CURTISS WRIGHT Flow Control Company
DeltaValve

Coking.com Calgary Conference - September 15-17, 2009

Innovative Solutions for Coke Drum Life Extension

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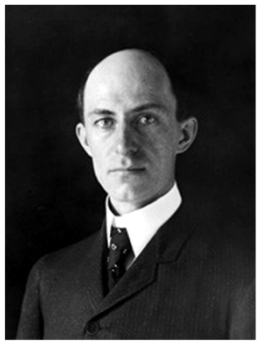
VP/CTO Curtiss Wright Oil and Gas Technology Development Center

CURTISS WRIGHT

A Heritage of Firsts
A History of Innovations

Glenn Curtiss

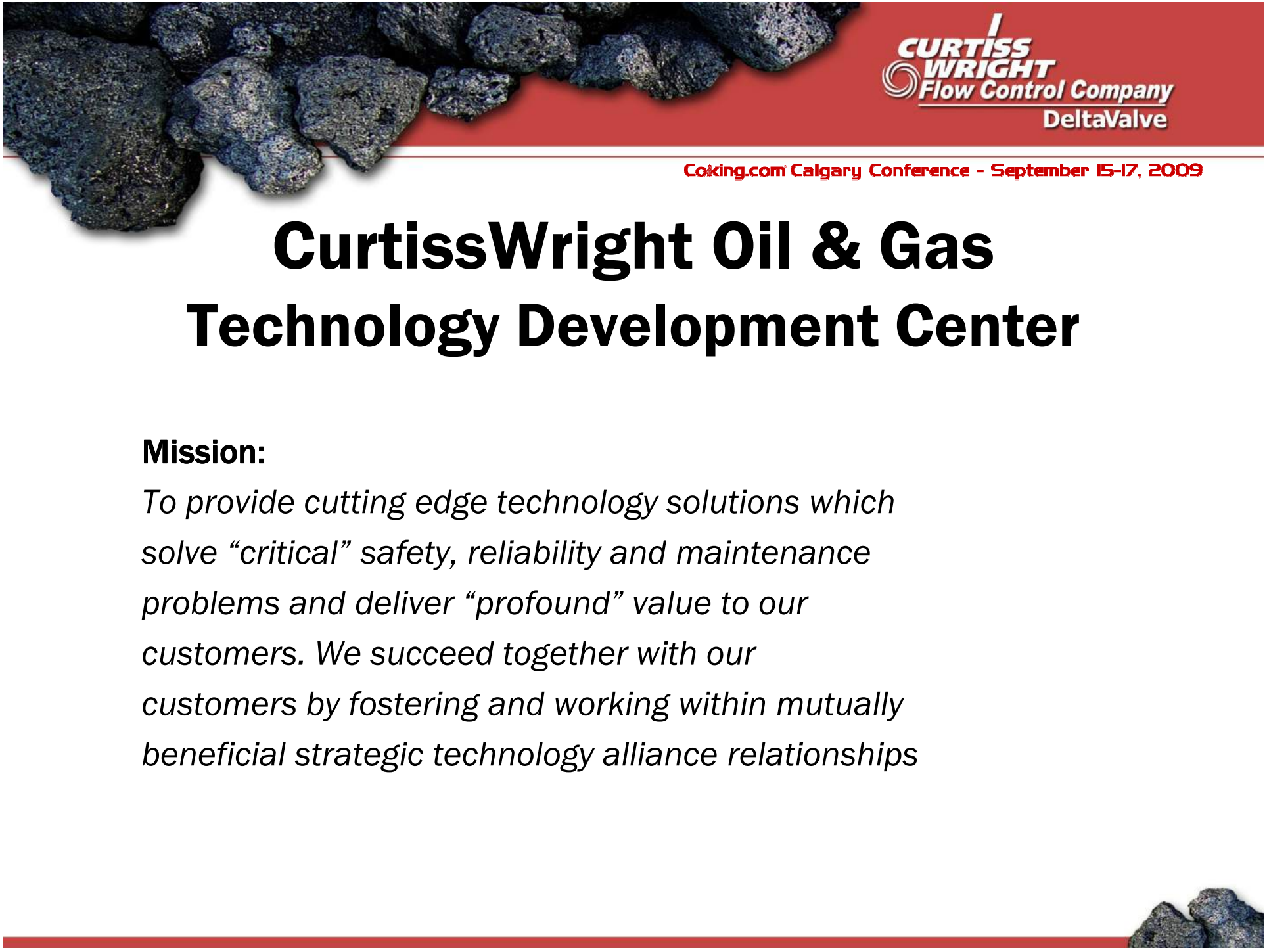


Wilbur Wright

Orville Wright

First Flight
December 17, 1903

Aviation's Pioneers



CurtissWright Oil & Gas Technology Development Center

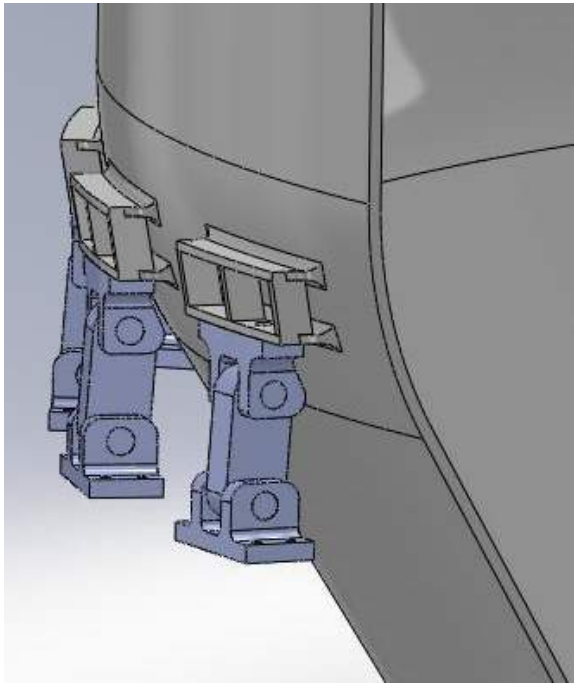
Mission:

To provide cutting edge technology solutions which solve "critical" safety, reliability and maintenance problems and deliver "profound" value to our customers. We succeed together with our customers by fostering and working within mutually beneficial strategic technology alliance relationships

