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Life Cycle of Delayed Coker Heater Tubes – An Experience

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Growth is Life

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Introduction & Financials

India's Most Profitable Company Today

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A market leader across energy and materials value chain (E&P, R&M, Petchem) and in consumer businesses (Digital Services and Retail)

- Most profitable company for the year 2018-19. Recorded a net income of US$ 5.7 billion
- Revenue of US$ 90.1 billion, PBDIT of US$ 13.4 billion. Market cap of ~$ 125 billion

Energy Value Chain

Refining and Marketing

- Largest, most complex single site refinery with 1.24 mb/d capacity
- Consistently outperforming regional margins
- ~58% volumes placed in international markets

Petrochemicals

- Ranked Top 10 globally in key products
- 2nd largest producer of polyester fibre/yarn globally
- FY19 Production: 37.7 MMT

Exploration and Production

- Significant expertise in deep-water operations
- Substantial exposure in US Shale
- R-Cluster first gas expected in 2H FY2021

Consumer-centric Businesses

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- India's largest retailer by revenue ($18.9 bn)
- 10,415 stores with 22 MM sq.ft. space
- Presence across 6,600+ cities
- One of the world's fastest store expansion – added ~10 stores a day in last 2 years

Reliance Jio

- All IP-data network with latest 4G LTE technology
- India's largest wireless data subscriber base : 306.7 Mn with net adds of 120 Mn in FY19
- ~10.9 GB per user per month
- Carrying 71% of the total industry's 4G data traffic (CY18)

US$1 = INR 69.155

Forty Years of Phenomenal Growth

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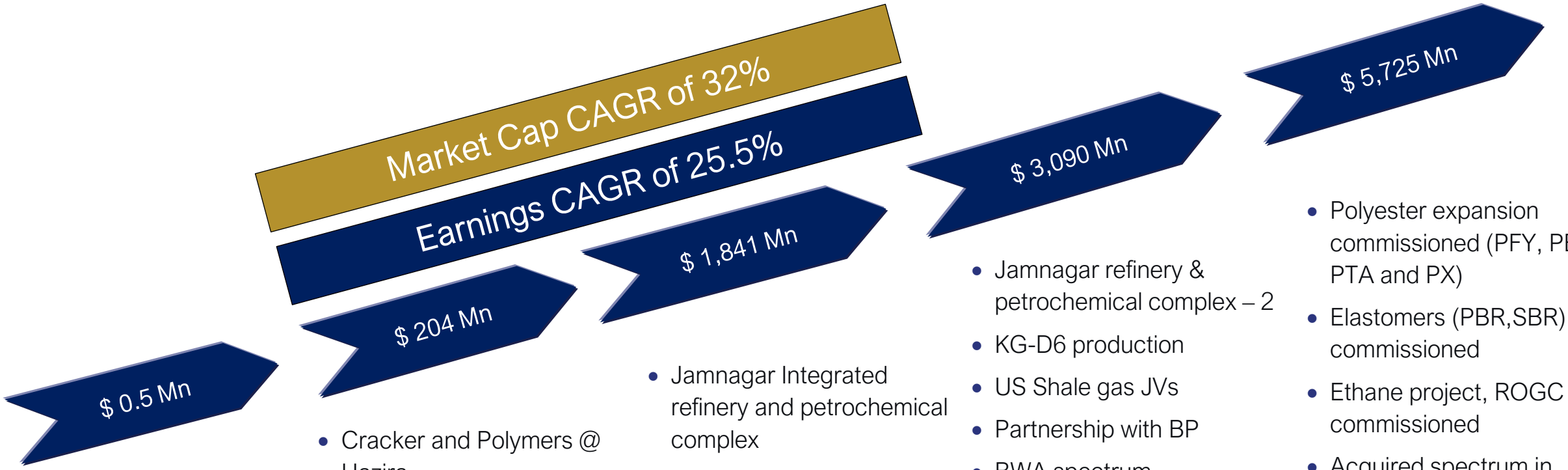

1977-87

- IPO
- Polyester @ Patalganga

1987-97

- Cracker and Polymers @ Hazira
- Fiber Intermediates @ Hazira
- Upstream – PMT
- GDR Issue
- 50/100 Years Yankee Bond

