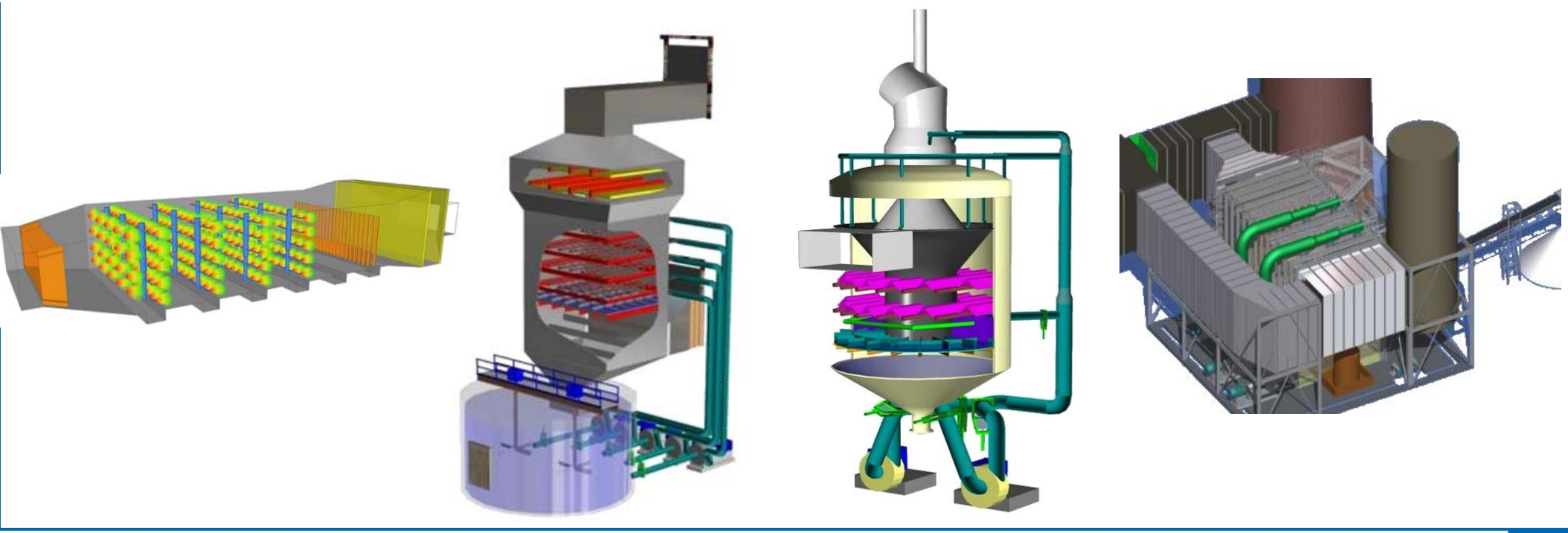
REINHOLD ENVIRONMENTAL Ltd.

2012 APC Round Table
& Expo Presentation

July 16-17, 2012, in Baltimore, MD / Hosted by Duke Energy, Entergy, FirstEnergy, Southern Company & TVA

All presentations posted on this website are copyrighted by Reinhold Environmental, Ltd (RE). Any unauthorized downloading, attempts to modify or to incorporate into other presentations, link to other websites, or obtain copies for any other uses than the training of attendees to RE's Conferences is expressively prohibited, unless approved in writing by RE or the original presenter. RE does not assume any liability for the accuracy or contents of any materials contained in this library which were presented and/or created by persons who were not employees of RE.



URS

Low Cost Wet FGD Upgrades for Complying with MATS Regulations

Presentation at:

2012 APC Round Table
Baltimore, MD
July 17, 2012

Workshop 17

Overview of MATS Regulations

	New Boilers		Existing Boilers	
	>8,300 Btu/lb	< 8,300 Btu/lb	>8,300 Btu/lb	< 8,300 Btu/lb
	lb/MM Btu	lb/MM Btu	lb/MM Btu	lb/MM Btu
PM	0.0050	0.005	0.03	0.03
SO_2 (Surrogate for HCl)	0.04	0.04	0.20	0.20
Hg	1.0E-09	4.0E-06	1.0E-06	4.0E-06

- Covers all Electric Power Plants
  - Implementation by 2015
- PM limit is also a surrogate to HAP metals excluding Hg
  - Condensables such as SO_3 are excluded
- SO_2 limit is a surrogate for acid gases
- Proposed Hg limit for new boilers likely to be challenged

Copyright © 2012 URS

Overall Strategy for Compliance

- Unscrubbed Units:
  - DSI - option for plants firing low sulfur fuel which have efficient precipitators or bag houses
  - Low cost wet FGD (e.g., Co-Flo™) preferred option for plants with precipitators firing medium or high sulfur coal
  - CDS good option for plants which need new PM control systems
- Scrubbed Units:
  - Economics favor upgrade of wet FGD
  - Upgraded wet FGD systems provide multi-pollutant control and can be technology focal point for MATS compliance
    - SO_2
    - Hg
    - Particulate

Copyright © 2012 URS

MATS Control Technology with Wet FGD

- 0.20 lb/MM Btu SO_2 can be achieved on all scrubber upgrade projects even with high sulfur coal
- Technology available to achieve high removal of oxidized Hg
  - Bromide addition
  - SCR catalysts being developed to enhance Hg oxidation
  - Additives available to minimize or eliminate re-emissions
- New technology to “polish” Hg removal downstream of wet FGD (e.g., Gore)
- High efficiency wet FGD can serve as a device to remove additional PM (polishing step)

