REINHOLD ENVIRONMENTAL ®

2026 Reinhold/PCUG Round Table Presentation

Hosted by TVA, Southern Company and Vistra

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2026 Reinhold Environmental Round Table

Managing SCR Systems through Plant End-of-Life or Natural Gas Conversion

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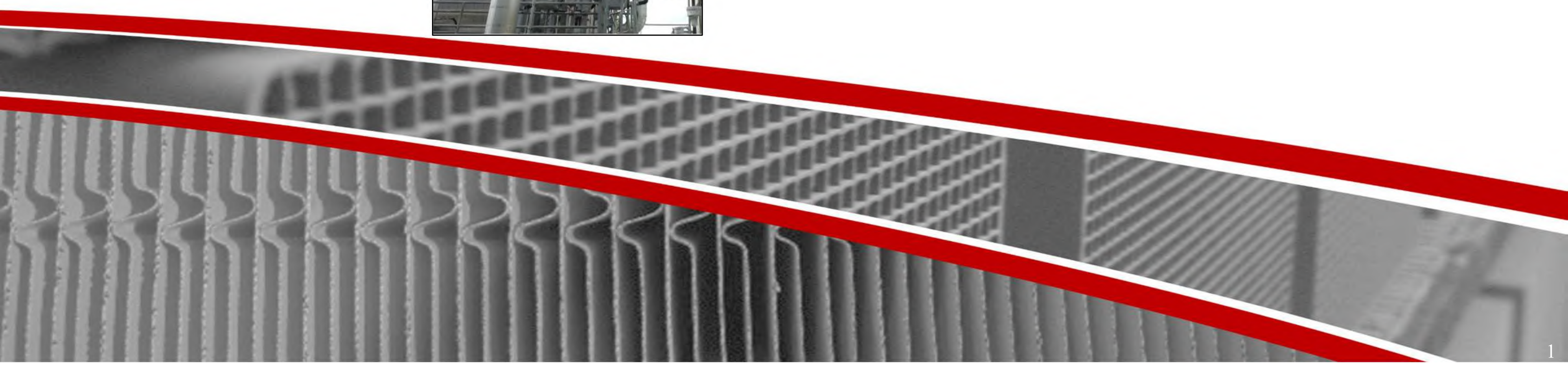
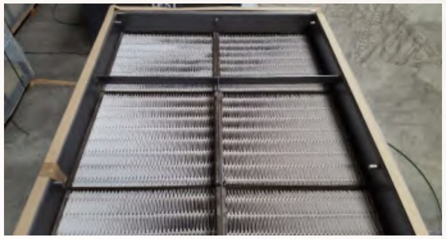
June 22, 2026

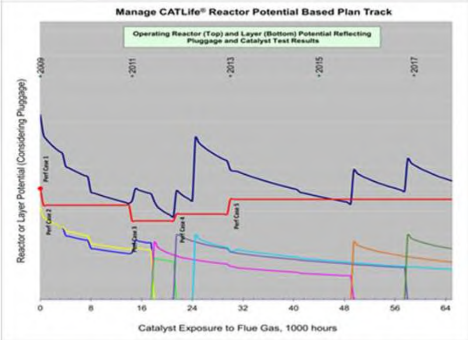


Introduction

Coal-fired power plants facing end-of-life or natural gas conversion must ensure SCR performance is maintained while limiting risk and capital and O&M expenditures throughout the transition. Proper SCR system analysis and collaboration with plant personnel are crucial to achieve these goals. This presentation will explore details of a real-life case example of a plant working through this transition.



- Presentation Road Map
  - Background
  - Case-Study Minnesota Power Boswell Unit 3

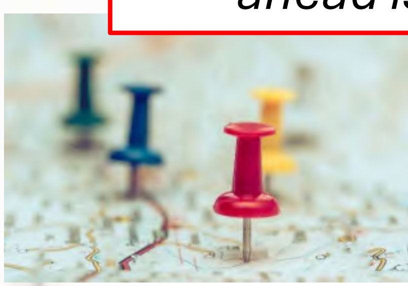


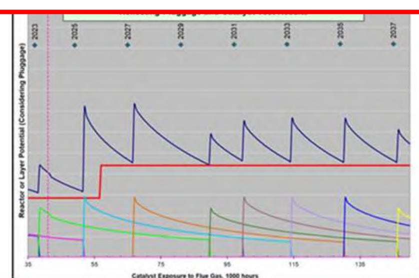
Background

Unique aspects of short-term catalyst management optimization

- Simplifying solutions
- Emphasis on balancing capital and O&M spend
- Identifying operational ‘knobs-to-turn’
- Scenario management becomes critical
  - Plans change frequently
- Accurately defining performance and system requirements provides the most bang-for-buck
  - Knowing which way to turn starts with knowing where you are

“Map out your future- but do it in pencil. The road ahead is as long as you make it.”- Jon Bon Jovi





Case Study-
Minnesota Power Boswell Unit 3

Boswell Unit 3

Operations

- 364 MW, T-fired, PRB
- SCR commercial operation in 2010 as 3+1, single reactor
- Historical SCR pluggage problems
- Originally 5.7 mm, 2 x 625 mm plate catalyst
- Began working with CERAM on a limited basis in 2014
- Changing combustion, deactivation, operating targets

Plans

- 2029 EOY refuel or coal-to-gas conversion
- Reduce capital costs
- Provide flexibility in catalyst management planning for potential coal-to-gas conversion
  - Gas-fired operating conditions yet to be determined

