

## Reformer Care A Complete Asset Integrity Solution

- + LOTIS® LASER-BASED INTERNAL INSPECTION TECHNOLOGY
- + MANTIS™ EXTERNAL CRAWLER INSPECTION TECHNOLOGY
- + LIFEQUEST™ REFORMER REMAINING LIFE ASSESSMENT
- + INTEGRATED SOLUTION SET FOR STEAM REFORMERS

# LOTIS® & MANTIS™ INSPECTION TECHNOLOGIES

## Reformer Care Solution Includes:

- + Inspection and Data Analysis
- + Remaining Life Assessment
- + Advanced Engineering

## Benefits

### Reduced Operational Risk

- + Minimizes risk of unplanned shutdown due to premature tube failure
- + Allows plant engineers to manage and often extend tube life beyond 100,000 operating hours
- + Allows operators to improve reformer output and operate within an integrity window, providing a holistic approach to the operational needs
- + Baseline inspections at tube manufacturing facility to ensure tubes meet your specifications prior to shipment

### Cost-effectiveness

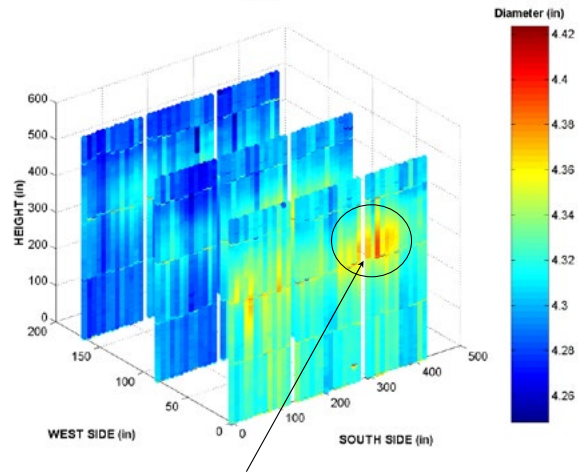
- + Provides large quantity of diagnostic information
- + Minimizes unplanned outage potential – typical outage cost is \$250K USD per day; average down time 7-10 days often costs operators = \$1.7M USD in lost production
- + Enables cost management and financial planning for future tube replacement

### Time Efficiency

- + Rapid inspection process (typically 2-3 minutes per tube) reduces reformer downtime
- + Can be performed alongside catalyst loading/unloading teams with no additional time required
- + Tube life monitored over entire life cycle; other inspection techniques are useful only at or very near end of tube life which is often too late for remnant life prediction or effective tube replacement management

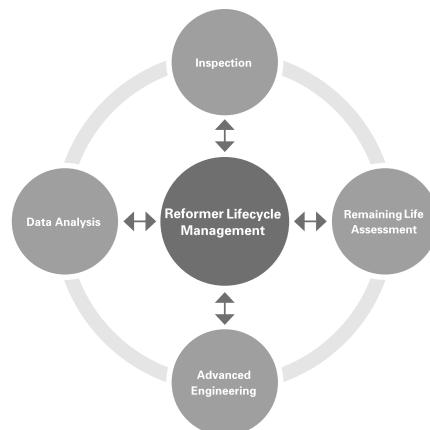
## Failure Mechanisms Identified/Quantified

- + Creep strain
- + Bulging or swelling
- + Manufacturing flaws



## Features & Capabilities

- + Inspection data feeds directly into LifeQuest Reformer for remaining life assessment
- + LOTIS inspects 100% of reformer tube
- + Highly accurate and repeatable results
- + Collects millions of data points during typical inspection
- + No couplant required
- + Provides increased confidence in inspection results through combined NDT methodologies
- + Performs inspection with or without catalyst in tubes and each time reformer is taken offline



### Remaining Life Engineering Assessment

- + Fitness-for-Service and remaining life engineering assessments in accordance with API 579 and ASME FFS-1/2007
- + Proprietary materials database for HP alloys and microalloys, representing 25+ years of empirical data
- + Proprietary advanced creep model with primary, secondary and tertiary regimes

### Advanced Engineering Assessment

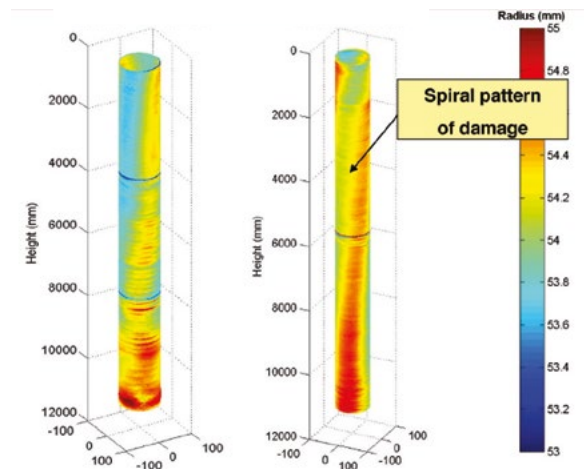
- + Assessment of high temperature components such as header systems and inlet and outlet pigtails
- + 3D elastic-plastic Finite Element Analysis and Computational Fluid Dynamics modeling of ancillary equipment
- + Assessment technology backed by extensive in-house materials testing of post-service HP alloys
- + Materials engineering and lab support specializing in high temperature material assessment, including accelerated creep-rupture testing
- + World leader in fracture mechanics
- + RBI and RBA assessment of all major syngas plant components

### LifeQuest Reformer Remaining Life Assessment Software

- + Highly advanced tool combines Fitness-for-Service assessment and our proprietary materials database to determine remaining life for each tube; not dependent upon input operating conditions like other assessment methodologies
- + Finite Element Analysis assesses through-wall creep damage gradient; includes longitudinal and through-thickness stress gradients to accurately model current condition, historical stresses and predicted stresses
- + Measured creep damage is matched with model output to accurately assess effective operating metal temperature
- + Developed by leading industry experts

### Analysis & Assessment Capabilities

- + Increases confidence in remaining life predictions
- + Quantifies and predicts total creep damage
- + Provides deterministic and probabilistic life assessments for each tube
- + Provides remaining life of each inspected and assessed reformer tube
- + Analyzes 100% of LOTIS inspection data



### Reformer Care Overview

- + Unique solution to attain operational safety and reliability goals
- + Enables proactive decision making
- + Eliminates premature harvesting of reformer tubes
- + Improves knowledge of turnaround requirements and reduces costs with proper planning
- + Increases understanding of reformer operation and limitations
- + Addresses all reformer systems



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 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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