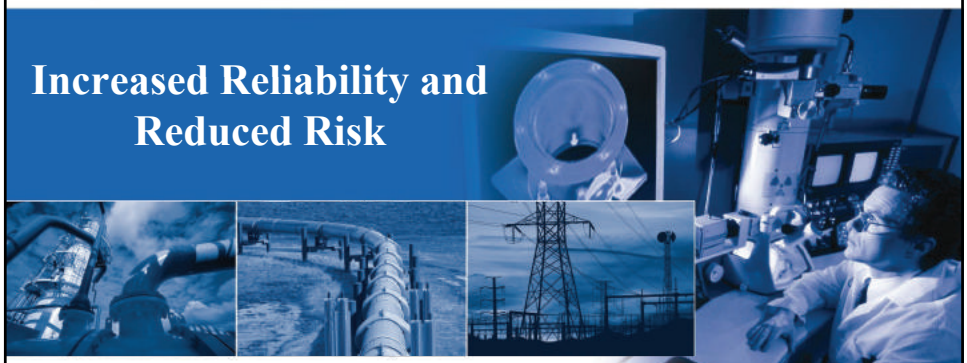
Increased Reliability and Reduced Risk



Applying FTIS™ Intelligent Pigging Technology to Inspect Certain Process Heaters Containing Plugged Headers

Process Heater Risk Management Solutions

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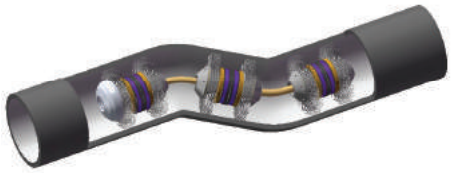
FTIS™ Design Advancements



Prototype
* Development: 1995
* Investment: $1.5M USD
* 8 Ultrasonic Sensors
* 4" to 8" Pipe
* 1 mile maximum

Generations- I, II, III,IV, V
* Development: 1998 - 2007
* Investment: $4M USD
* 16 - 32 Ultrasonic Sensors
* 4" to 8" Pipe
* 1 mile maximum
* More robust design
* Increased data analysis algorithms
* 2D & 3D Modeling
* LifeQuest Remaining Life capabilities

Generation - VI
* Development: 2007 - 2008
* Investment: $1.5M USD
* 48 - 96 Ultrasonic Sensors
* +100% inspection coverage
* 3" to 12" Pipe
* 25 mile maximum
* Additional robust design features
* Increased data analysis algorithms
* Additional positioning technology

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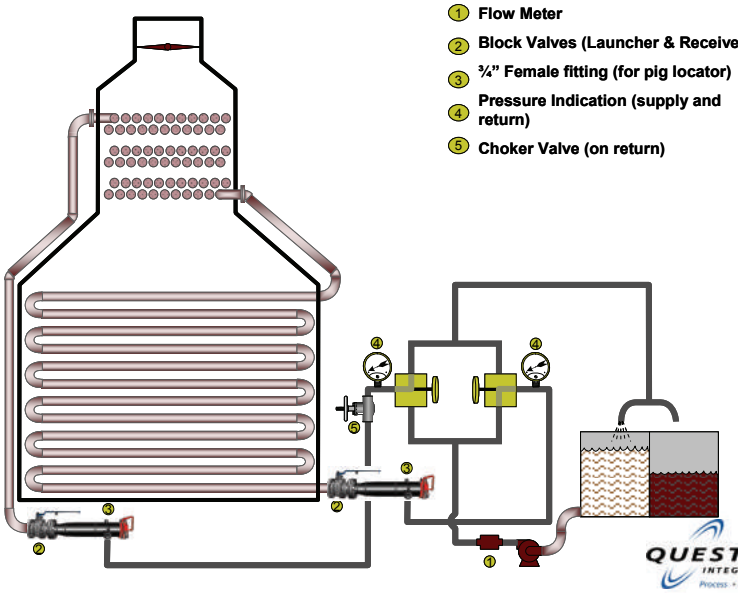
Heater Configuration

1. Flow Meter
2. Block Valves (Launcher & Receiver)
3. ¾" Female fitting (for pig locator)
4. Pressure Indication (supply and return)
5. Choker Valve (on return)