Defining Operational Goals

2010
SCR began commercial operation

2014
Start of catalyst management

2015
First AIG tuning, 3- vs 4-layer model comparison

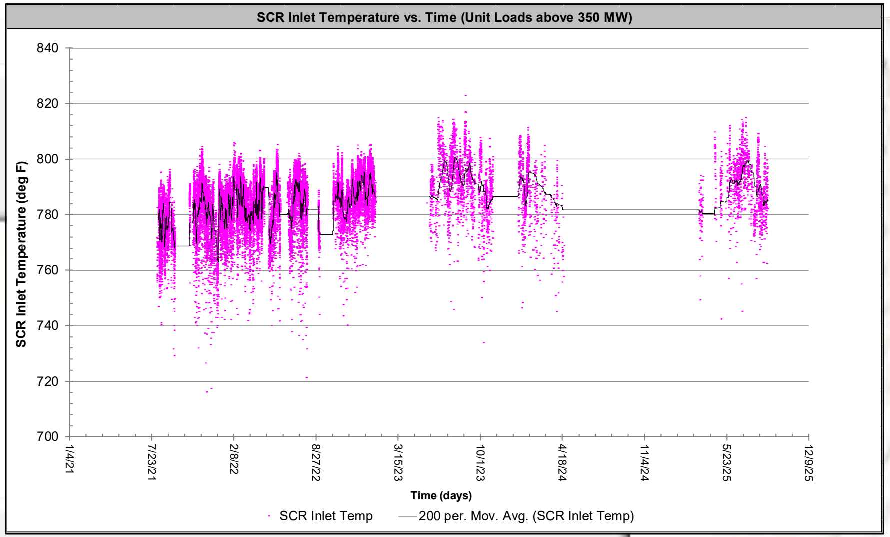
2016
Boswell opts for 3-layer operation

2017
Boswell directive to reduce from 4 to 3 events over 10-yr plan

2019–2023
Two events in this window; slip increasing to 10 ppm

2029
Coal-to-gas conversion

Roadblocks in Planning



Operational changes

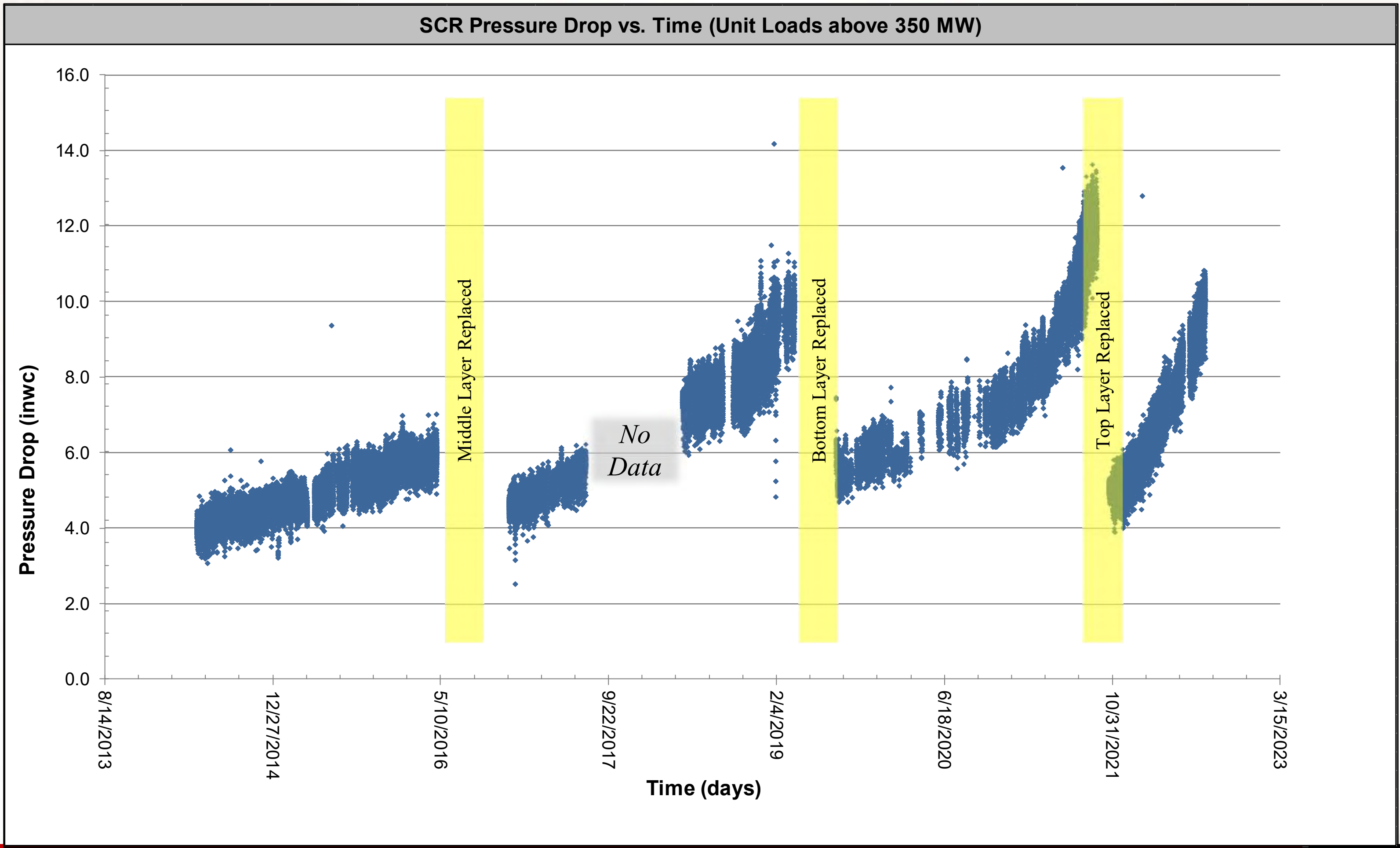
- Changes in fuels and combustion
  - Increasing SCR temperatures (750°F to >800°F), etc.
- Continued deterioration of existing LPA screen
  - Increasing catalyst pluggage

"Detours"

- Increasing slip
  - Eliminating one catalyst event
  - Three-layer operation instead of four-layer
    - dP concern with four layers

Corrective action needed to maintain NOx reduction goals!

Pressure Drop Concerns



Recalculating…

What is the best means of course correction with a shortened timeline?

- Avoiding tolls - limiting O&M impact
- Avoiding construction – limiting capital impact
- Identifying cost-effective solutions to both
- Discussions/lessons from this case study applicable to EOL analysis