1997-2007

- Jamnagar Integrated refinery and petrochemical complex
- KG-D6 discovery
- IPCL acquisition
- Foray into organized retail
- Recron Malaysia
- Fortune Global 500

2007-12

- Jamnagar refinery & petrochemical complex – 2
- KG-D6 production
- US Shale gas JVs
- Partnership with BP
- BWA spectrum
- Launched biggest ever hydrocarbon capex program
- Innovative financing – perpetual bond, EXIM facilities

2012-19

- Polyester expansion commissioned (PFY, PET, PTA and PX)
- Elastomers (PBR,SBR) commissioned
- Ethane project, ROGC commissioned
- Acquired spectrum in 800/1800 MHz band
- JIO crosses 300 mn subscriber milestone
- CBM production
- Gasification under stabilization

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Author

Present Affiliation	**General Manager** **Section Head - Corrosion & Inspection,** **Reliance Industries Limited, Gujarat-India** **13 years of Experience in Oil & Gas Industry.** **Responsible for ensuring Reliability and Integrity of Static equipment & Piping at Jamnagar Refinery.**
Academic Qualification	**Bachelor in Mechanical Engineering** **API certified inspector for Pressure vessel, Piping, Risk Based Inspection & Tankages (API 510,570,571,580 and 653)** **Level II in RT, MT, LT & UT.**
Area of Specialization and external presentations	**Inspection of Static equipment** **Risk Based Inspection (RBI) Management** **Corrosion Management in Refinery** **Advanced Non-destructive Testing** **Root Cause Analysis of critical failures** **Coke Drum Reliability**
Paper Title	**Life Cycle of Delayed Coker Heater Tubes – An Experience**

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INTRODUCTION/ ABSTRACT

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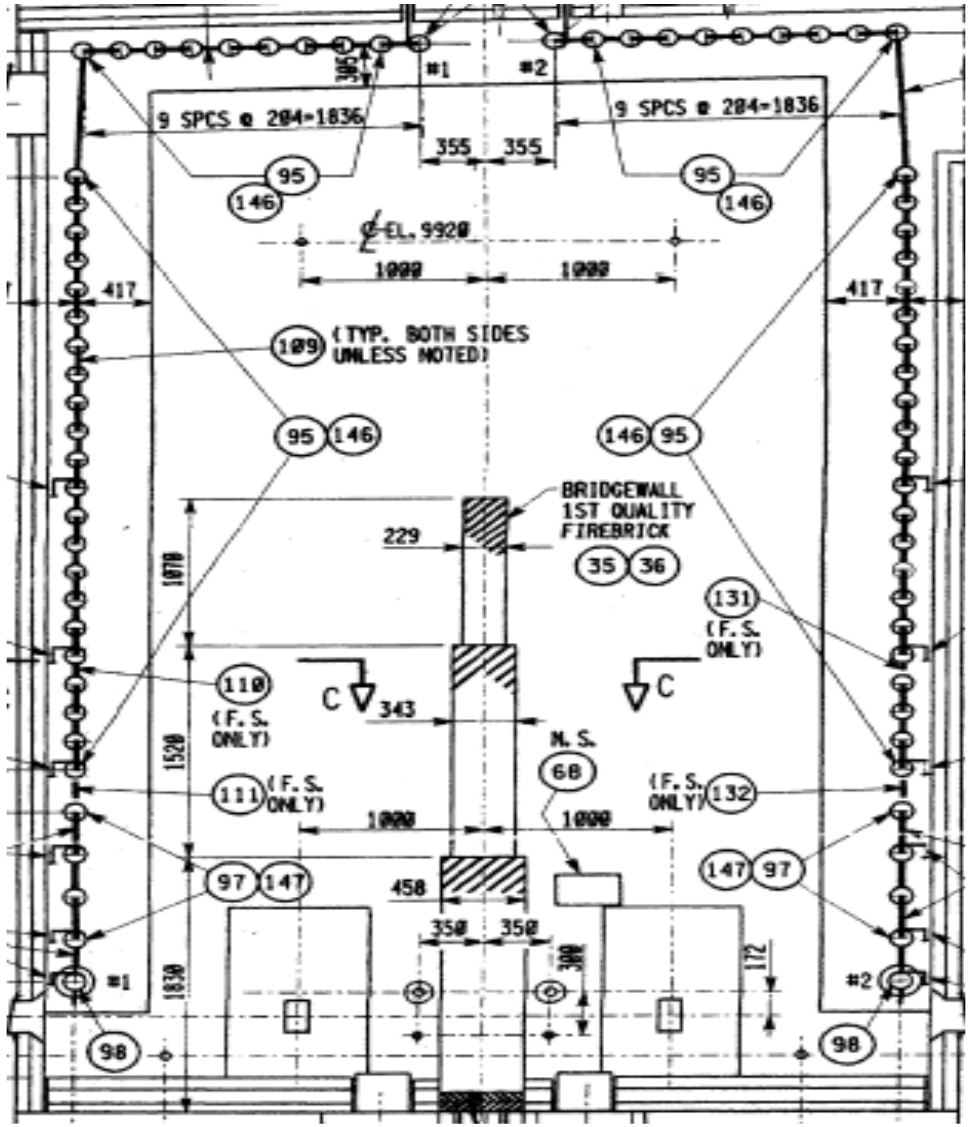
- Coker unit of Reliance Industries Limited, Jamnagar-Gujarat DTA Refinery was commissioned in Year 1999.
- Gradual thickness loss from inner wall has been observed in radiant section tubes of the heater coils.
- Scrapper pigging is being carried out periodically for removal of adhered coke deposit inside the coils in radiant section tubes.
- NDE & Inspection revealed a significant thickness loss in alloy steel tubes over a period of time.
- The thickness loss was mainly attributed removal of the protective sulphide layer (formed due to high temperature sulphidation) by scrapper pigging and exposing fresh surface for sulphidation and corrosion.
- An in-house strategy has been developed to ensure reliability of heater tubes in DTA refinery coker.
- This paper discusses the cause of heater tube thickness deterioration, Inspection strategy for heater coils, systematic approach for procurement of spare tubes and replacement methodology of tubes.