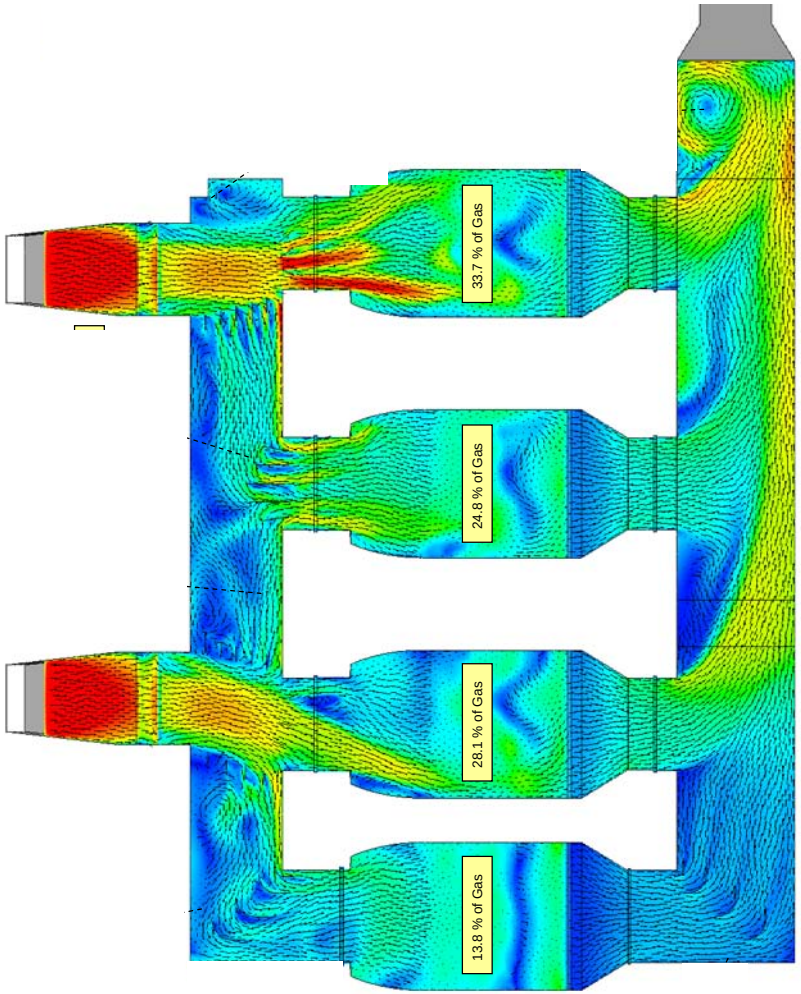
Copyright © 2012 URS

Typical Problems with Old Wet FGD Systems

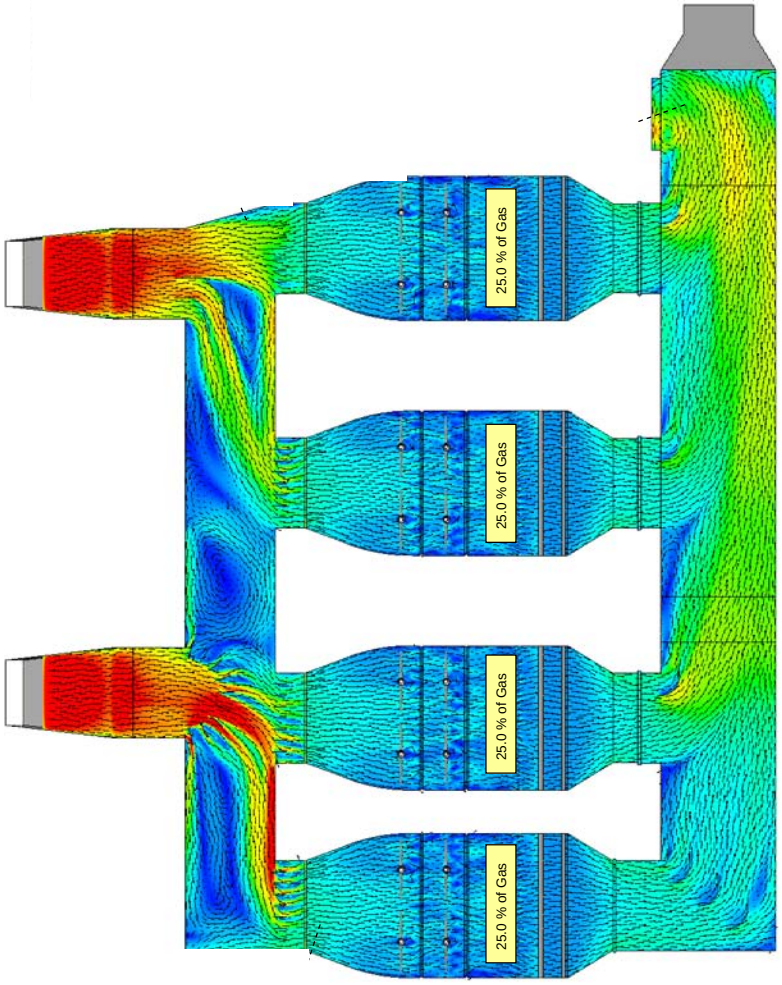
- Gas Distribution among modules
- Gas Distribution inside absorber modules
- Poor spray coverage
- Wall sneakage
- Poor ME gas distribution
- Chemistry deficiencies