Cost Effective Course Correction

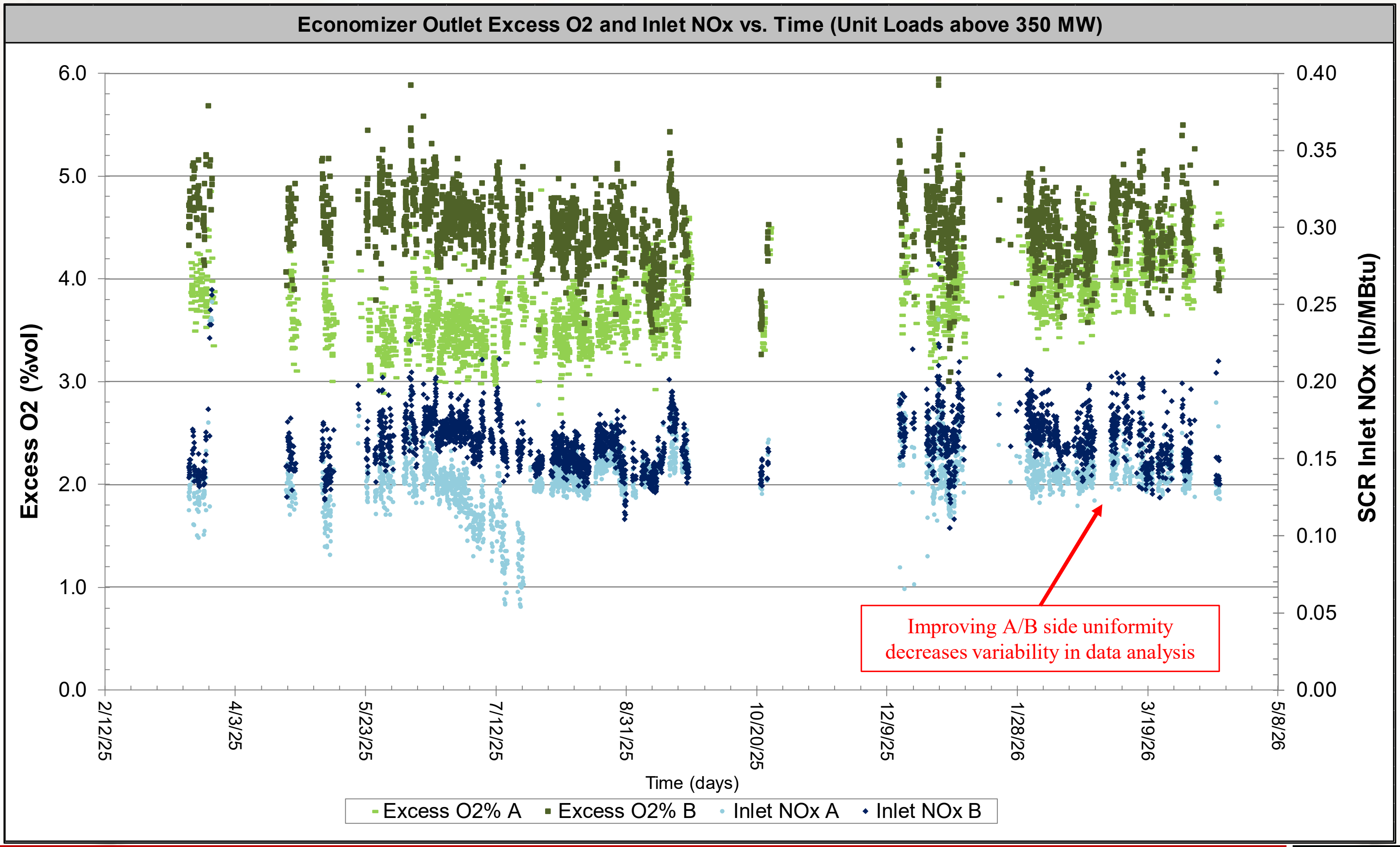
Fixing root causes

- LPA screen replacement (*Fall 2022*)
  - O&M (dP) and capital (catalyst) benefits
  - LPA carryover through economizer bypass (no LPA screen)
- Combustion control improvements
  - Improve firing uniformity
- Installing a fourth layer
- AIG Check
  - Ensuring NH_3:NOx distribution and DeNOx reaction has best chance for success

Addressing symptoms

- Extensive outage cleaning (*Fall 2022*)
- Accurately identifying limiting operating cases (DeNOx demand)
- Manage catalyst decisions to available surface area and deactivation rates
- Optimizing catalyst geometry for high residual pluggage and LPA carryover
- Install fourth catalyst layer

Combustion Improvements



Identifying Limiting Operating Case

- Mining DCS data to determine realistic high load cases (high DeNOx demand)
  - Recognize applicable statistics and any shortcomings in available data
- Identify appropriate ammonia slip targets

Boswell Unit 3 Operations Basis		
Parameter	**Original Design Basis**	**Most Recent Model Basis Case Load >350 MW Sept-Dec 2025 Data**
Inlet NOx, lb/MMBtu	0.5	0.204(1)
Outlet NOx, lb/MMBtu	0.05	0.054
Ammonia Slip, ppmvdc	2	< 5-7(2)
Fuel Burn Rate, MMBtu/hr	3,517	3,523(3)
Flue Gas Temperature, °F	760	790(4)
Gas Flow Rate, acfm	1,843,000	2,014,300

Notes:

(1) Average full load plus two standard deviations from 2025 DCS data.

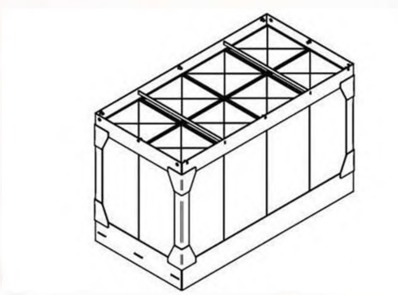
(2) Estimated ammonia slip considering operating data and expected catalyst pluggage. Correcting from current to 5 ppm.

(3) Average full load plus one standard deviation from 2025 DCS data.

(4) The average temperature at full load is 790 °F with a maximum measured of 821 °F (+1 standard deviation is 800 °F).

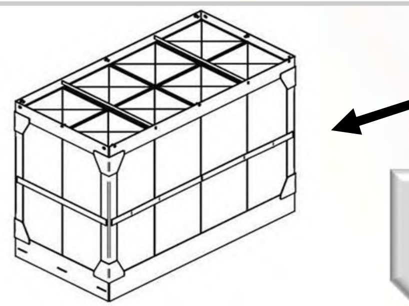
Addressing Catalyst Pluggage

- Replacement of LPA screen
- Aggressive outage cleaning
- Addressing existing/legacy pluggage
  - Previously plugged upper layers impacting layers below
  - Ash sweeper maintenance and operation
- Eliminating sublayer pluggage, increase pitch



Single Sublayer

- Cleaning Energy Reaches Top to Bottom
- Eliminates Sublayer Pluggage
- Easier to Pass Large Particle Ash (LPA)
- Lowest Pluggage and Minimal Long Term Pressure Drop