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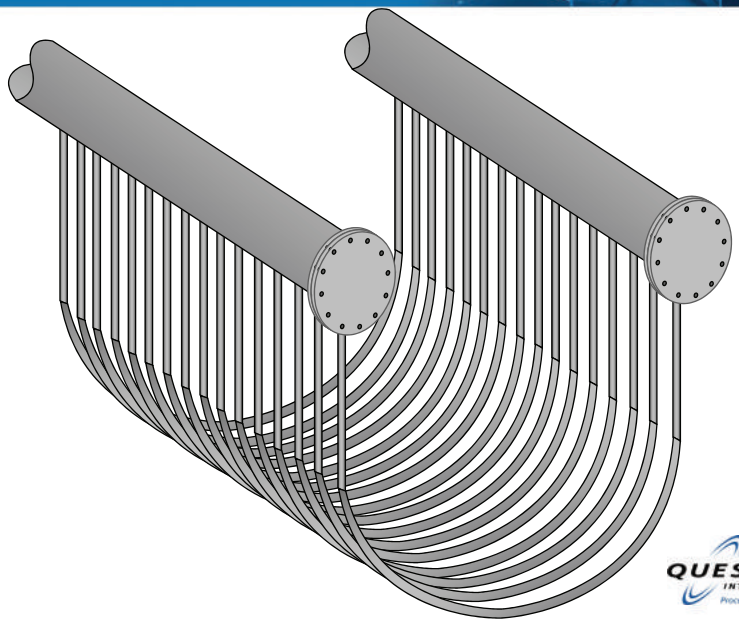
UOP Platforming™ Heater / CCR (Arbor Design)



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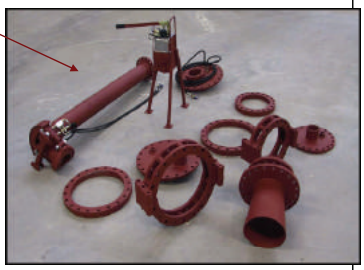
Applications

❑ ***Furnaces Piping / Tubing*** ***(~500 Heater Coils Inspected Each Year!)***

- ✓ Numerous Furnace Types *(Platformers (CCR), Vacuum, Coker, Crude, Can, Cabin, etc.)*
- ✓ Various Coil Configurations *(Vertical, Horizontal, U-Shape, etc.)*
- ✓ Changing Diameter Coils *(4" ◊ 5" ◊ 6" ◊ 8")*
- ✓ Non-pigable furnaces in some cases *(i.e. Common Headers) (Common Header Delivery Systems*)*

❑ ***Pipelines***

- ✓ Underground / Buried / Road Crossings
- ✓ Insulated (i.e. Asbestos)
- ✓ Overhead (i.e. Congested Pipe Racks)
- ✓ In Plant / Between Plants / Wharf Lines



**Common Header Delivery System only available in Europe at this time*

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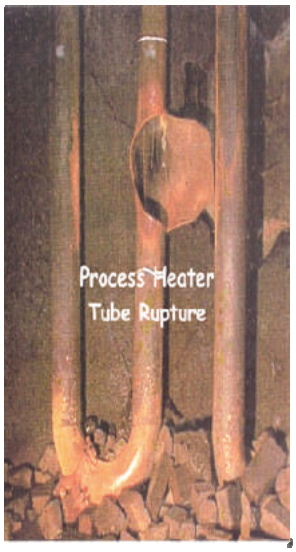
FTIS™ / LOTIS® Detectable Failure Mechanisms



Naphtha Hydrotreater

- *Pipe/Tube Wall Loss*
  - ✓Corrosion *(Int. or Ext.)*
  - ✓Erosion *(Int. or Ext.)*
  - ✓Pitting *(Int. or Ext.)*
  - ✓Mechanical Damage *(Int. or Ext.)*
- *Deformation*
  - ✓Bulging *(i.e. Flame Impingement)*
  - ✓Swelling *(i.e. Creep Strain)*
  - ✓Denting
  - ✓Ovality