Innovative Solutions for Coke Drum Life Extension

Center Feed Injection

Linked Drum Support



Comparison

- Side Feed Entry
- Center Feed Injection
- Bottom Feed Entry

Side Feed Entry

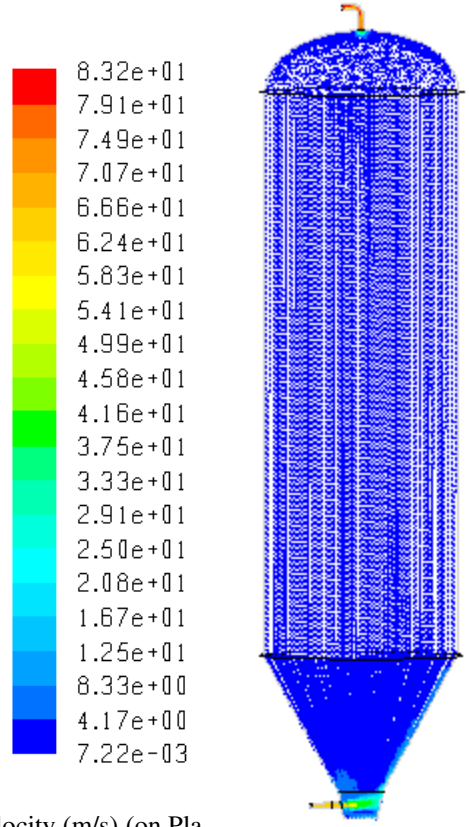
- **Reliability Issues**
  - Potential reduction in fatigue cycle life of drum
- **Contributing Factors**
  - Massively uneven thermal distribution during feed causing hot spots across from feed line
  - CFD Analysis suggests flow tends to spiral against drum wall then proceed vertically up one side of the drum wall
  - Quench behavior suggests similar thermal characteristics induced on drum shell with normal quench time on side feed entry as a fast quench with a bottom feed (water directed to drum walls causing faster cooling)

Side Feed Entry

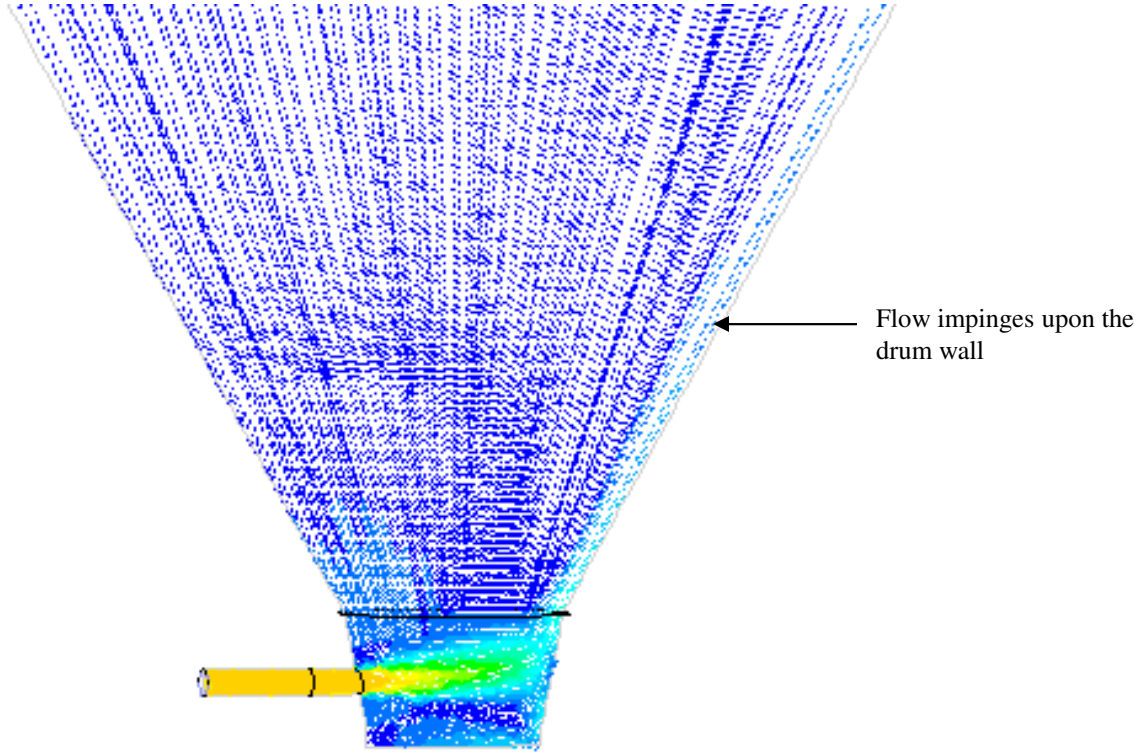
- **Safety Issues**
  - Increase in boil over (geyser effect)
- **Operational challenges**
  - Increased Coke Cutting Time
- **Water Quench issues**
  - Abnormal pressure spikes during WQ
  - Longer Quench Times Required to permeate the coke bed

Results – Straight Side-entry Nozzle, Flow Condition #2

The simulations represent the beginning of the coking process when VRC vapor is injected into an empty drum



Velocity (m/s) (on Pla...



PN 123971 PN 123995

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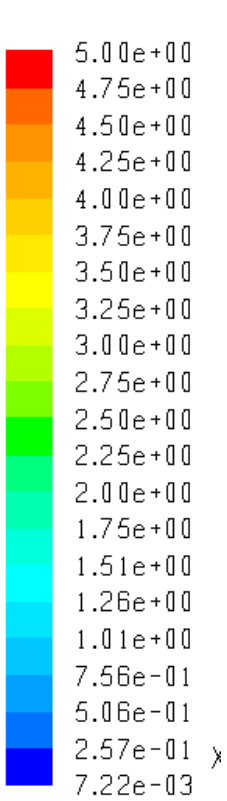

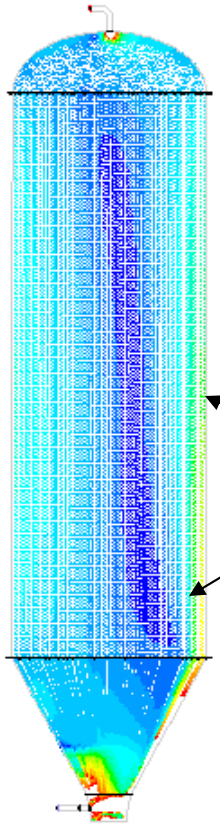

Slight unsteadiness is observed in the flow in the upper portion of the drum. This aspect is not explored in detail as the overall flow pattern inside the drum is almost unchanged.