HEATER CONFIGURATION

- Single Fired, Twin cell and Four pass heater
- Alloy Steel tubes – 9Cr and 1 Mo
- 20 years of operation
- Higher tube ID for bottom tubes
- One heater feeds two drums (called one block)



COKER FURNACE DETAILS

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- Behaviour of coker furnace tubes are different from other conventional fired heaters due to severe coking in tubes.

- Frequent decoking is required based on following two reasons:

    a. Coke layer build up in ID of tubes leading to pressure drop.

    b. Increase in Tube metal skin temperature

VARIOUS METHODS OF DECOKING OF TUBES:

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Steam Air Decoking

- Option available, but discontinued.

Online Spalling

- **Merits:**
  - a) Individual passes can be spalled if construction of furnace permits.
  - b) Helps in extending run length between two pigging cycles.
- **Demerits:**
  - a) Spalling can be non uniform
  - b) TMT does not return to clean tube levels
  - c) Depends on quality of coke.

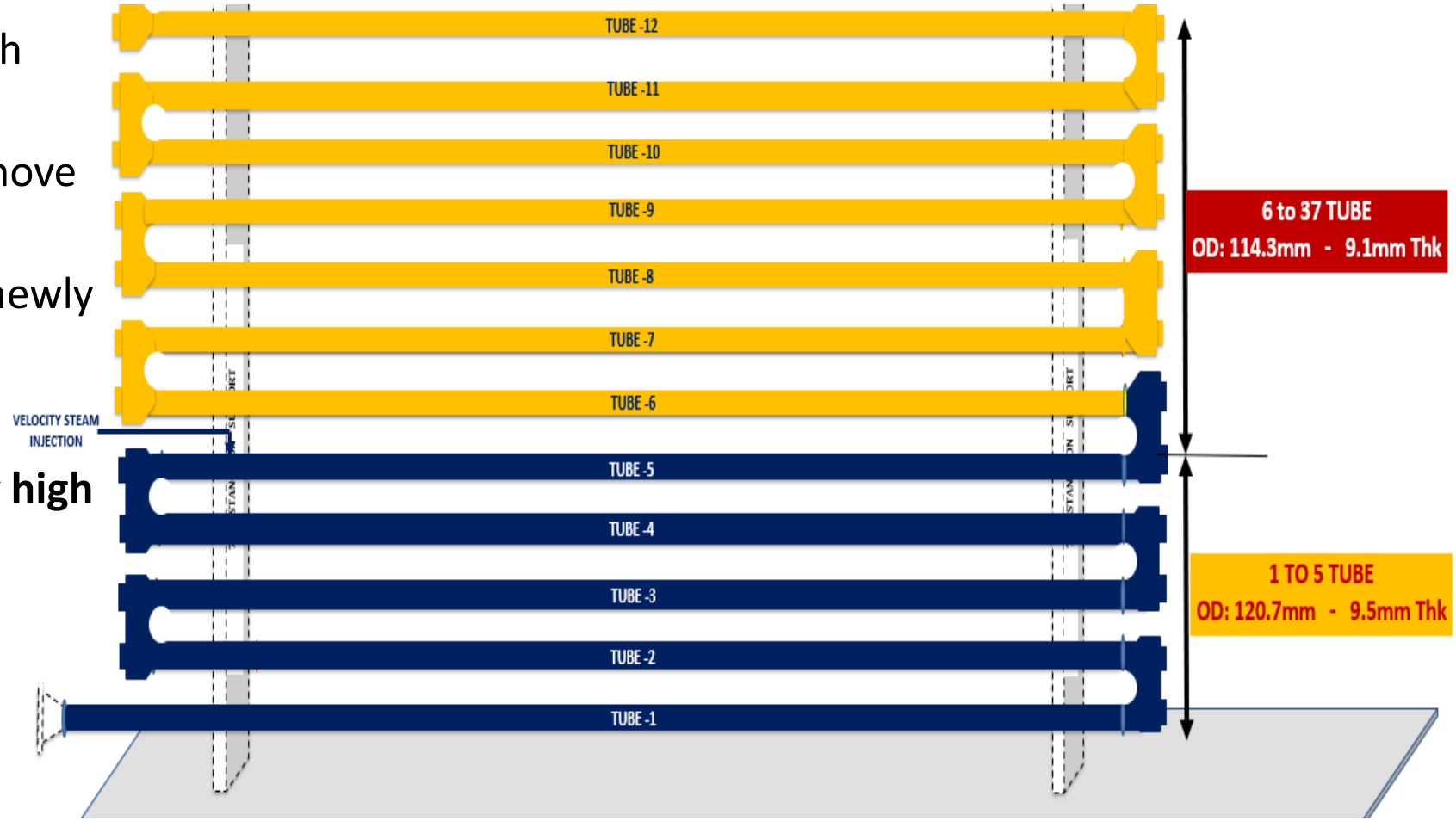
Scrapper Pigging

- **Merits**: Helps in achieving longer run length after pigging
- **Demerits**: Heater needs to be taken out of operation

PROBLEM STATEMENT

- Thickness loss observed in tube – detected during periodic ultrasonic thickness mapping
- Max wall loss observed in tube with change in ID
- Trend shows less wall loss as we move towards inlet side.
- Accelerated wall loss observed in newly replaced tubes.

- **Cast plug headers have inherently high original thickness as compared to straight tubes and were safe for operation.**