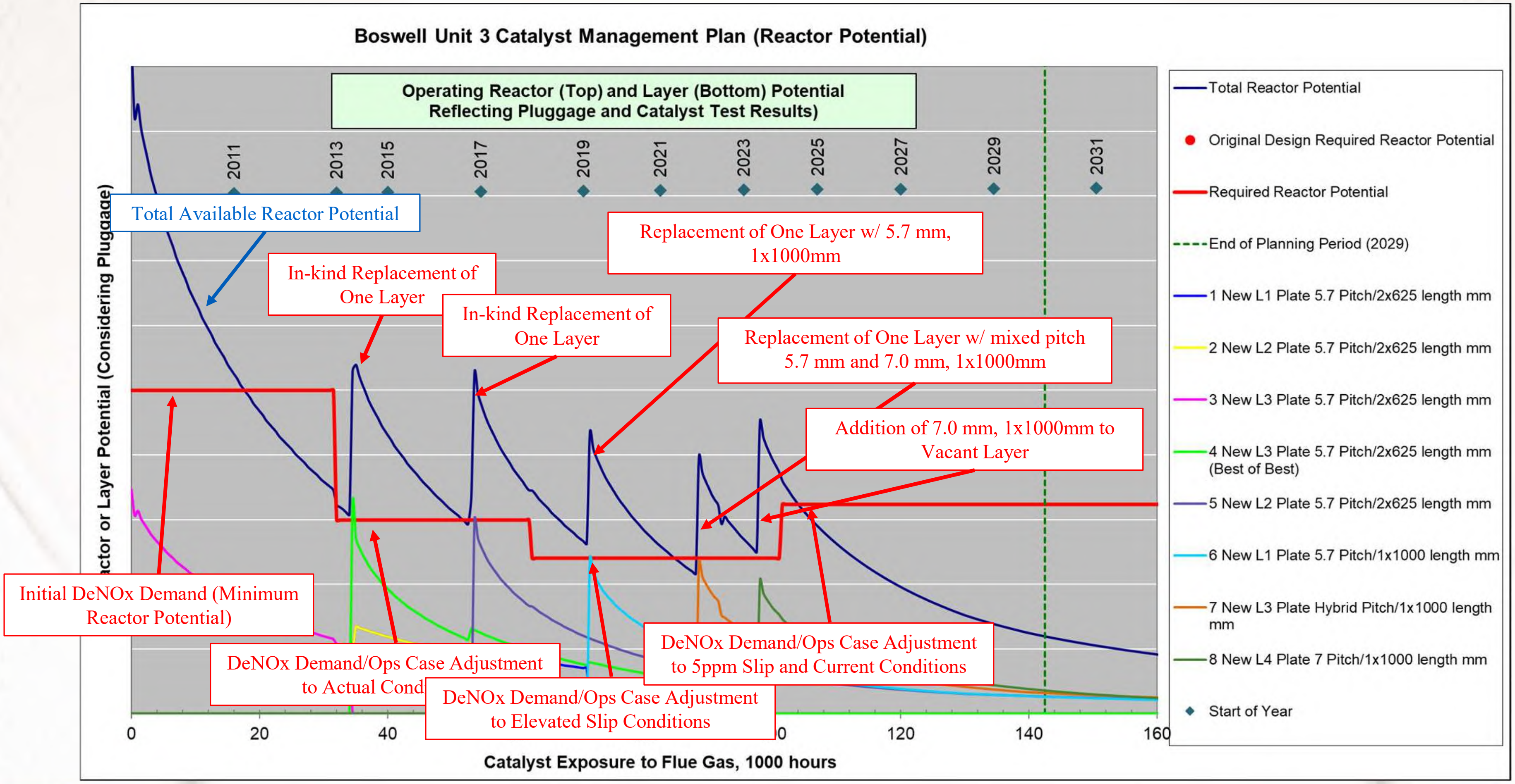


Gap Between Sublayers

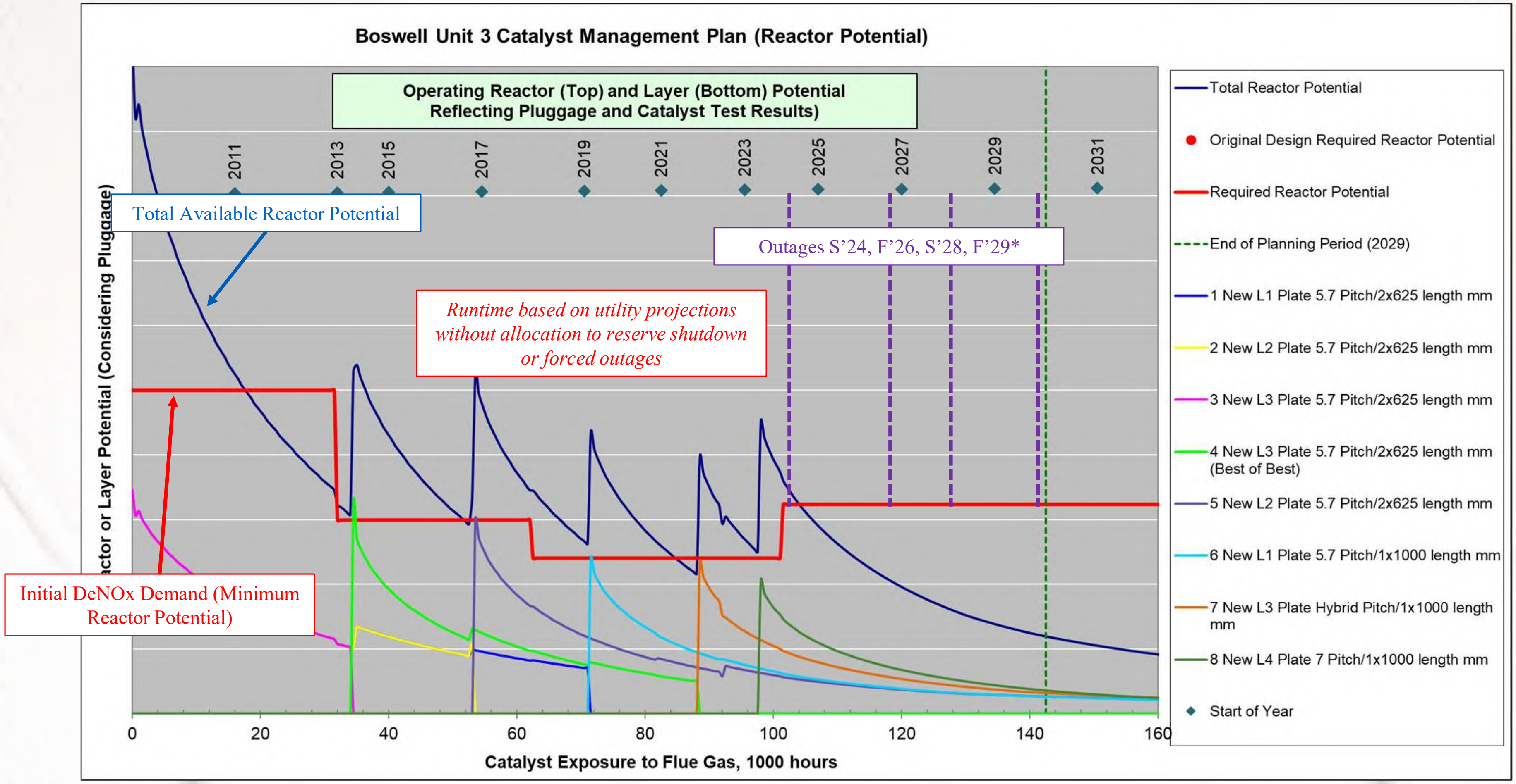
Two Sublayer Design

- Cleaning Energy Dissipates in Gap
- LPA Can Lodge in Sublayer
- Pluggage Potentially Builds in Sublayer
- More Susceptible to Non-Uniform Flow Conditions