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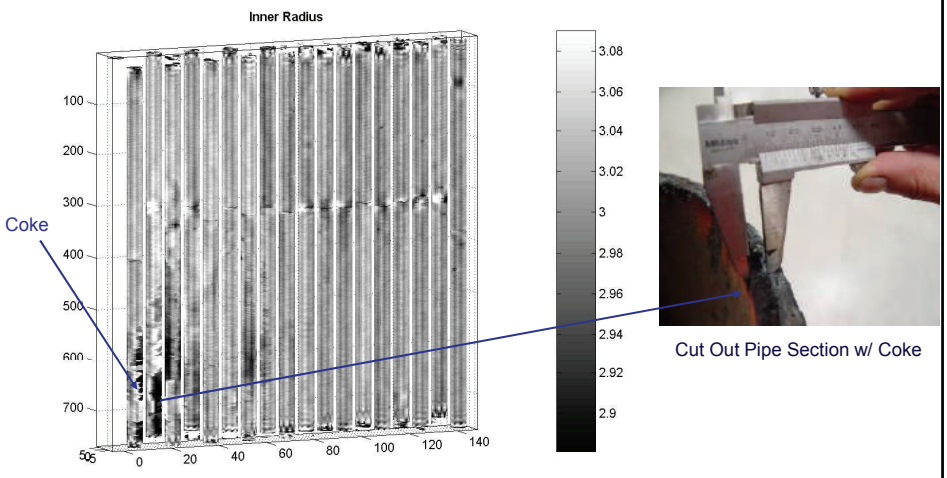
Decoking Quality Control / Quality Assurance



Cut Out Pipe Section w/ Coke

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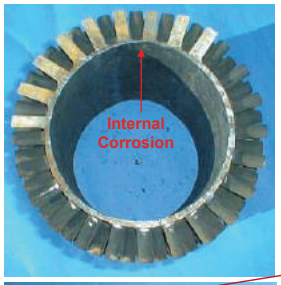
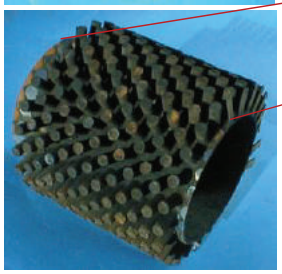
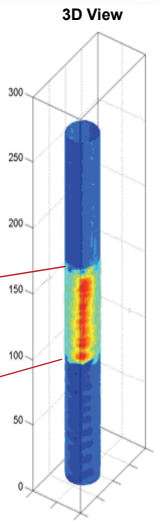
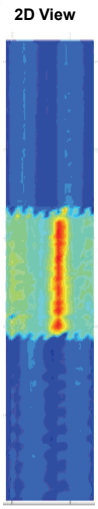
Convection Pipe Studded / Finned Pipe









New Pipe

Sample Convection Pipe

New Pipe

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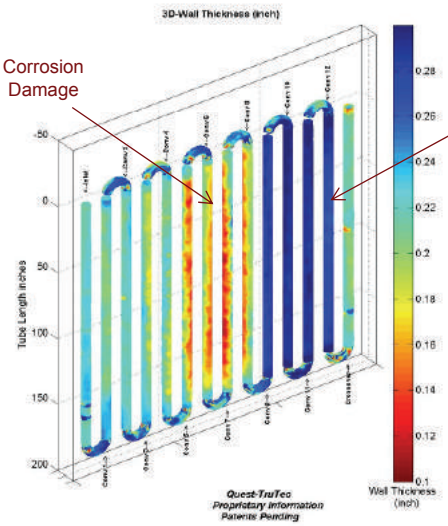
Corrosion (Convection Section)



The Weakest Link In the System Can Cost Your Plant!

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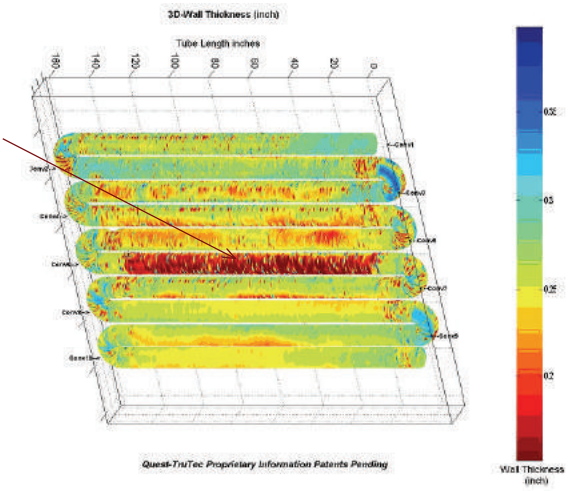
Corrosion (Convection Section)