HEATER TUBE LAYOUT SHOWING METAL LOSS

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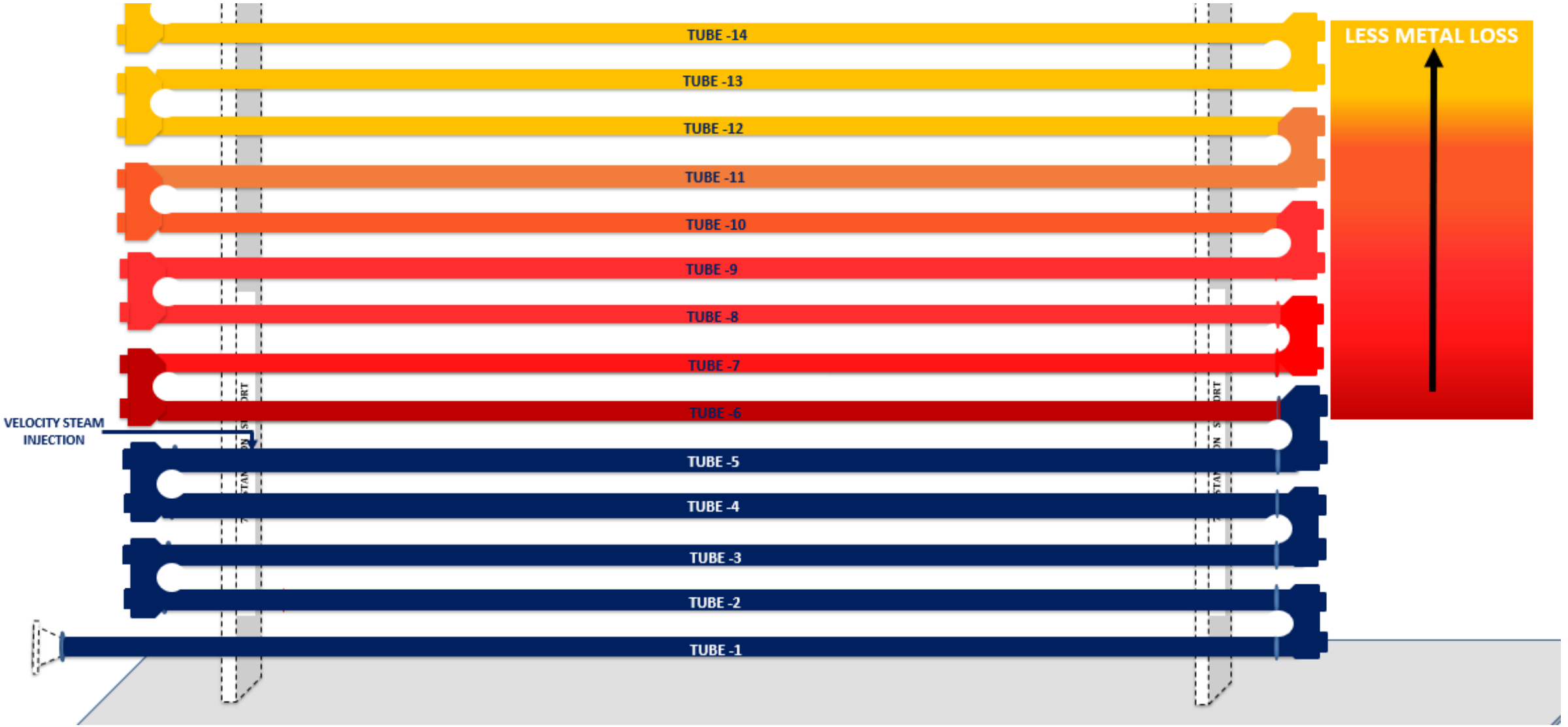