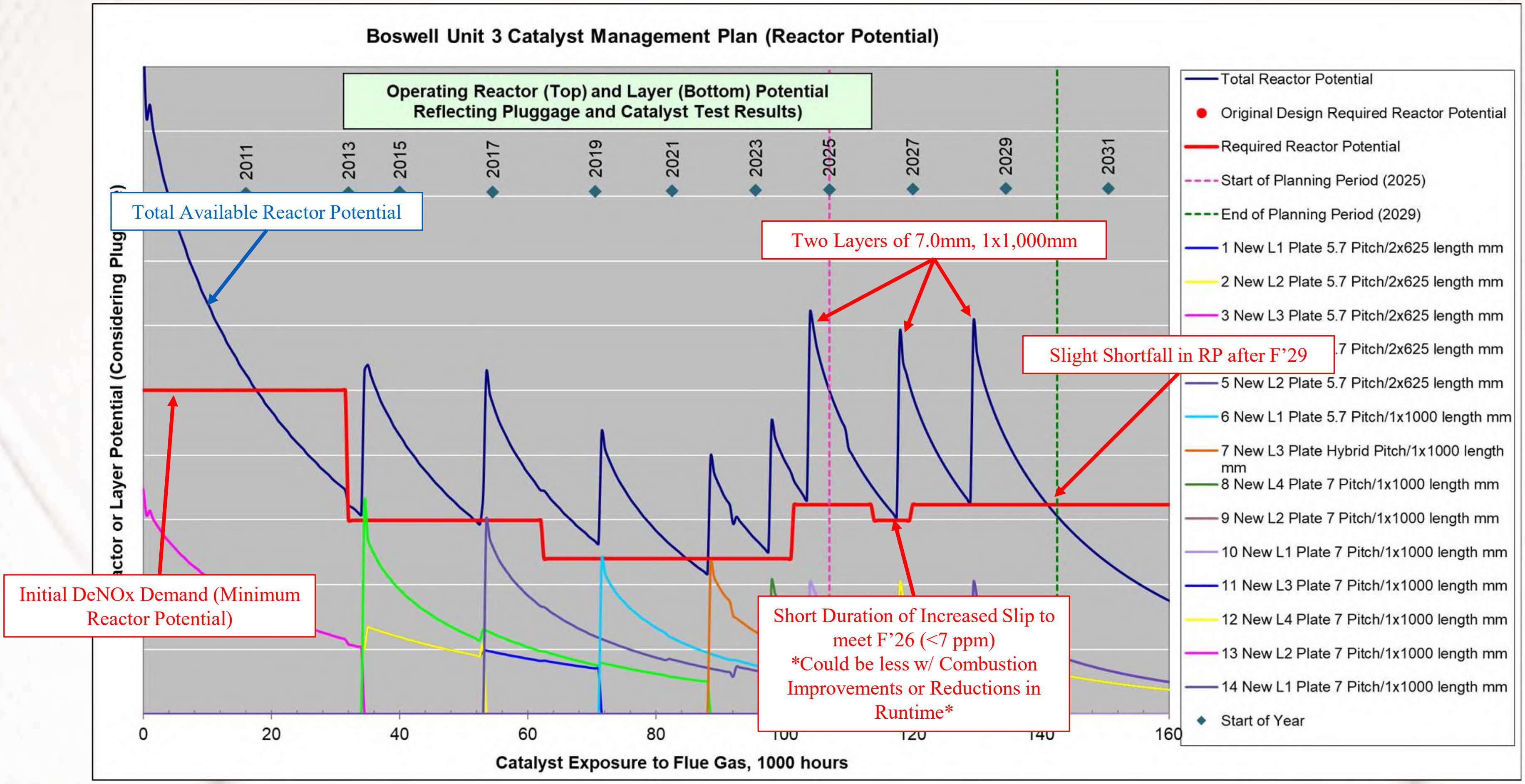
Catalyst Management Strategy



Catalyst Management Strategy

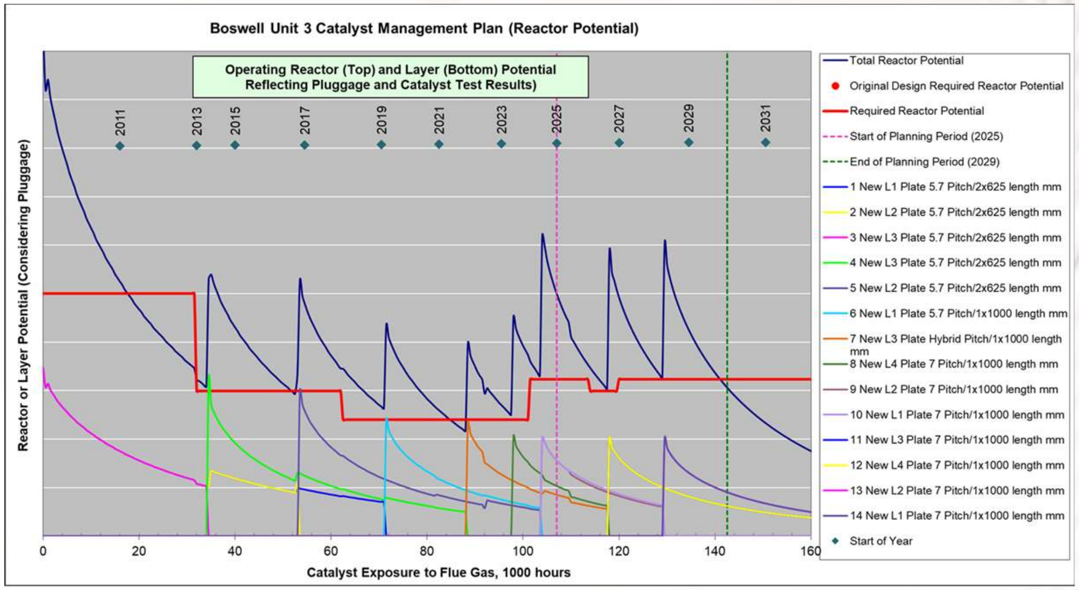


Catalyst Management Strategy- 7.0mm, 1 x 1,000mm



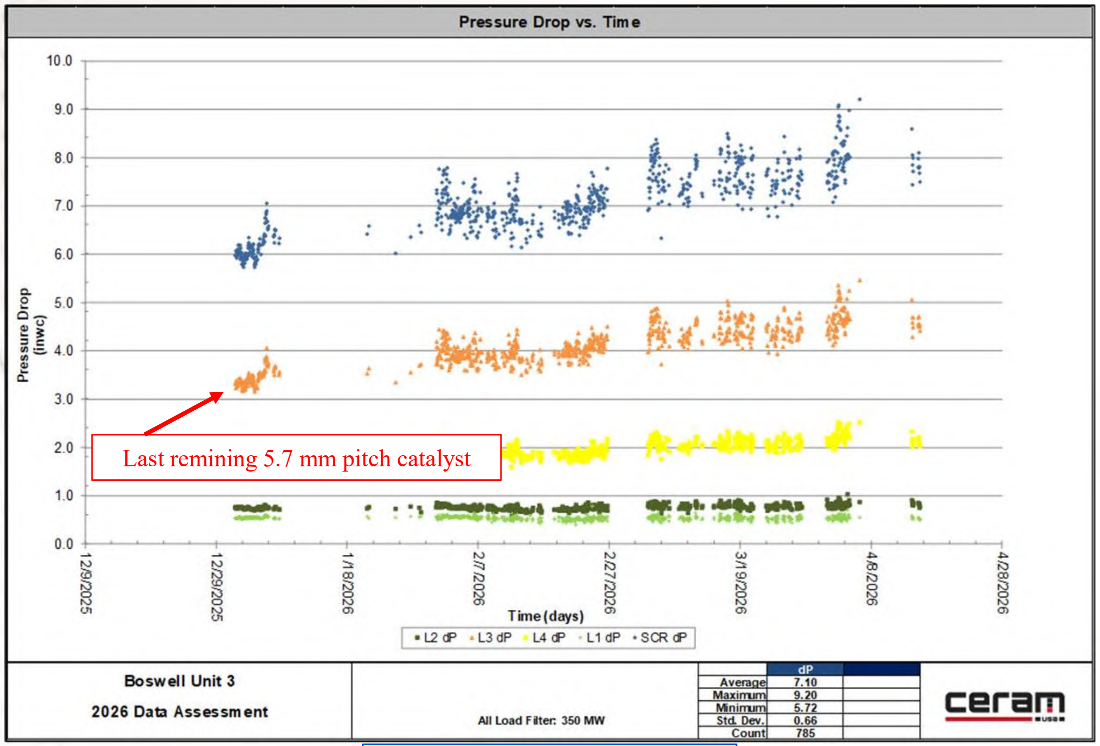
The Two Layer, 7.0mm, 1x1,000mm Approach

- Addresses dP problem
  - Cycles through heavily plugged layers
- Meets the outage schedule*