Copyright © 2012 URS

Unbalanced Flow Among Absorber Modules



Before Upgrade

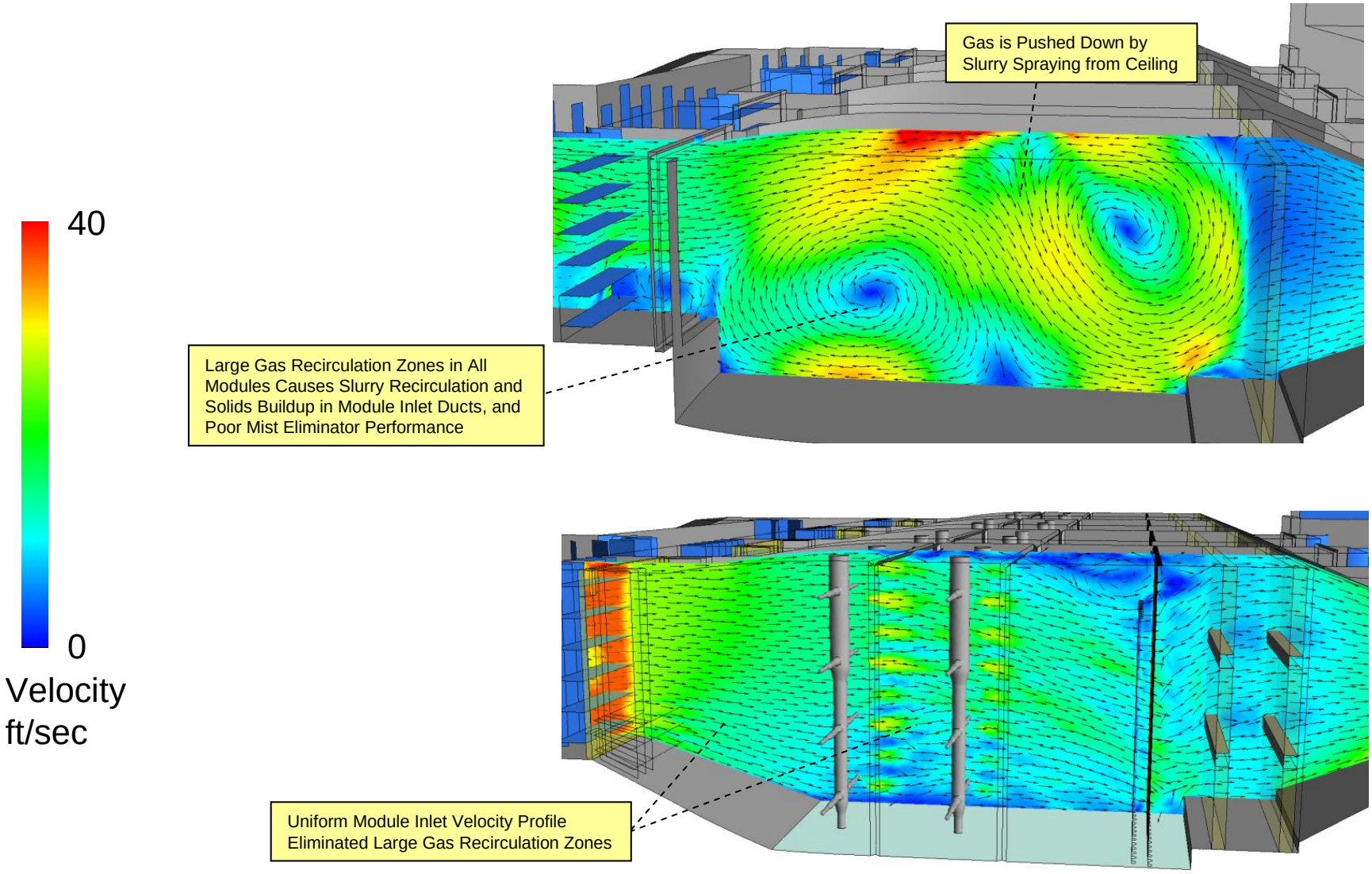


After Upgrade

Copyright © 2012 URS

Poor Gas Distribution

Case 1: Existing Crossflow Configuration, All Modules In Service