THICKNESS VARIATION ACROSS TUBES

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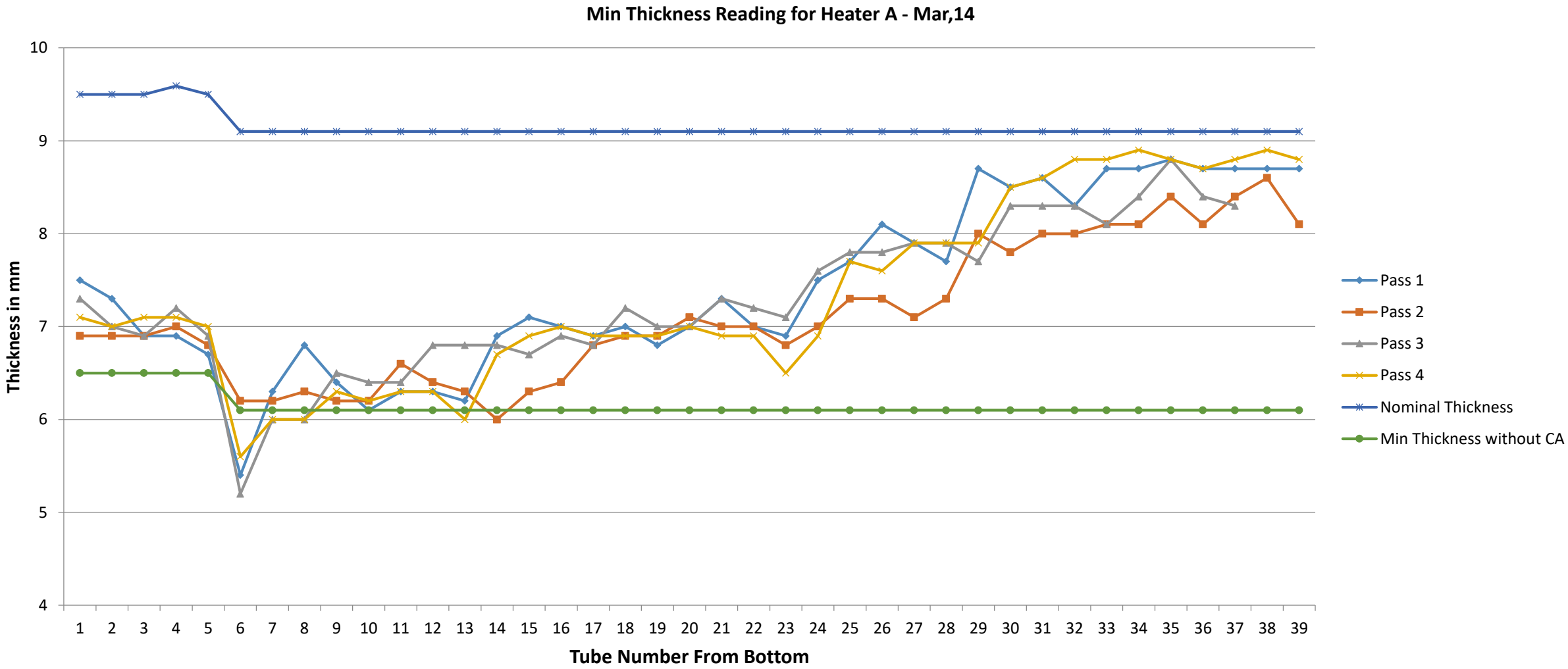
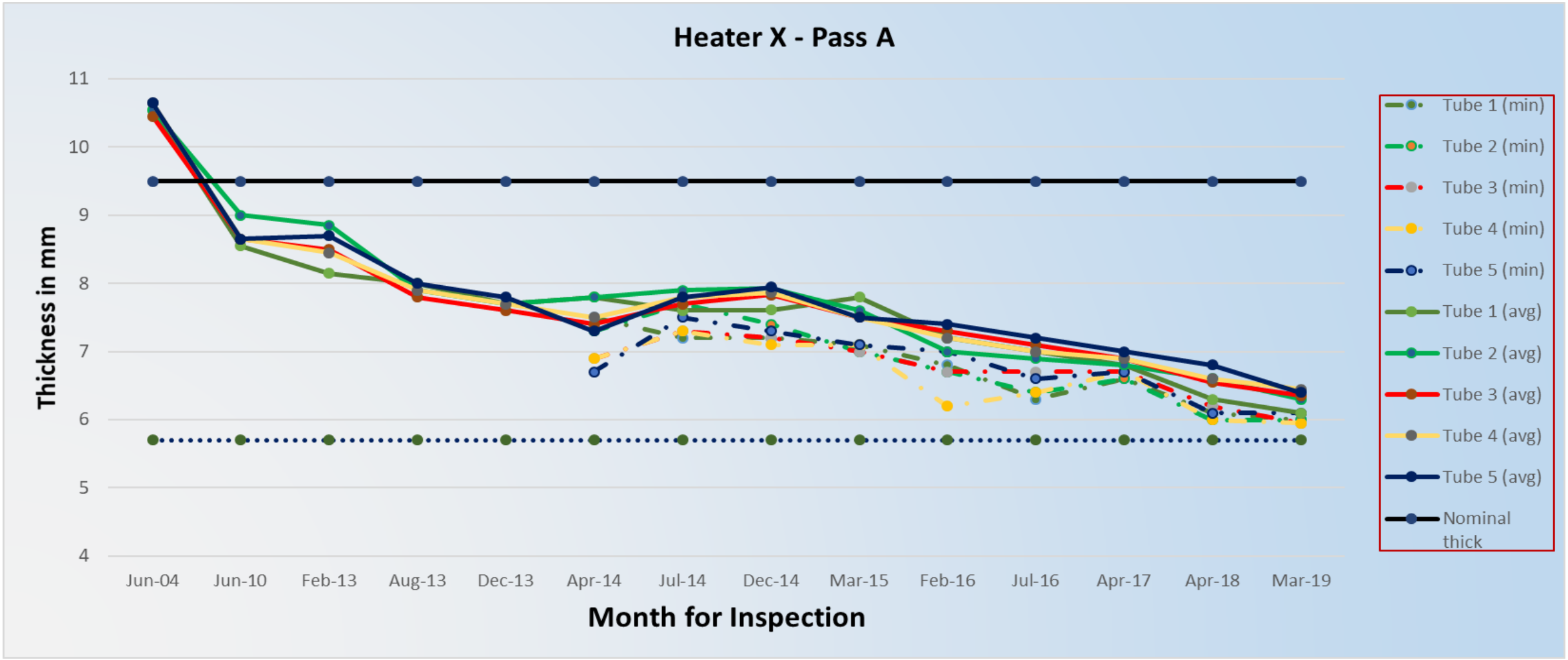