- Facilitates two decision points
  - Spring 2028
    - One or two layers to EOY 2029
    - Smaller pitch or longer length?
  - Fall 2029
    - Will targets change?
    - Additional clarity on NG conversion

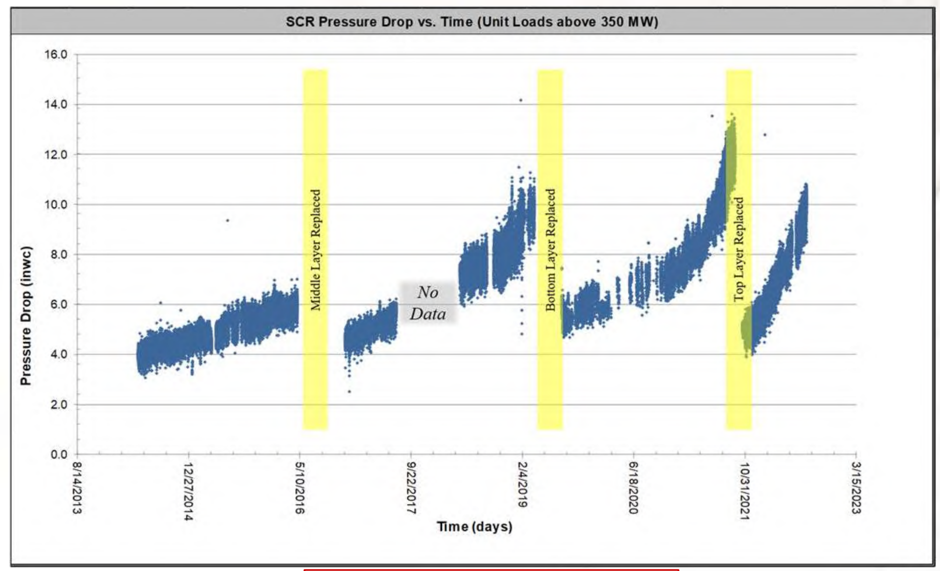


The Two Layer, 7.0mm, 1x1,000mm dP

- Four layers of shorter catalyst, larger pitch
  - dP improvements and gains in RP