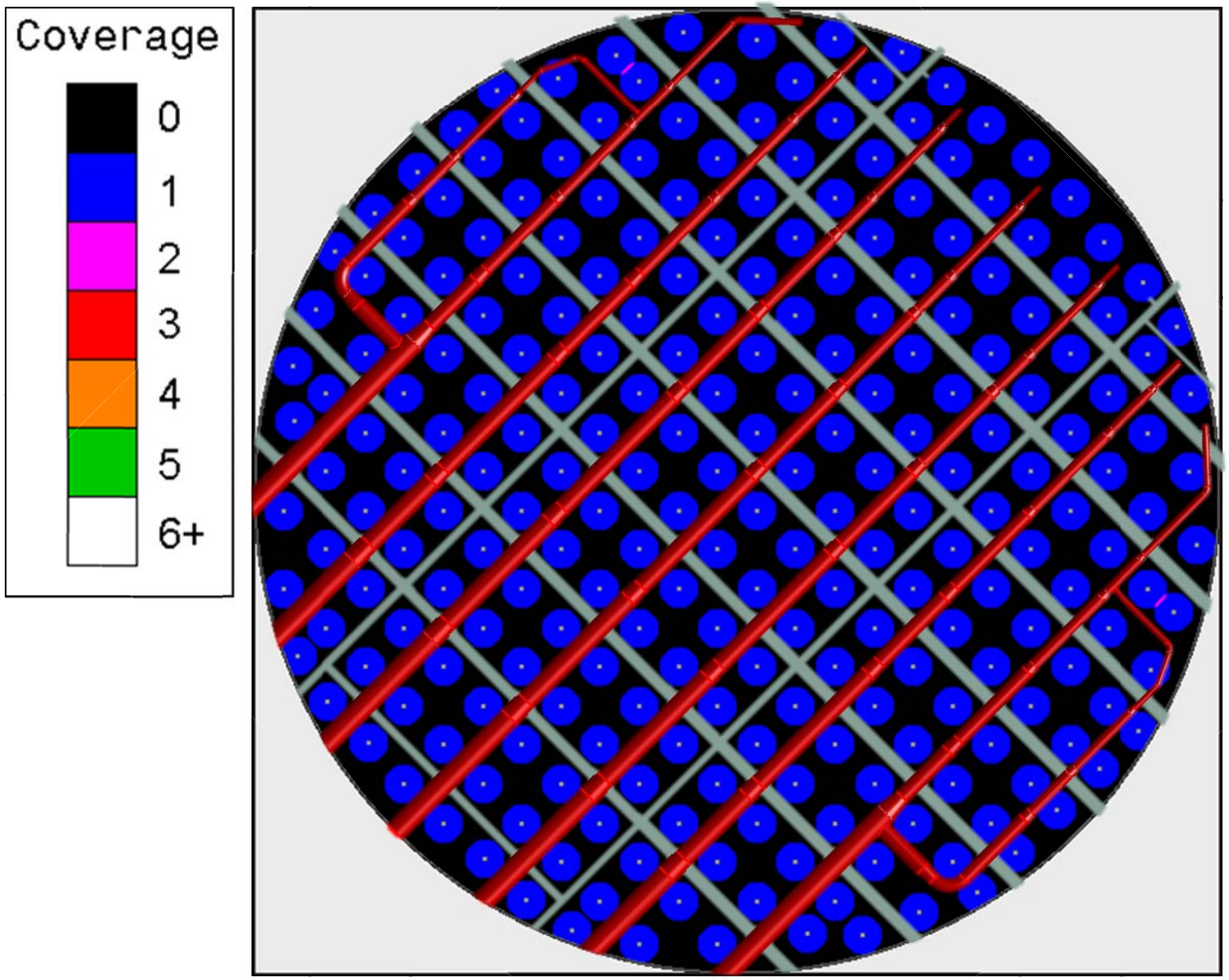


Case 2: Cocurrent Spray Conversion, All Modules In Service

Copyright © 2012 URS

Poor Spray Coverage

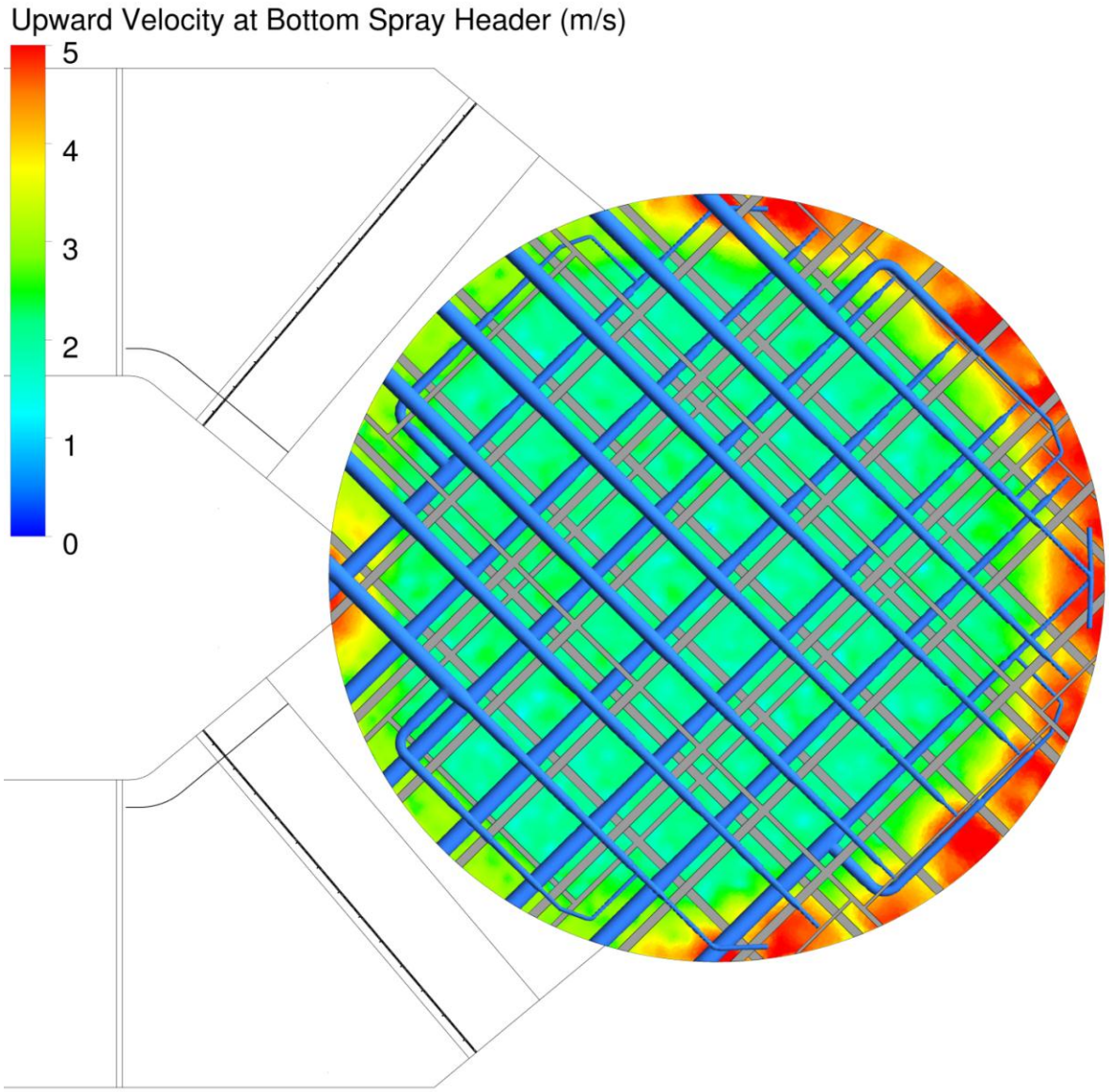
- 39% spray coverage
- 90-degree spray nozzles
- Sneakage