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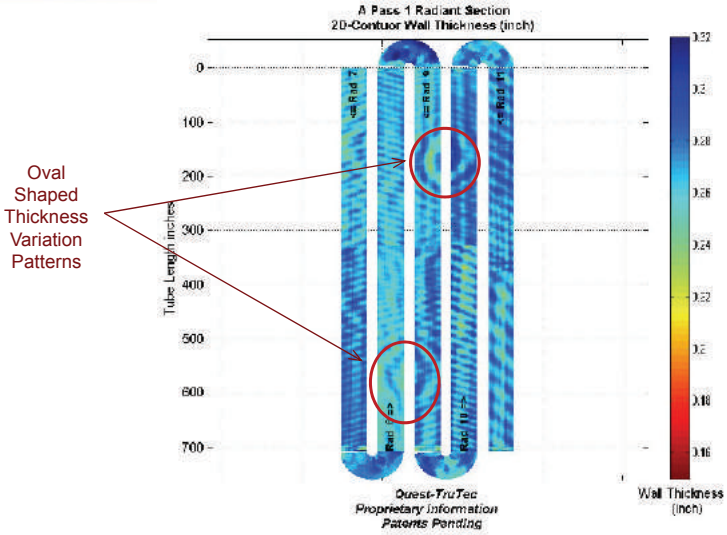
Various Tube Wall Thickness (Radiant Section)



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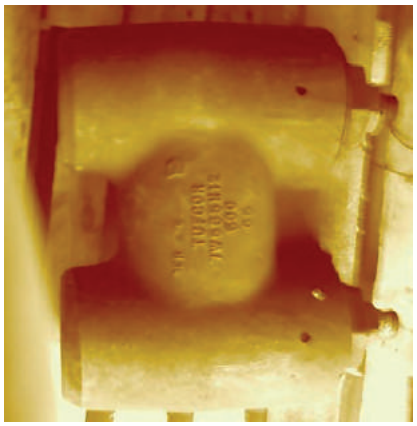
Plugged Headers

- Also known as mule ear returns
- Cast fittings mounted at the ends of serpentine piping coils
- Original intent was to allow access to the interior of the heater in the event of a coke blockage



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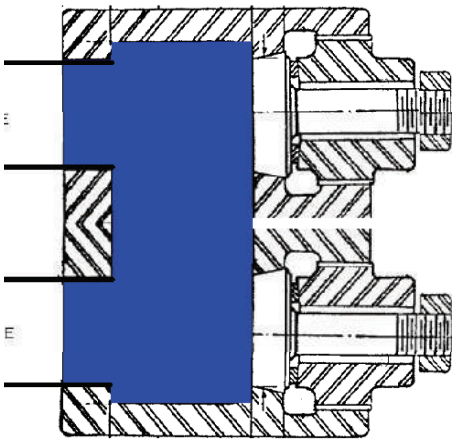
FTIS™ - Previous Generations

- Previous generations of FTIS could not navigate the rectangular-shaped configuration
- Global demand for this navigational capability still exists



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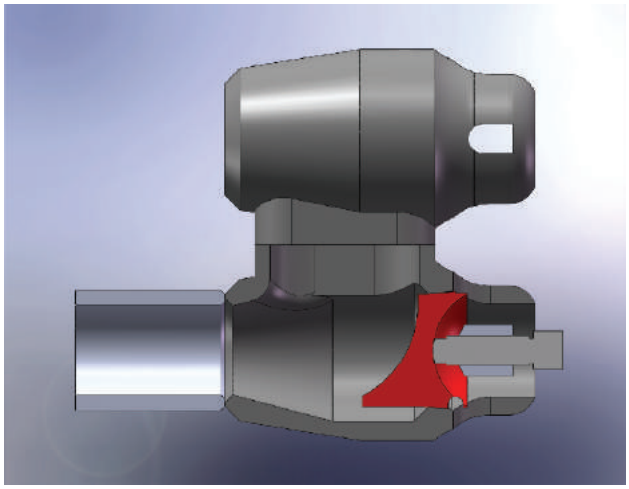
Plugged Header Inserts