Flow velocity along the wall is 5m/s or higher

Velocity (m/s) (on Plane 1)

Red color denotes velocity of **5 m/s** . The white region next to red denotes velocity higher than **5 m/s**

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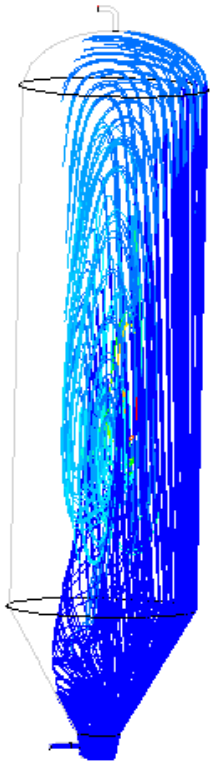
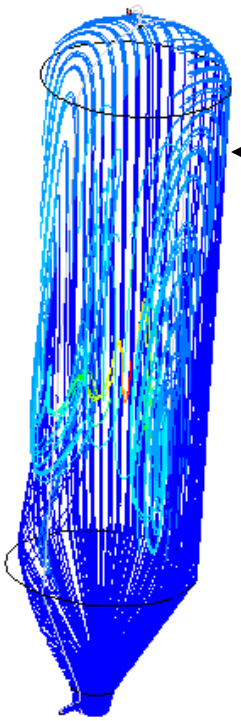


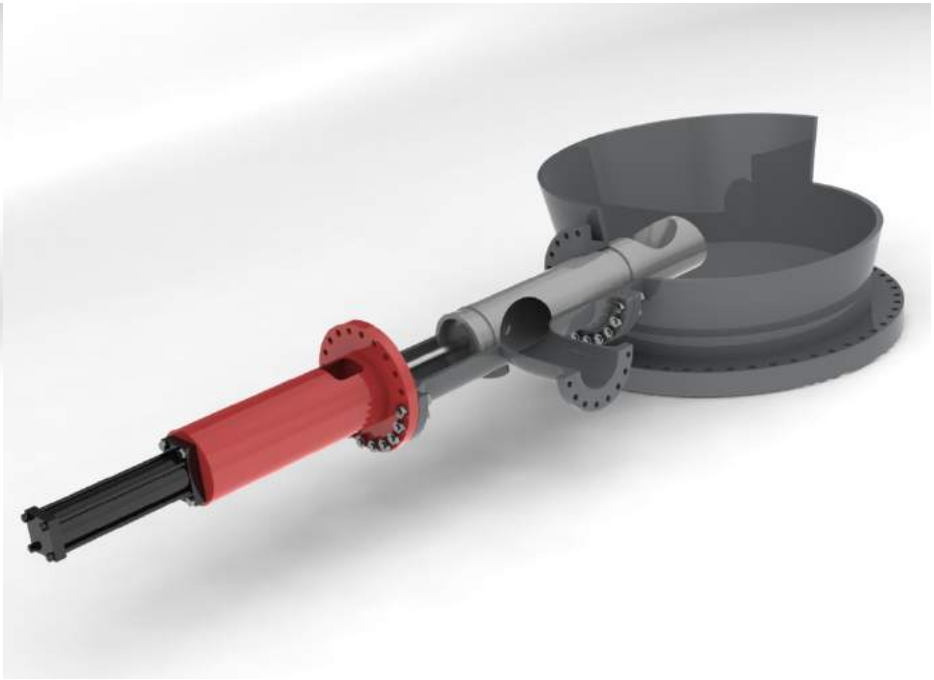
Path lines of flow originating at the inlet



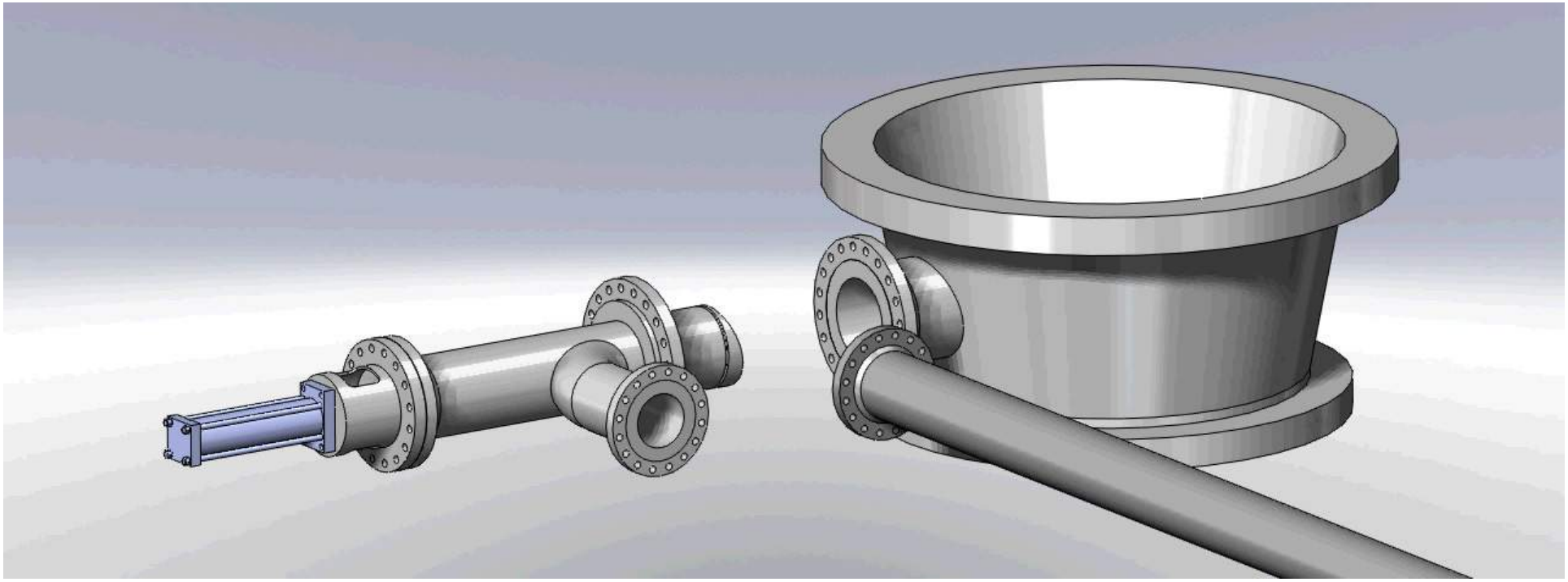
Alternate view

The analysis and path lines shows that the flow impinges upon the drum wall. The impingement causes the flow to disperse partially around the circumference of the drum; the flow then rises vertically upwards along the walls of the drum.