Copyright © 2012 URS

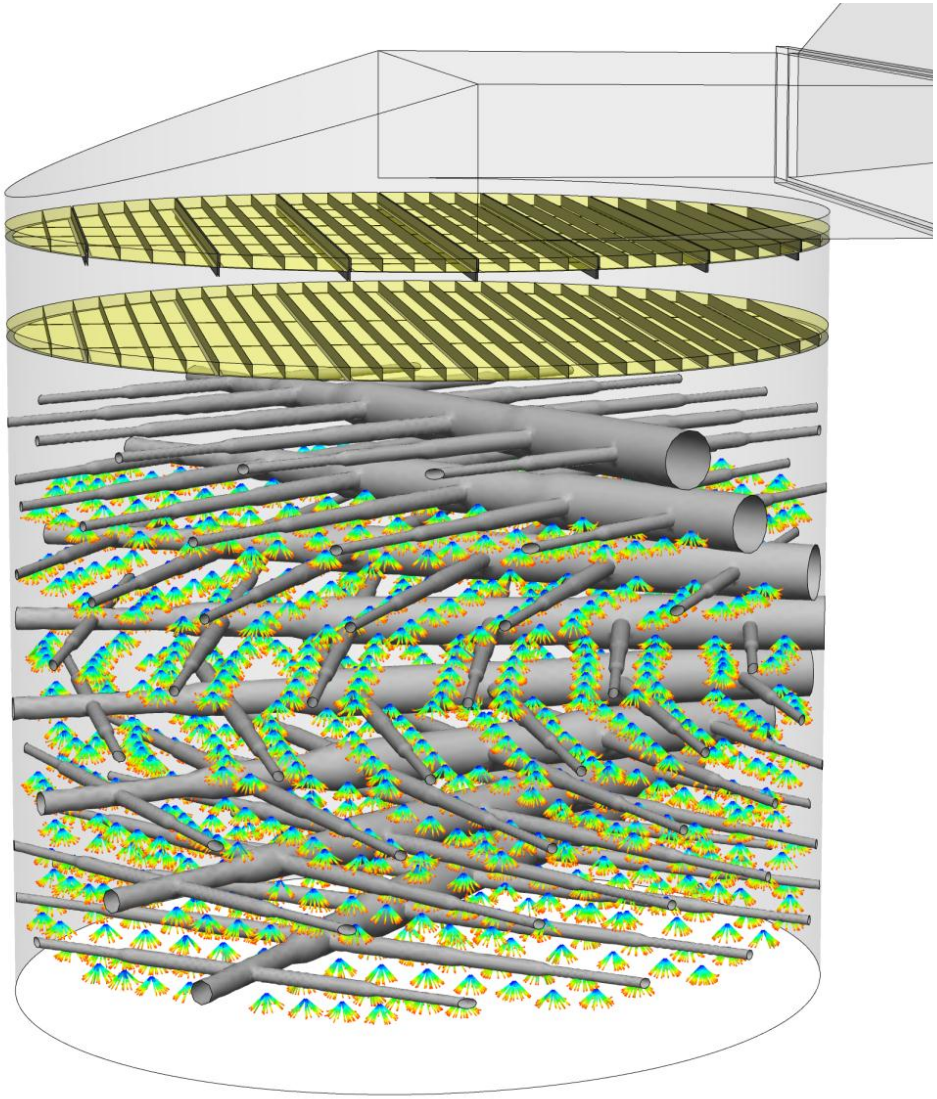
Wall Sneakage

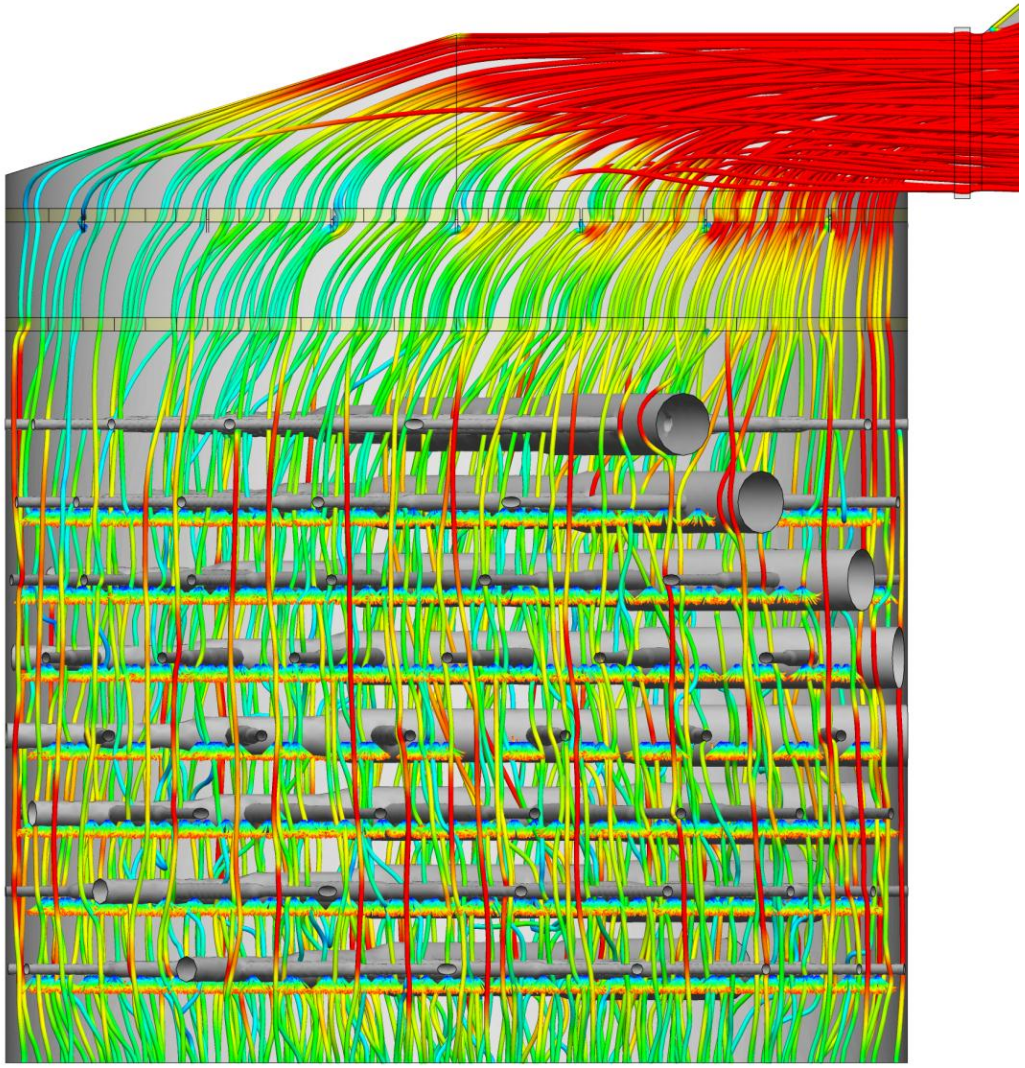
- Poor spray coverage will lead to internal and peripheral gas sneakage
- Will often limit SO_2 removal to 95 percent regardless of pH and number of spray headers in service