THICKNESS PROFILE FOR BOTTOM TUBES IN TWO PASSES



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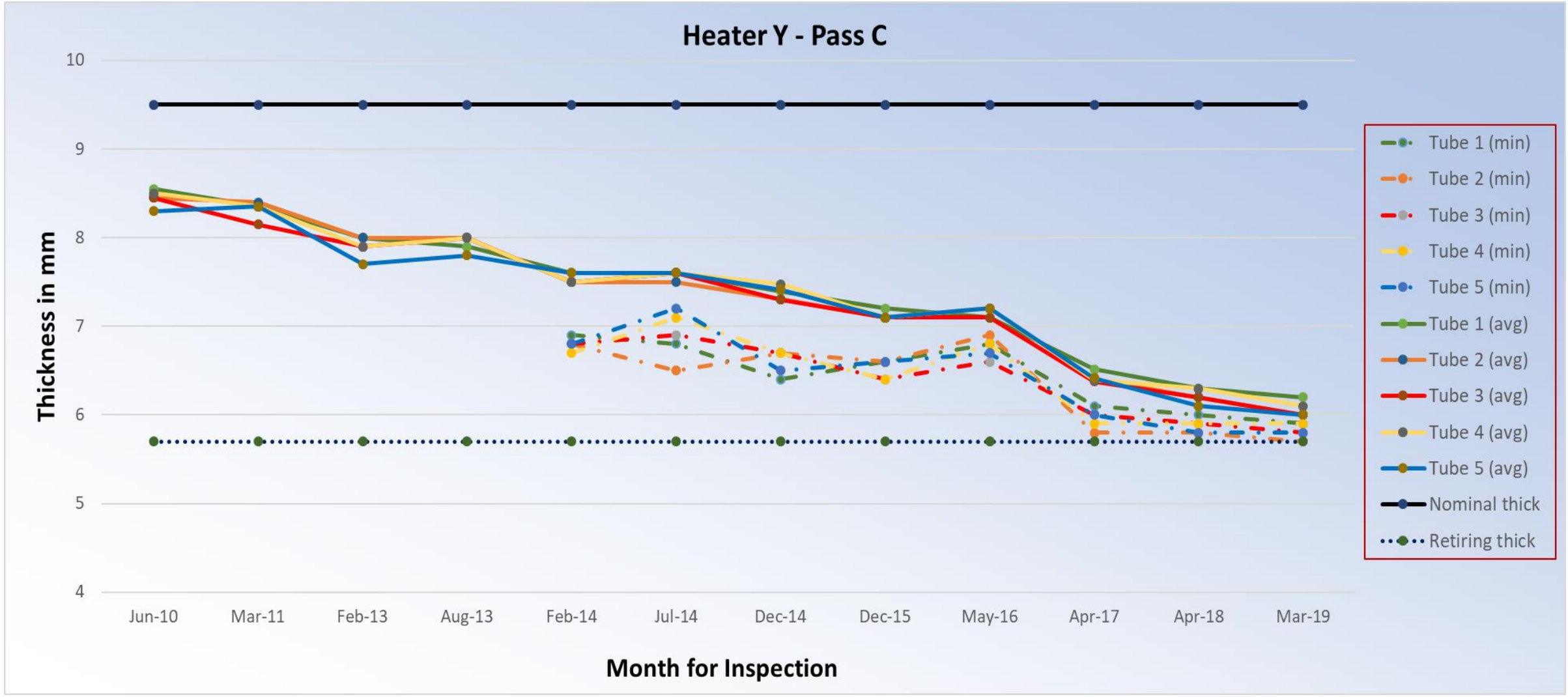