Center Feed Injection Nozzle



Center Feed Injection Nozzle



Center Feed Injection Nozzle

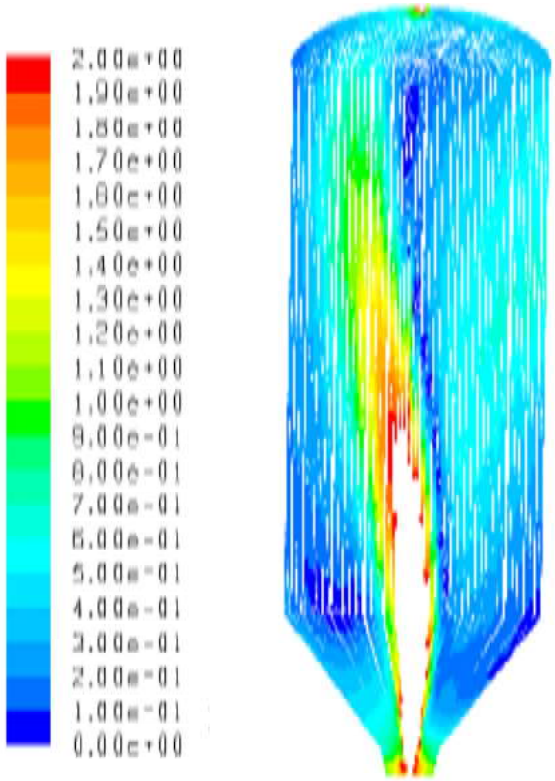
- **Features**
  - Provides same flow properties as bottom feed
  - Injection mode during Pre-warm, Feed, Strip and Quench
  - Retracted mode during Cutting
  - Blocks off and seals feed Line during cutting operation
  - Does not require flush water to keep feed-line clean during cutting

Center Feed Injection Nozzle

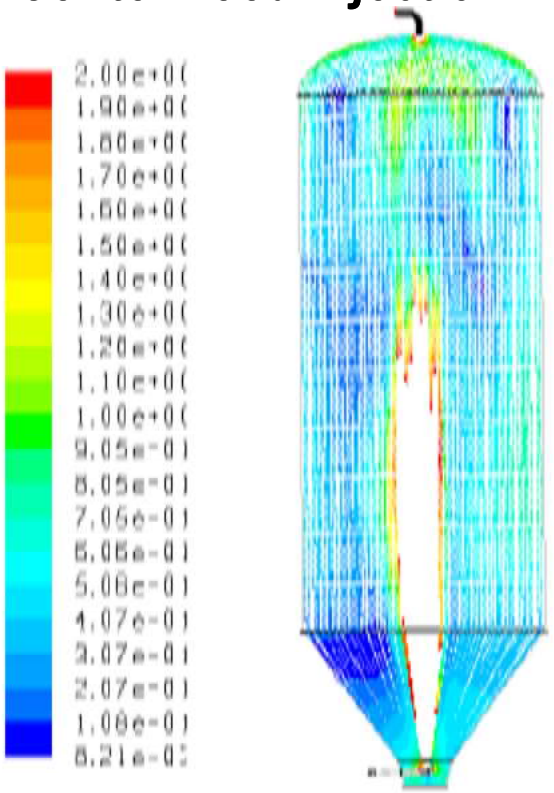
- **Features**
  - Injection Nozzle can be removed and replaced between drum cycles
  - Injection Nozzle can be removed and replaced with elbow for normal side feed between drum cycles

Bottom Feed / Center Feed Injection Comparison

Bottom Feed Inlet Line



Center Feed Injection



Center Feed Injection Nozzle

- **Installation Target 2009**
- **Low Risk to Alliance Partner**
  - Design allows easy replacement with new nozzle or standard side feed elbow Between Cycles during test phase
  - Alliance partner to receive full benefits of alliance relationship
- **Benefits Delayed Coking Industry Worldwide**