Copyright © 2012 URS

Poor Mist Eliminator Performance

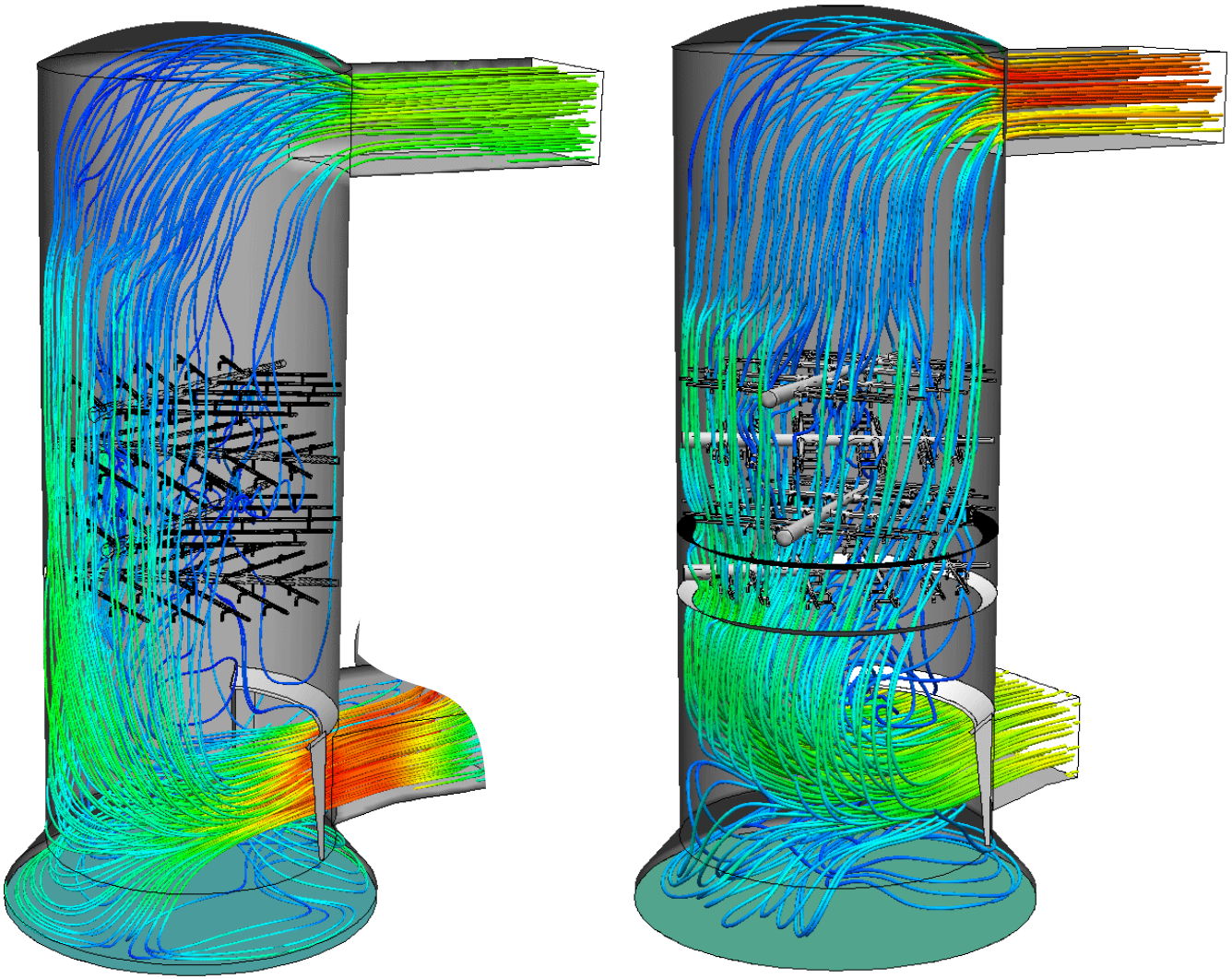




Copyright © 2012 URS

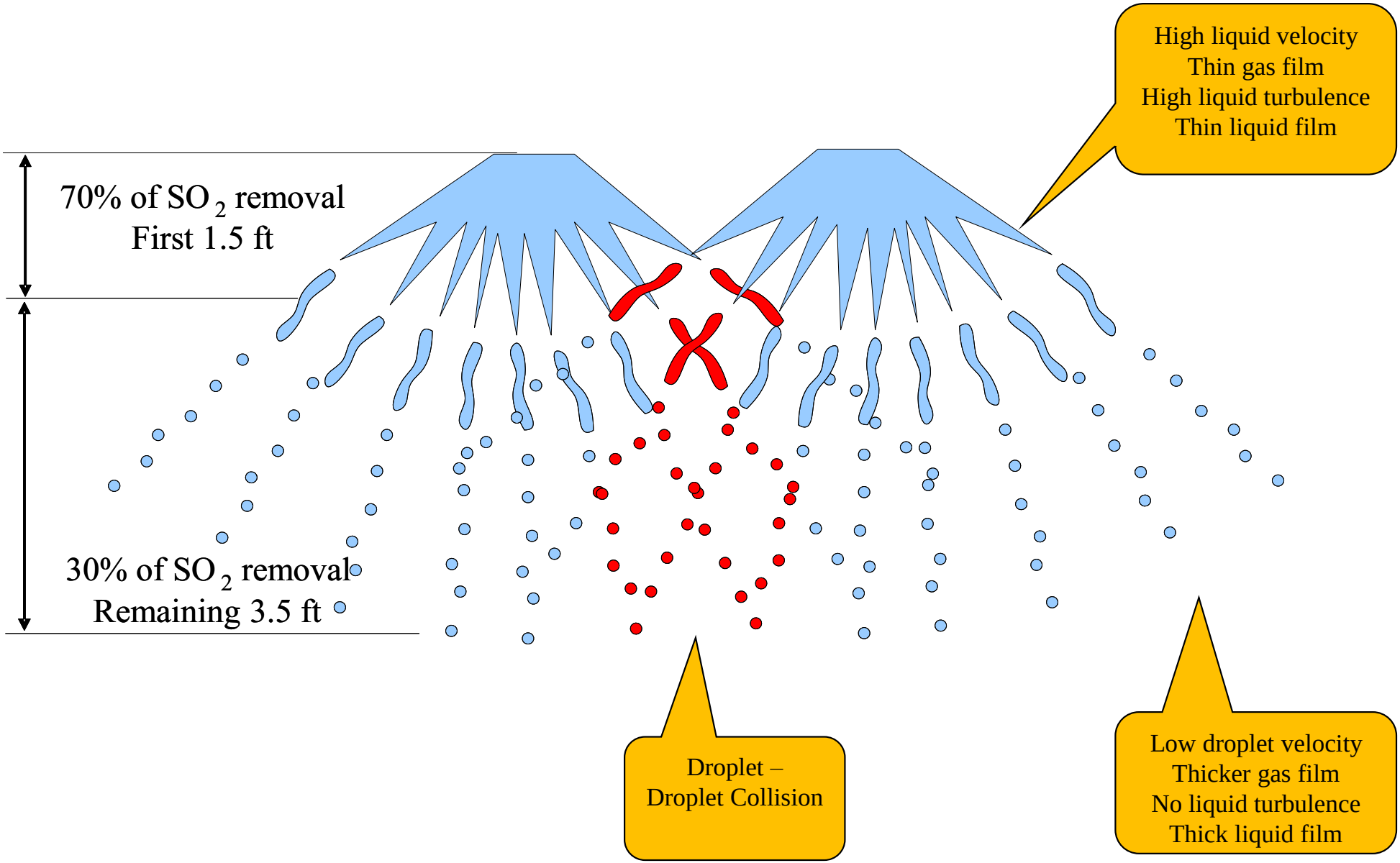
Available Tools

- Improved spray headers and spray nozzles
- Liquid distributi rings
- Dual-flow sieve trays
- Gore
- Modeling
  - CFD modeling
  - Process simulation modeling