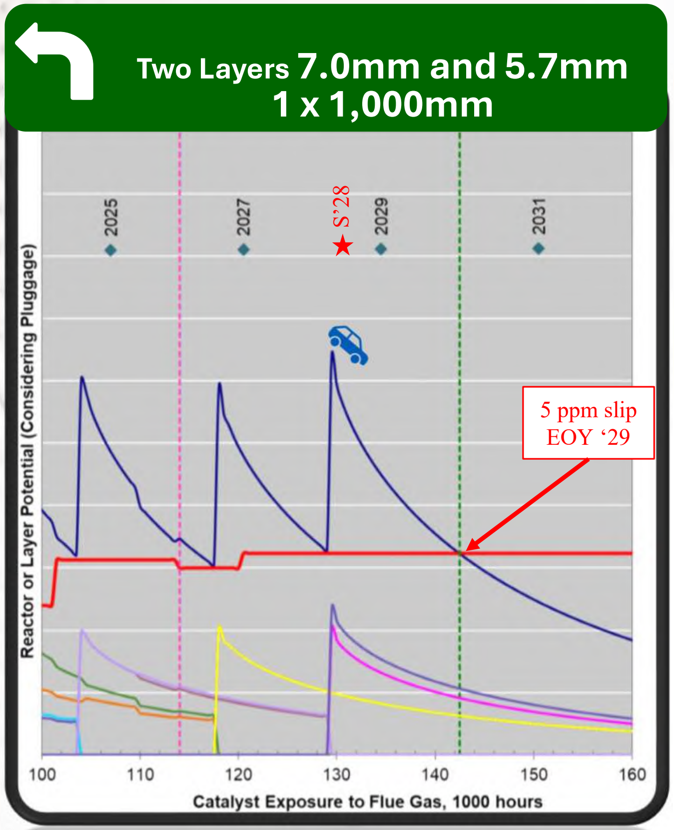


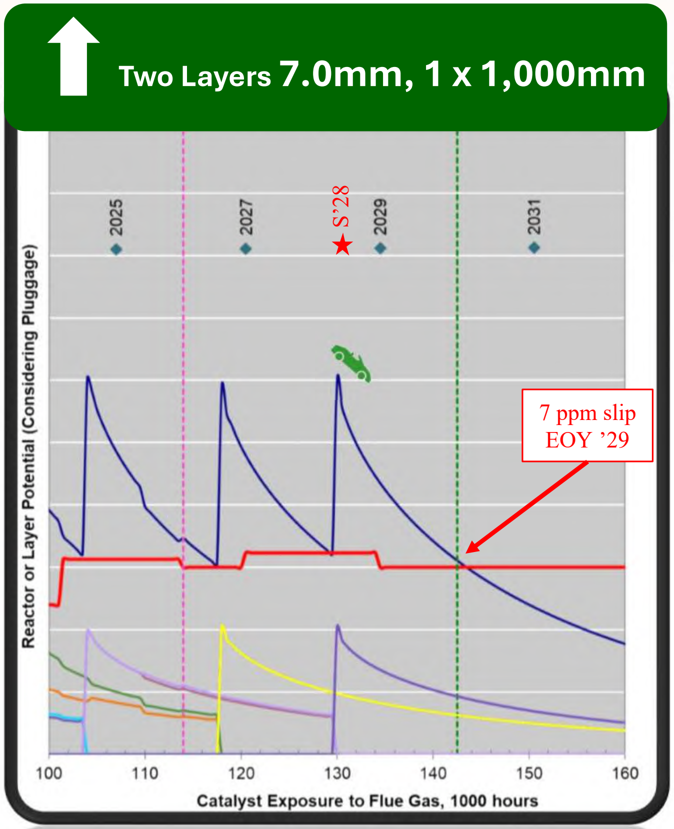
Current

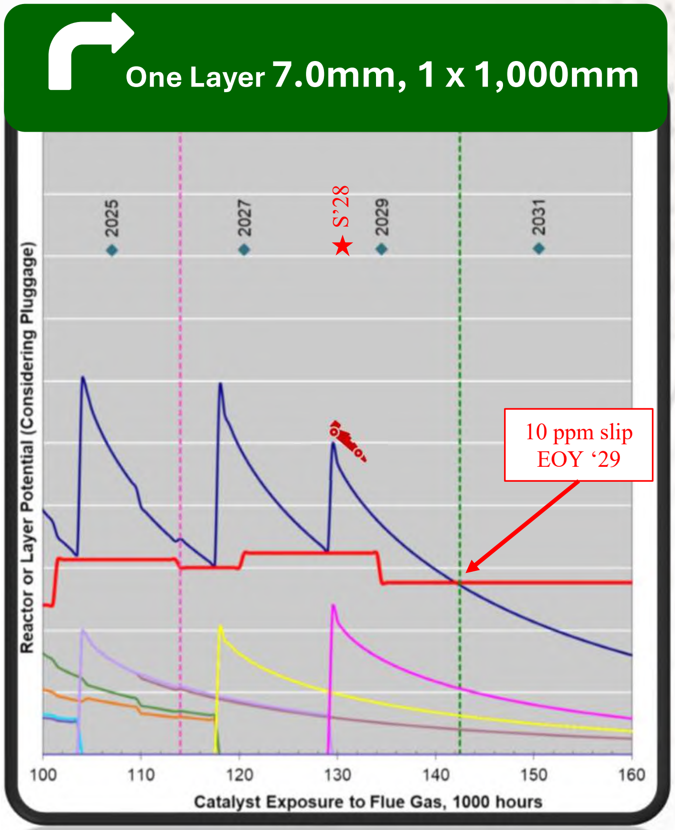


Previous

Spring 2028 Decision Point







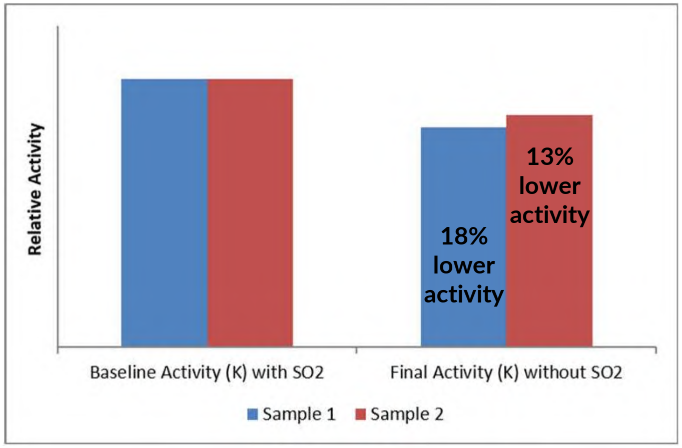
2030 Gas-Conversion

- Design details aren't available; hypothetical case presented
  - 30% lower inlet NOx
  - Maintain outlet NOx
  - Stabilize slip at 5 ppm
  - SCR inlet temp reduced by 50°F
  - Heat input approximated

Boswell Unit 3 Operations Basis		
Parameter	**Most Recent Model Basis Case Load >350 MW Sept-Dec 2025 Data**	**Example NG Operating Case (Values Estimated)**
Inlet NOx, ppmvdc	150	105
Outlet NOx, ppmvdc	40	40
Ammonia Slip, ppmvdc	< 5-7	5
Fuel Burn Rate, MMBtu/hr	3,523	3600
Flue Gas Temperature, °F	790	740
Gas Flow Rate, acfm	2,014,300	1,758,032

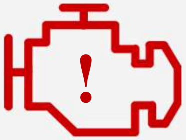
Natural Gas Conversion: Effects on Existing Catalyst

- Catalyst designed for coal relies on SO_2 in the flue gas to promote DeNOx
  - In NG stream without SO_2, catalyst activity will be reduced (reduced reactor potential)
    - NG catalyst generally has more active metals
- CERAM recommends testing used catalyst as-received with SO_2 and after catalyst is conditioned to no SO_2 environment
  - Condition in hot, SO_2 free flue gas to drive off residual SO_2
  - Perform repeated catalyst activity tests until activity levels out
  - Perform final catalyst activity test without SO_2 to determine catalyst activity in natural gas flue gas regime