WHY ACCELERATED WALL LOSS?

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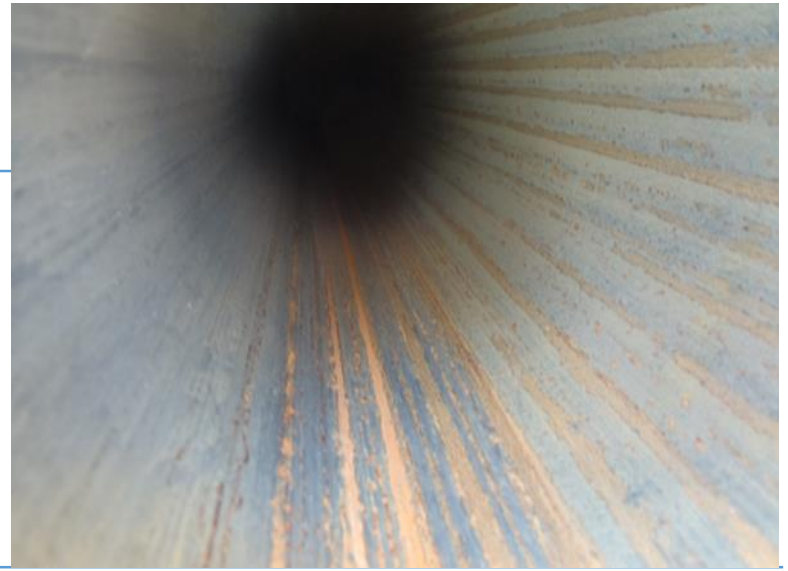
Hot Sulfidation

- Corrosion of alloy steel by sulfur compounds in high temperature environments.
- Coke deposit is expected to reduce corrosion rate.



Wall loss due to pigging

- Grooves observed on tube ID. Scrapper Pigging removed sulfide scales exposing fresh metal again for corrosion agian
- **Major contributor for wall loss.**

WHY ACCELERATED WALL LOSS?

INSPECTION OF FURNACE TUBES-PRESENT PRACTICE

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- Periodic thickness monitoring during Pigging slowdown:

  a. Scaffolding erection for full height thickness

  b. Power tool cleaning for spot thickness

- Intelligent pigging:

  Limitation due to mule ear (cast) plugs on both ends, which makes navigation of tool difficult. Discussion is under progress with various vendors.

STRATEGY FOR TUBE REPLACEMENT

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- Minimum thickness calculated as per API 530
- Tubes reliability to be maintained till next planned/opportunity shutdown.
- Thickness mapping carried out for radiation tubes showing accelerated rate during every decoking cycle.
- Tube replacement priority planned based on the thickness trends.

EXPERIENCE DURING TUBE REPLACEMENT

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- Prefabrication of full length tube carried (two tubes welded together) as pre fabrication activity.
- Hydrotest of assembly carried out using non-welded plugs.
- Final field weld minimized to one i.e. tube to mule ear weld for each tube
- Though mule ear plug replacement was not planned, ID of same was found enlarged by 3 to 4 mm and same considered for replacement during next outage.
- Stage inspection and controlled PWHT for good quality fabrication of alloy steel tubes.

CONCLUSION

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- Pigging should be done and controlled properly to prevent scrapping of parent metal.
- Periodic thickness mapping/NDT inspection is useful for trending the thickness loss. This can help to decide the tube procurement and replacement well in advance.
- Videoscopy of tubes can indicate metal loss on tube ID due to scrapper pigging.
- Prefabrication (preparation of full length tube) can help to minimize field work and also reduce shutdown time.

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THANK YOU !