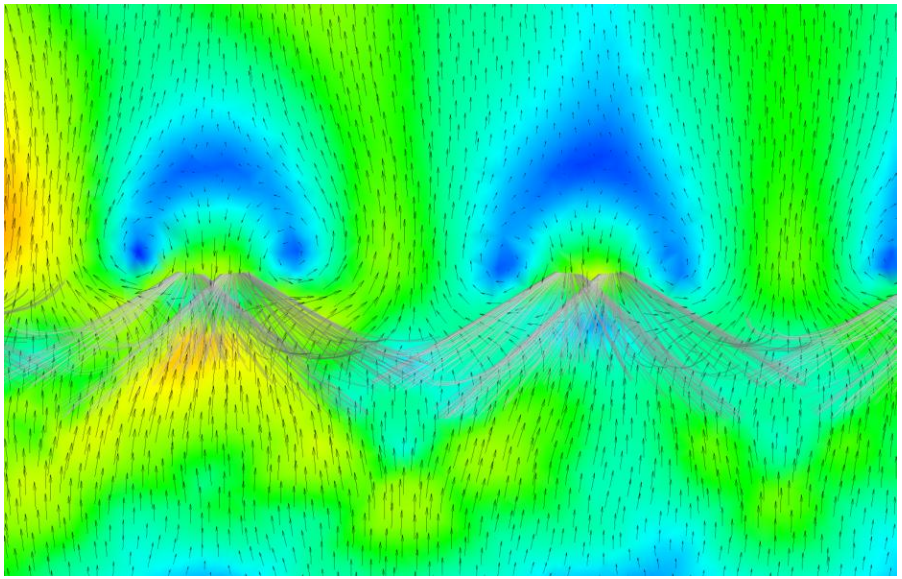
Copyright © 2012 URS

Nozzle Theory

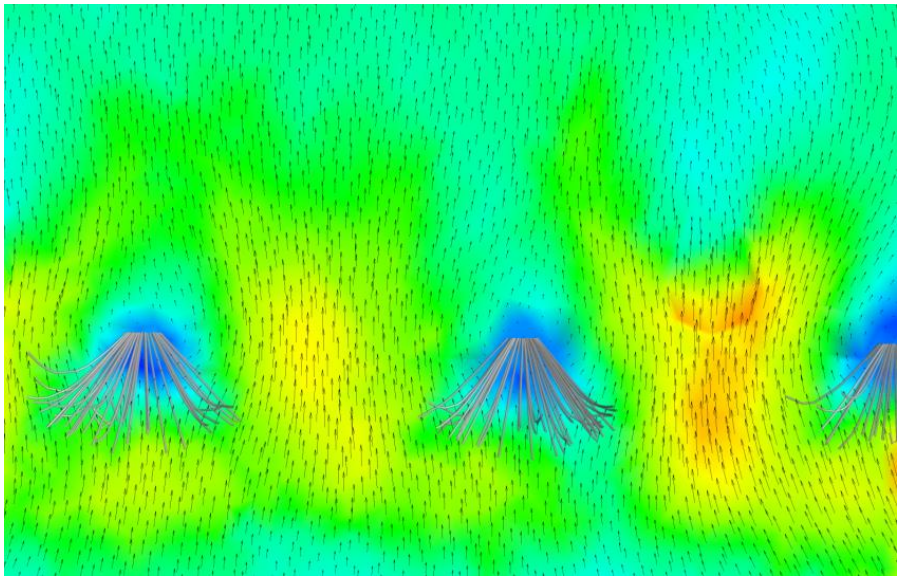


Copyright © 2012 URS

Comparison of Hollow and Full Cone Nozzles