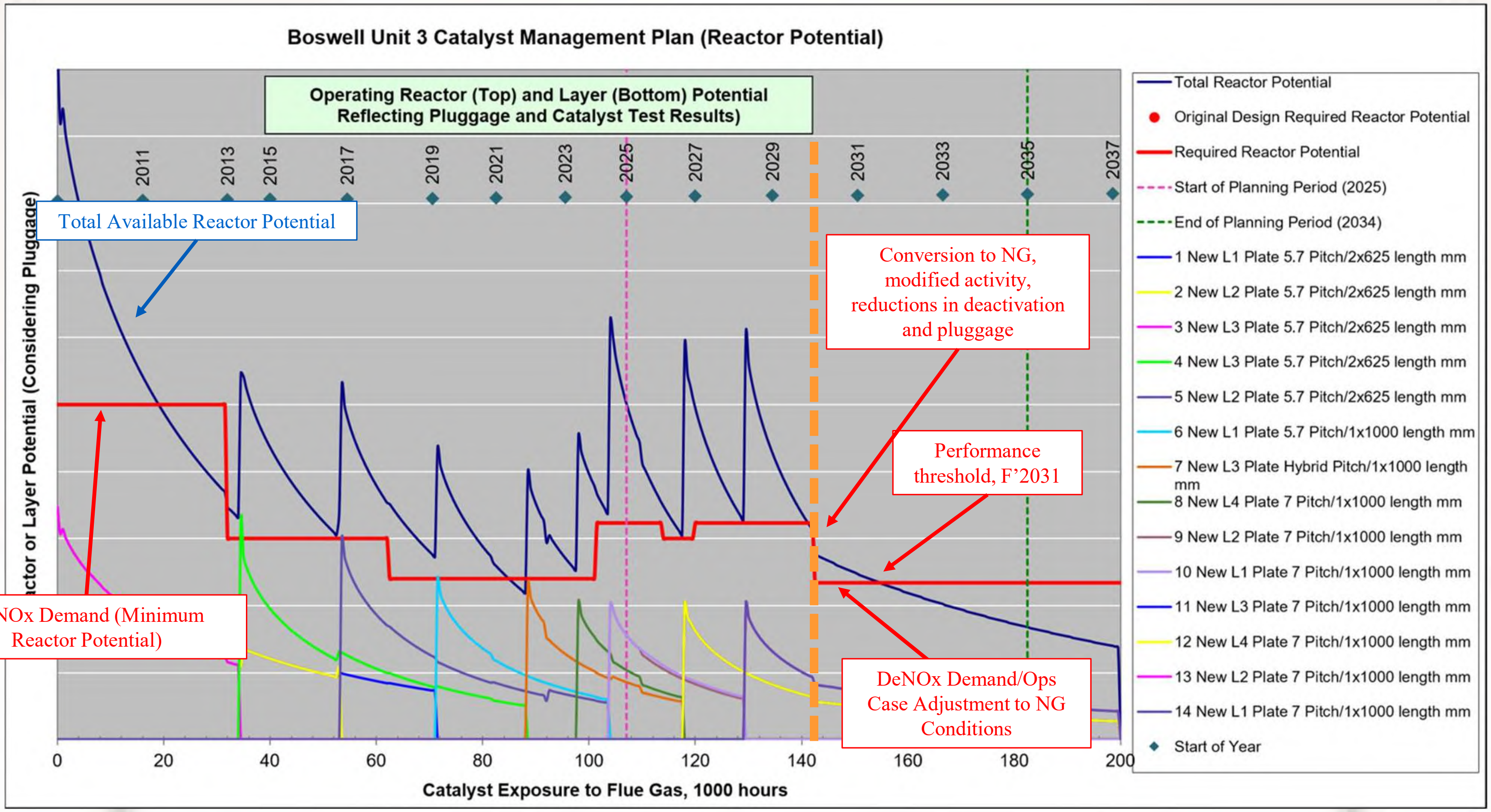
Gas Conversion Best Practice

- Remove all ash
- Re-evaluate DeNOx demand
- Ensure adequacy of whole system
  - Ammonia supply, control, etc.
- Test catalyst at representative NG conditions
  - SO_2 and temperature impacts
- Immediate conversion to smaller pitch may not be necessary
  - Truly small pitch gas catalyst is too fine for residual ash
  - Buffer period to for residual ash to settle

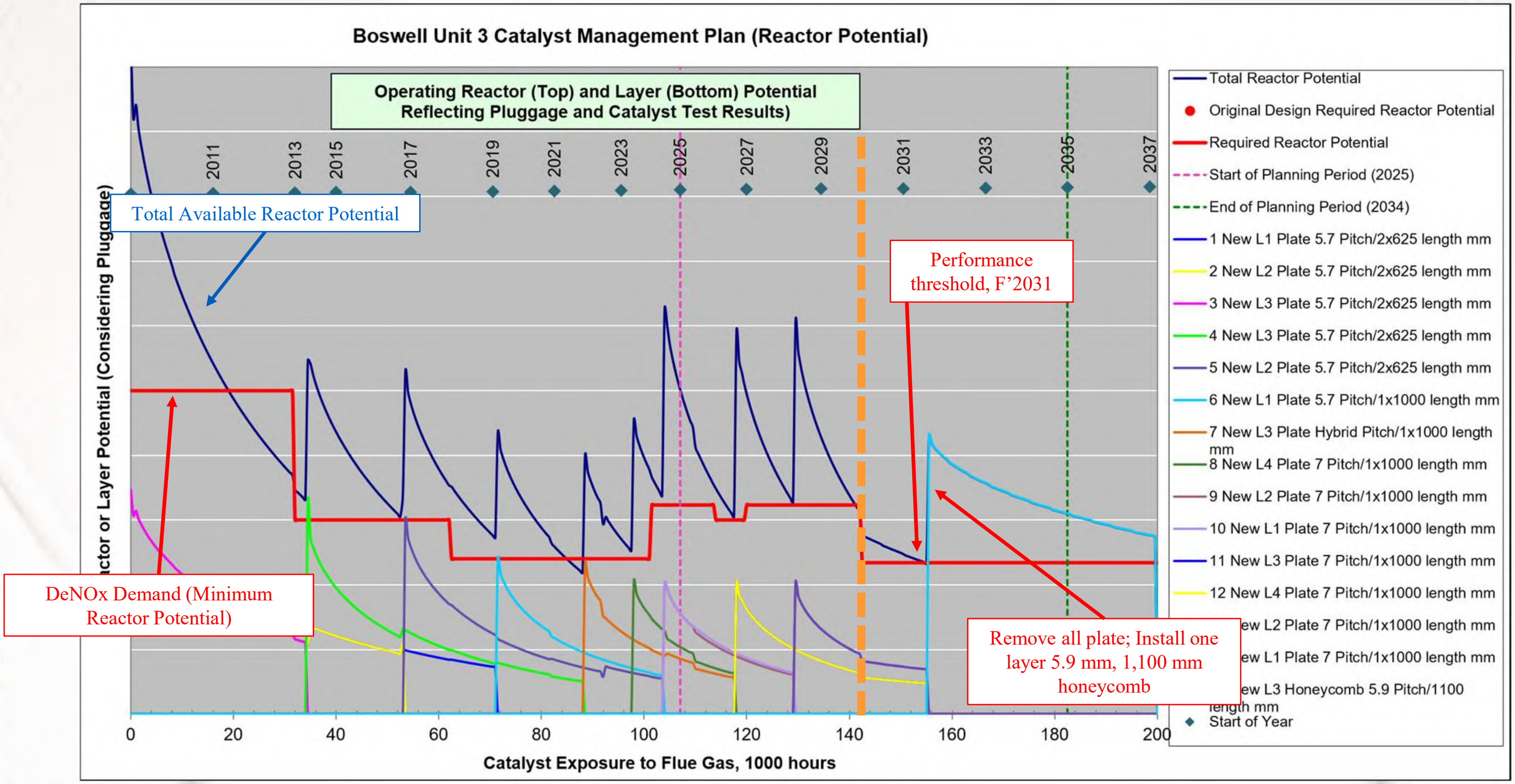


Perform a system diagnostic before the next leg of the journey

Catalyst Management: Coal-to-Gas Conversion



Catalyst Management: Coal-to-Gas Conversion



Conclusions

- Current strategy corrects issues and sets up next stage of unit operation
  - Four layers of single sublayer, large pitch
  - Addressing pluggage and providing sufficient reactor potential
- Situation still open-ended
  - Gas conversion details/schedule still up in the air
- Other options additionally considered to meet EOY 2029
  - Moving outages
  - Reverting to two sublayer design
  - Derates, etc.
- More aggressive approaches to EOY 2029 will moderate as runtime changes

Questions?

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