Shoe-horn style inserts round-off the hard internal angles



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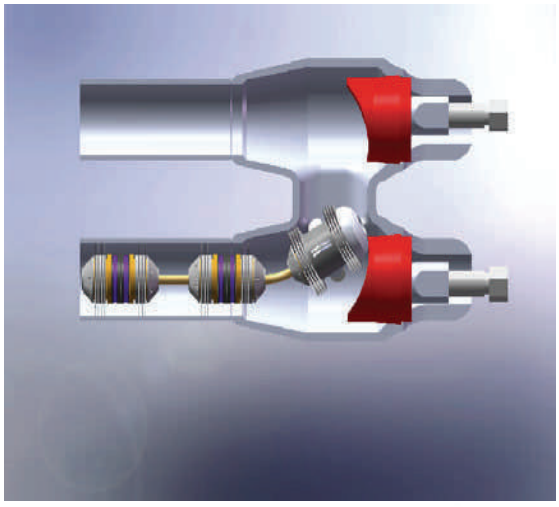
FTIS™ - New Generation

The new generation 4” FTIS™ has successfully navigated plugged headers with inserts of this type in 6” diameter heater coils.



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Case Study #1

CRUDE HEATER – Radiant Section

- Number of Coils / Passes = 5
- Radiant Pipe Material = A335-P9 (6” x Sch-40)
- General wall thinning caused by internal erosion/corrosion was detected throughout.
- Piping has been in service since 1994.
- Several return bends in the radiant section contained plugged headers with show-horn style inserts.
- Most significant wall thinning in radiant section (31% loss) was approximately 2x that in convection section
- Refinery personnel indicated radiant section coils were not previously navigable by intelligent pig technology.
- Refinery personnel indicated that without the FTIS™ inspection data, the wall thinning in the radiant section would have remained undetected.

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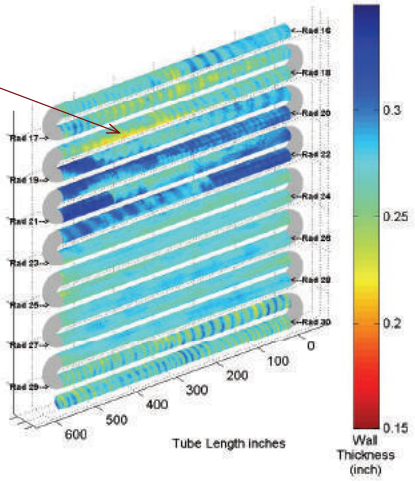
Case Study #1 – Corrosion Damage in Radiant Section

Wall Thinning Damage Caused by Erosion/Corrosion Damage



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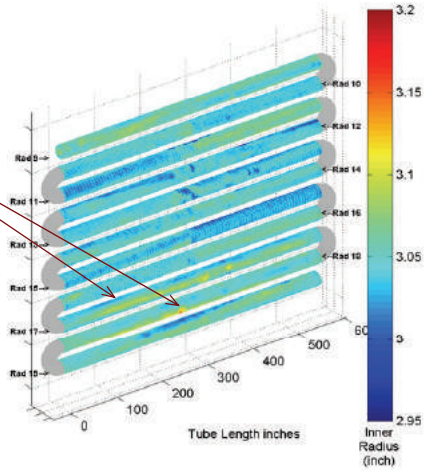
Case Study #1 – Corrosion Damage in Radiant Section

Wall Thinning Damage Caused by Erosion/Corrosion Damage



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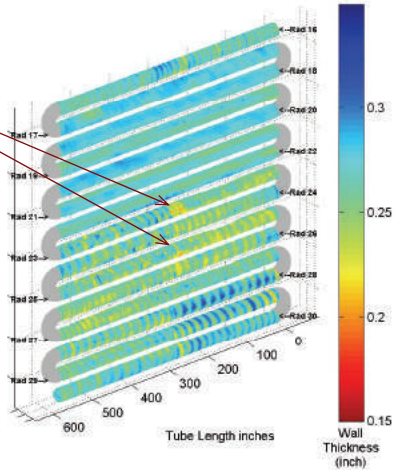
Case Study #1 - Corrosion Damage in Radiant Section

Wall Thinning Damage Caused by Erosion/Corrosion Damage



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THANK YOU!

PLEASE ASK ANY QUESTIONS THAT YOU MAY HAVE AT THIS TIME

Copies of presentation can be provided ***upon request.***

Contact: Tim Hill at *T.Hill@QuestReliability.com*
1.303.938.3023

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