Low Stress Linked Drum Support

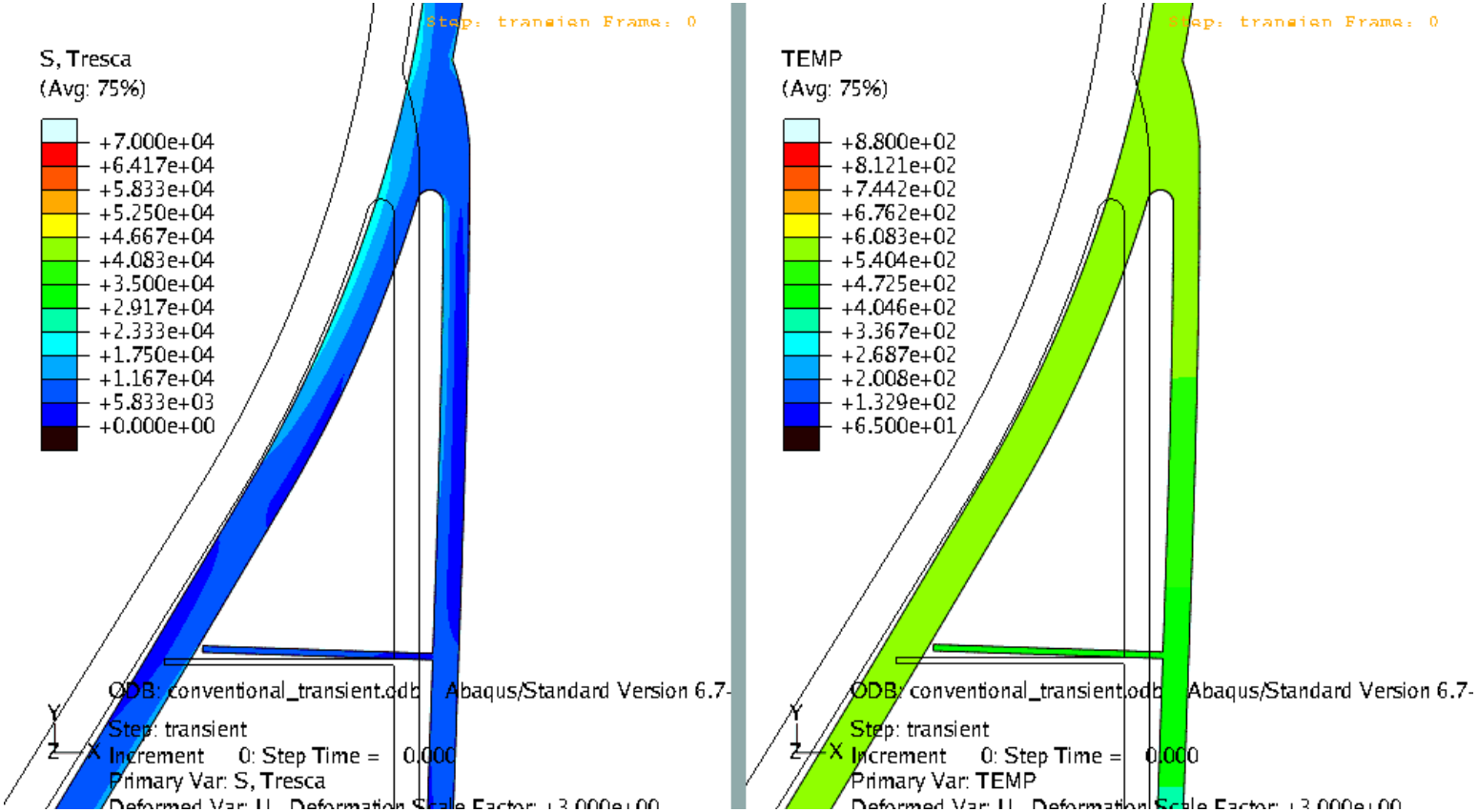
Low Stress Linked Drum Support

Why New Drum Support Technology?

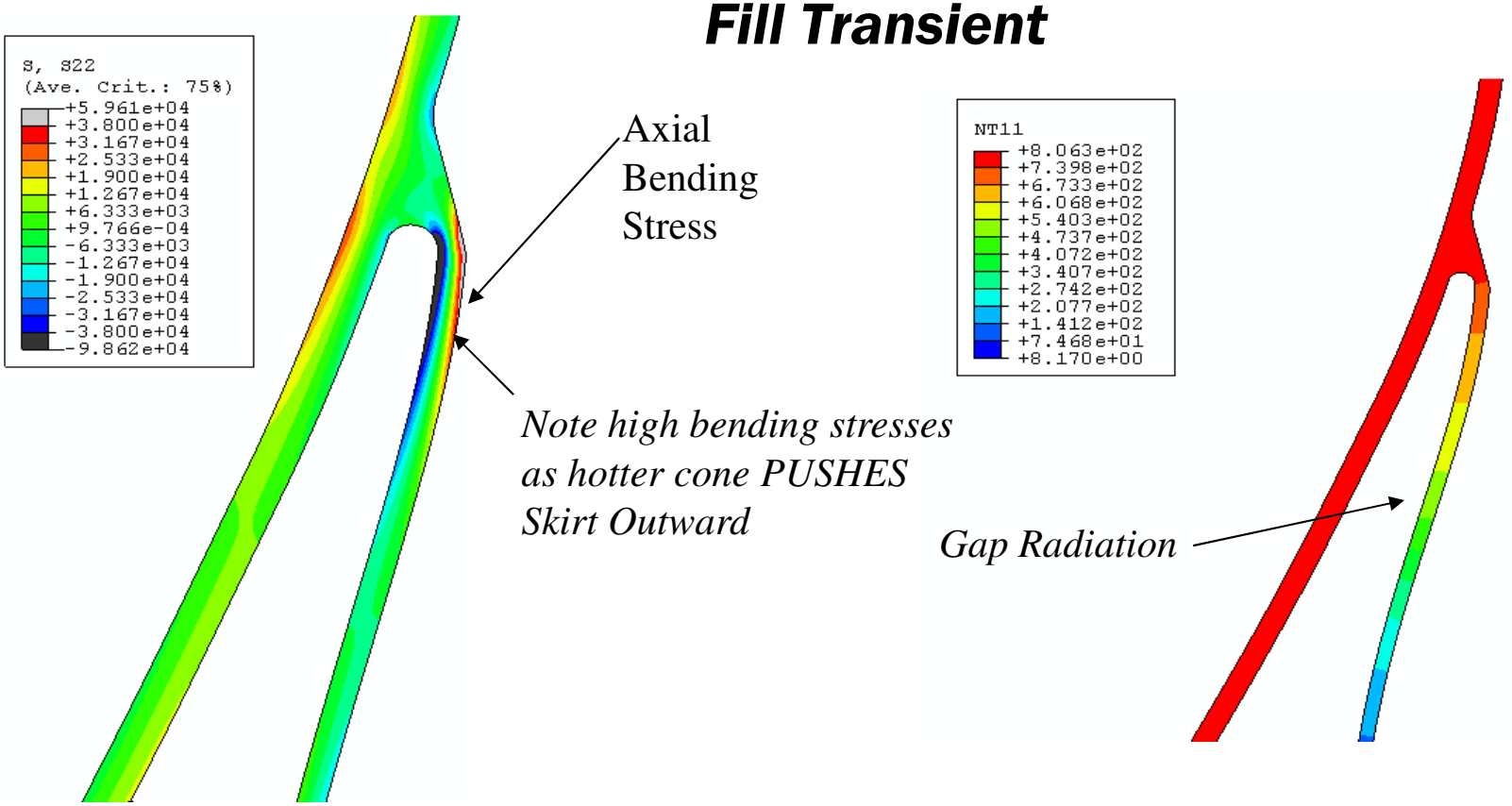
- **Existing Drum Skirt Technology**
  - Full perimeter welded skirts experience significant thermal gradient between the drum and top of skirt (fin effect) during rapid heating and cooling.
  - Significant mechanical stresses are induced as the wall of the skirt resists drum movements caused by thermal growth (push/pull effect)
  - Skirt welds fail by Low Cycle Fatigue at peak stress locations.

Existing Drum Skirt Technology

Low Cycle Fatigue



Example In-Line Skirt Axial Stress During the *Fill Transient*



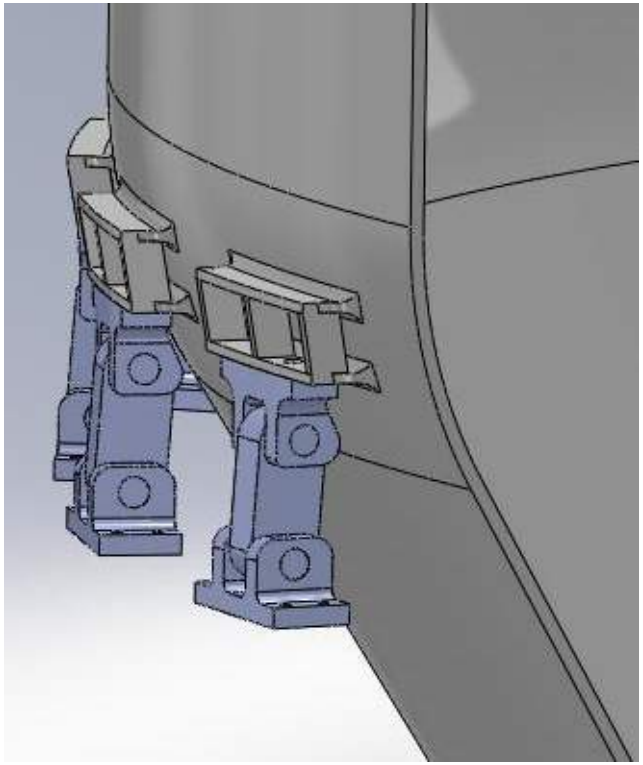
Low Stress Linked Drum Support

- **Linked Drum Support Technology**
  - Segmented attachment to drum designed to reduce hoop stress
  - Linkage design allows drum perimeter to expand thermally without constraint from the skirt wall
  - Link design eliminates stress reversals in skirt wall during quench cycle (Low Cycle Fatigue)
  - Dramatically improved fatigue life cycle

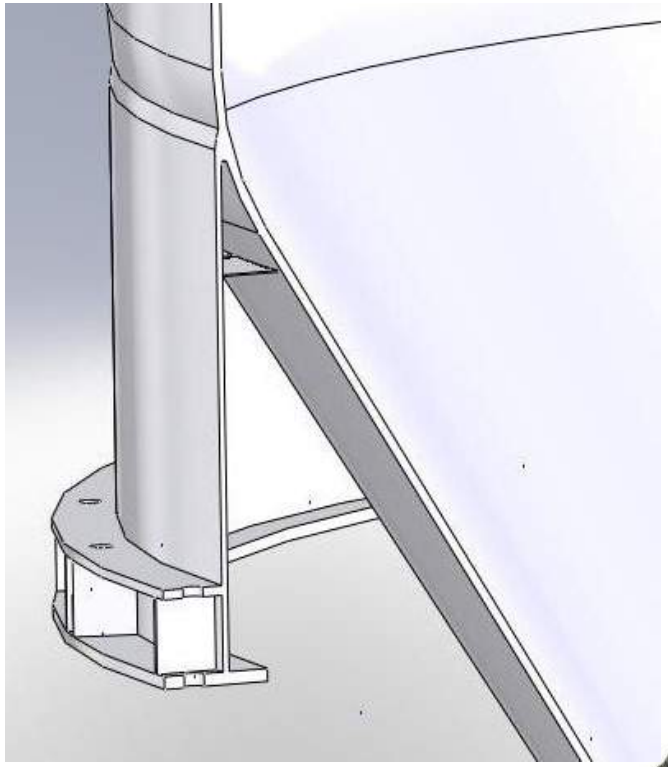
Design Comparison

Construction

Linked Drum Support

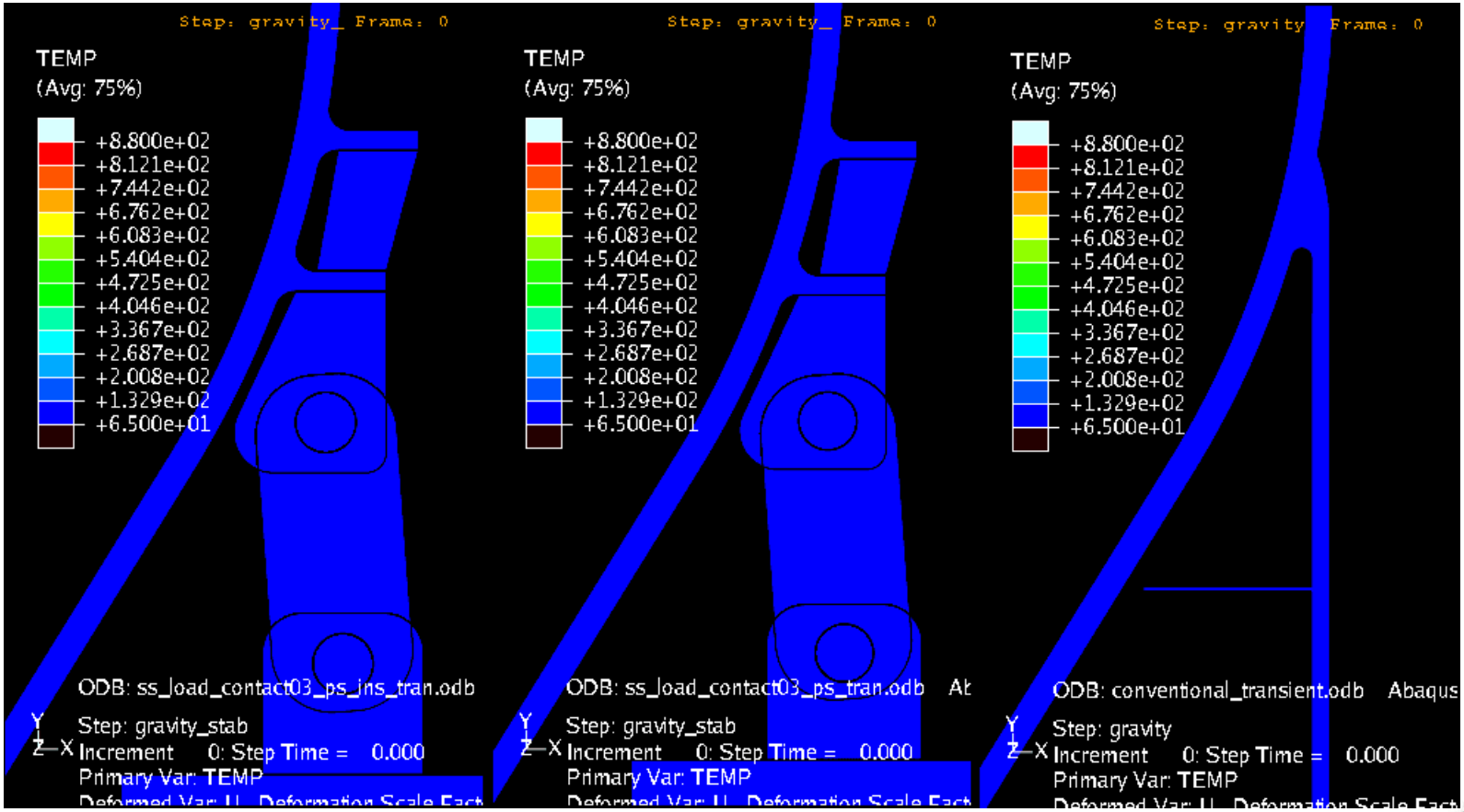


Standard Welded Drum Skirt



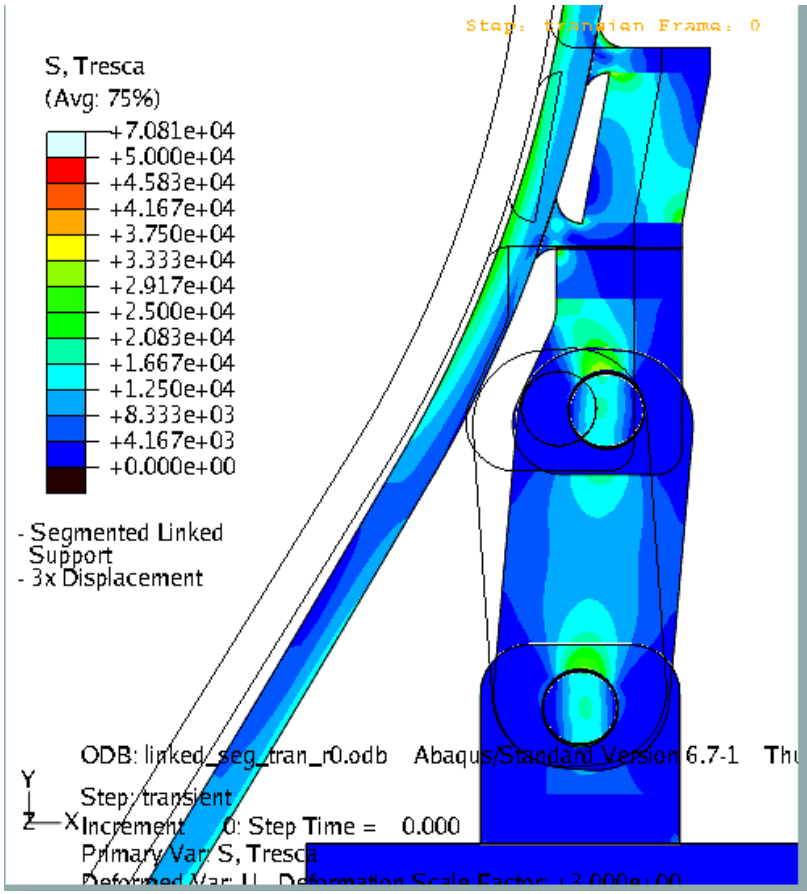
Design Comparison

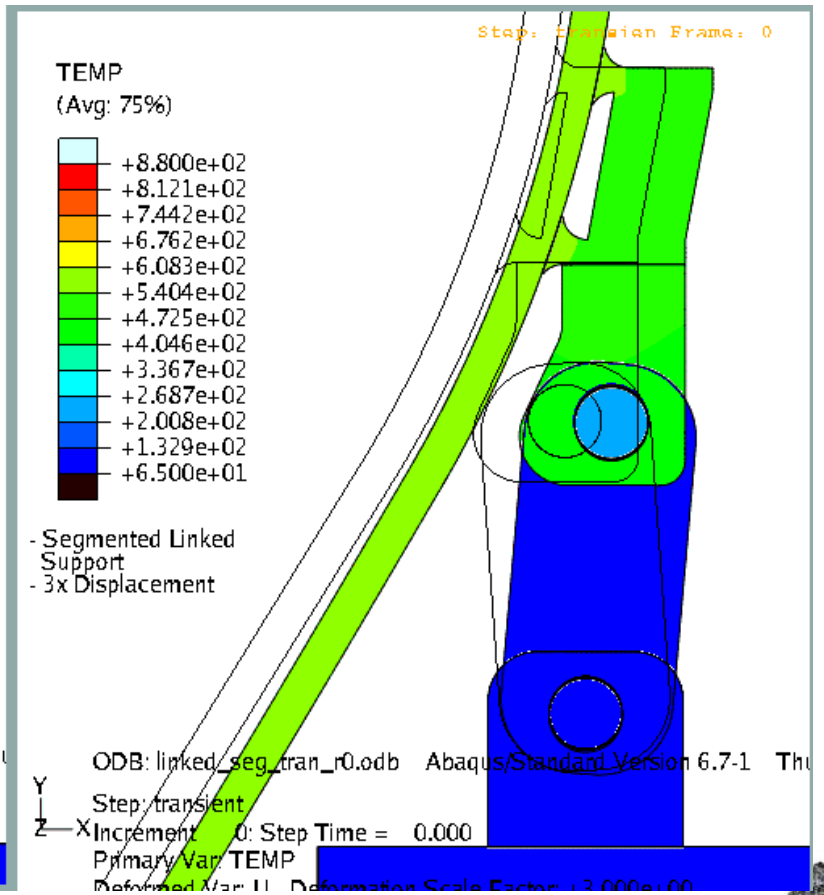
Expansion Compensation/Heat Transfer



Linked Drum Support

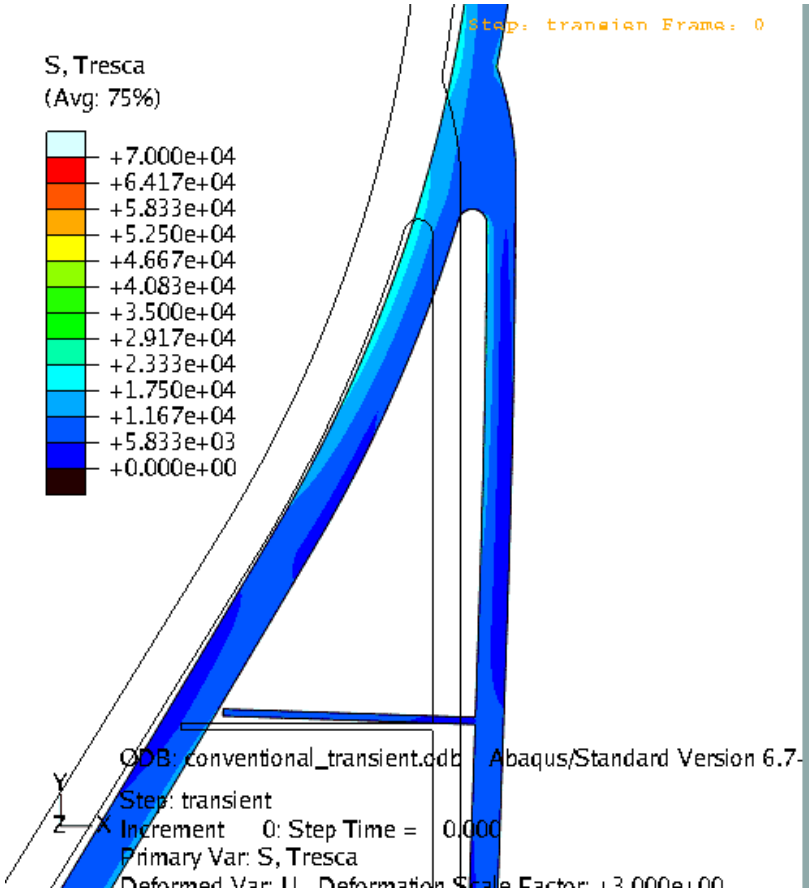
Transient Tresca / Heat Transfer

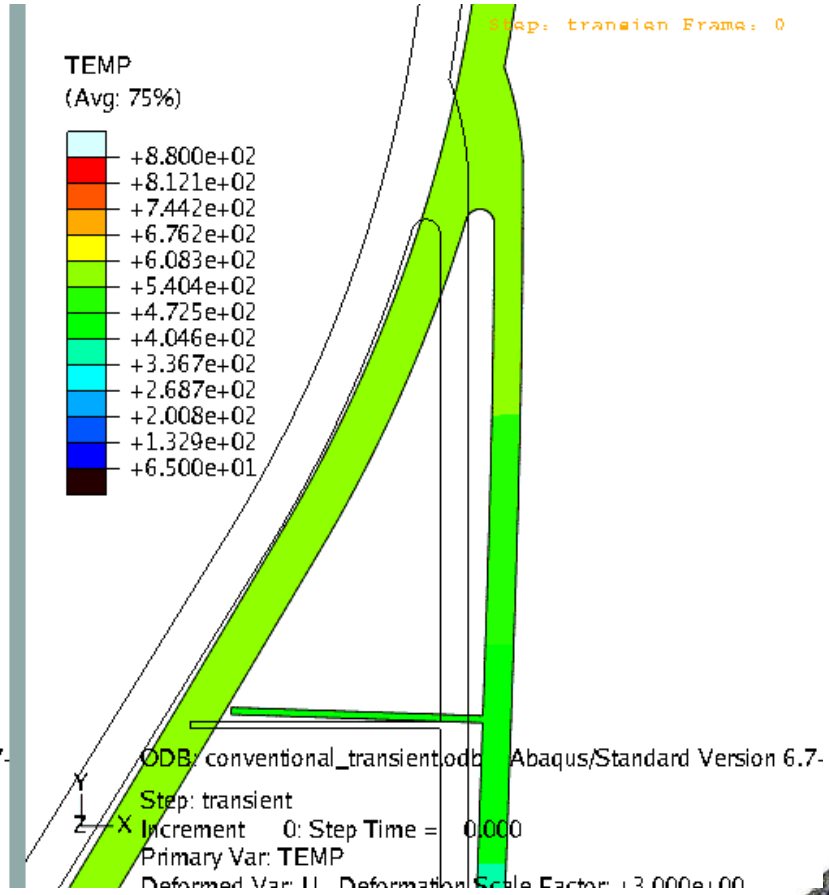




Conventional Drum Skirt

Transient Tresca /Heat Transfer





Design Comparison

Fatigue results Summary

Linked Drum Support

- Segmented linked support at bottom ring
- Max stress range = 25,500 psi
- Design cycle life = 40,600 cycles

Standard Welded Drum Skirt

- Conventional in-line skirt (1/2”radius) at top of skirt on ID max stress
- Range = 277,856 psi
- Design cycle life = 234 cycles

Strategic Technology Alliances

Strategic Technology Alliances

- Identify Critical Problems Requiring Solutions
- Multiply Creativity
- Help to Scientifically Test, Document and De-bug Technology Solutions with Real Life Testing
- Dramatically Shorten Time to Market
- Benefit Alliance Partners and Industry as a Whole

Coke Drum Life Improvement Technology Alliances

- Technology Design
  - CurtissWright Technology Development Center
- Technology Validation FEA/CFD/Site Evaluations
  - Stress Engineering
- Project Engineering
  - Major Engineering Firms
- Construction / Installation
  - Altair Strickland and Others
- Product Manufacture / Project Management
  - DeltaValve USA
- Refining Alliance Partner / Test Site
  - TBD

Enhanced Delayed Coker Technology

- Generation II Actuation System.....Prototype 2009)
  - Ultra Compact Length
  - No cooling box
  - No HPU
- Version II TUD .....(Prototype 2009)
- Full Range of 300# of Isolation Valves from 3-48".....(Release 2009)

Enhanced Delayed Coker Technology

- Enhanced Version BUD.....(Prototype 2009)
  - Low steam during feed
  - No change in steam flow while stroking
  - Fully Throttle-able
  - No Power Shroud
  - No Cooling Box

Demonstration Units

Demonstration units in display hall

1) Center Feed Injection Nozzle
2) TUD/Drill Stem Enclosure/Blowout Preventer
3) Auto Switch Tool
4) Isolation Valve