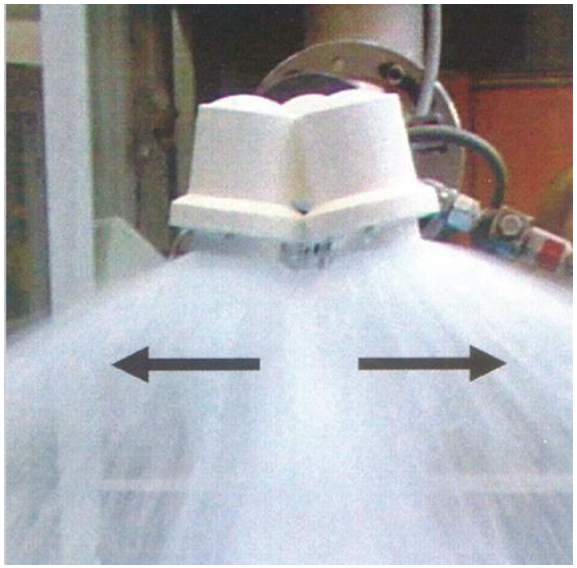
Hollow Cone Spray



Full Cone Spray

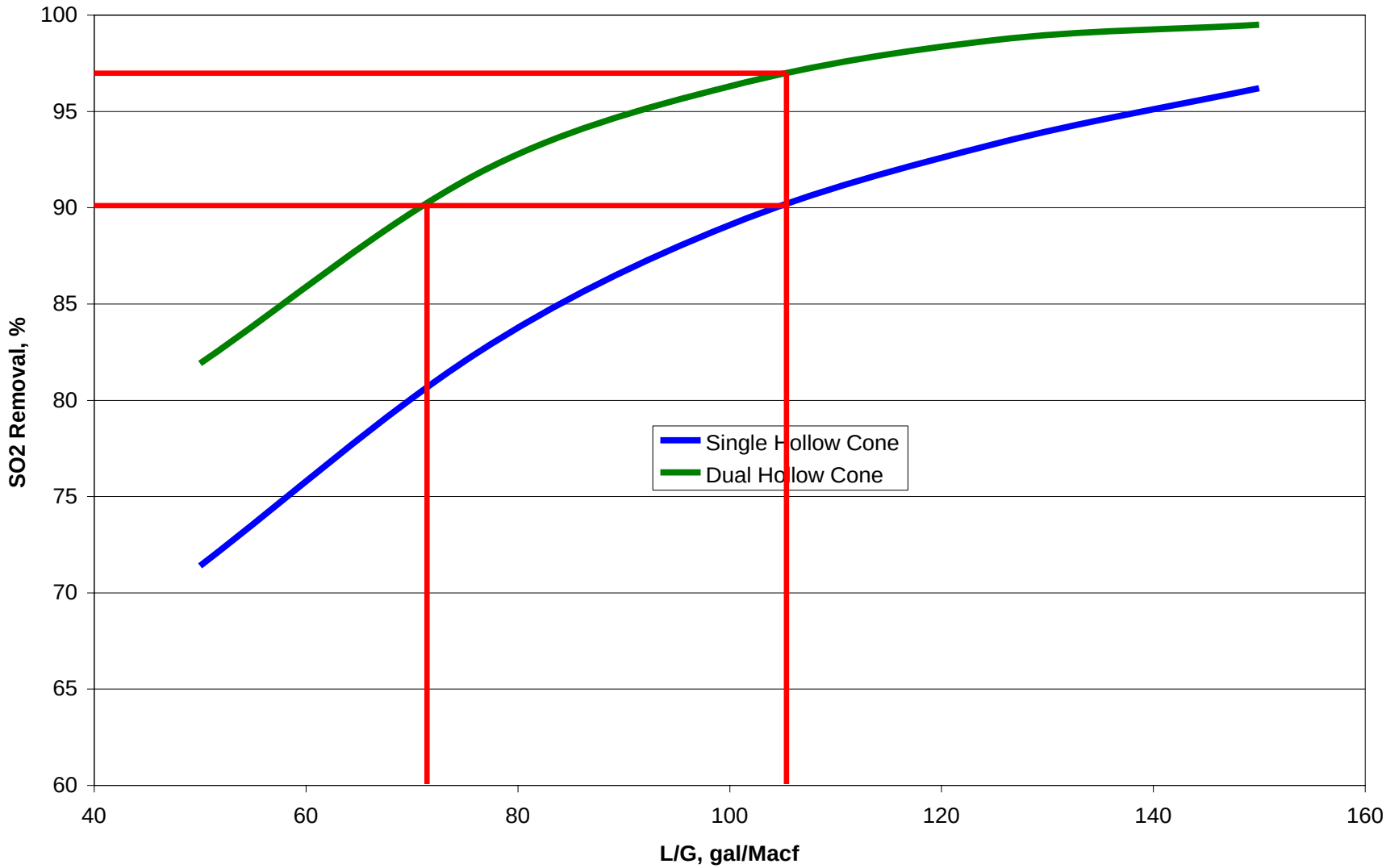
Copyright © 2012 URS

Double Hollow Cone Spray Nozzle



Copyright © 2012 URS

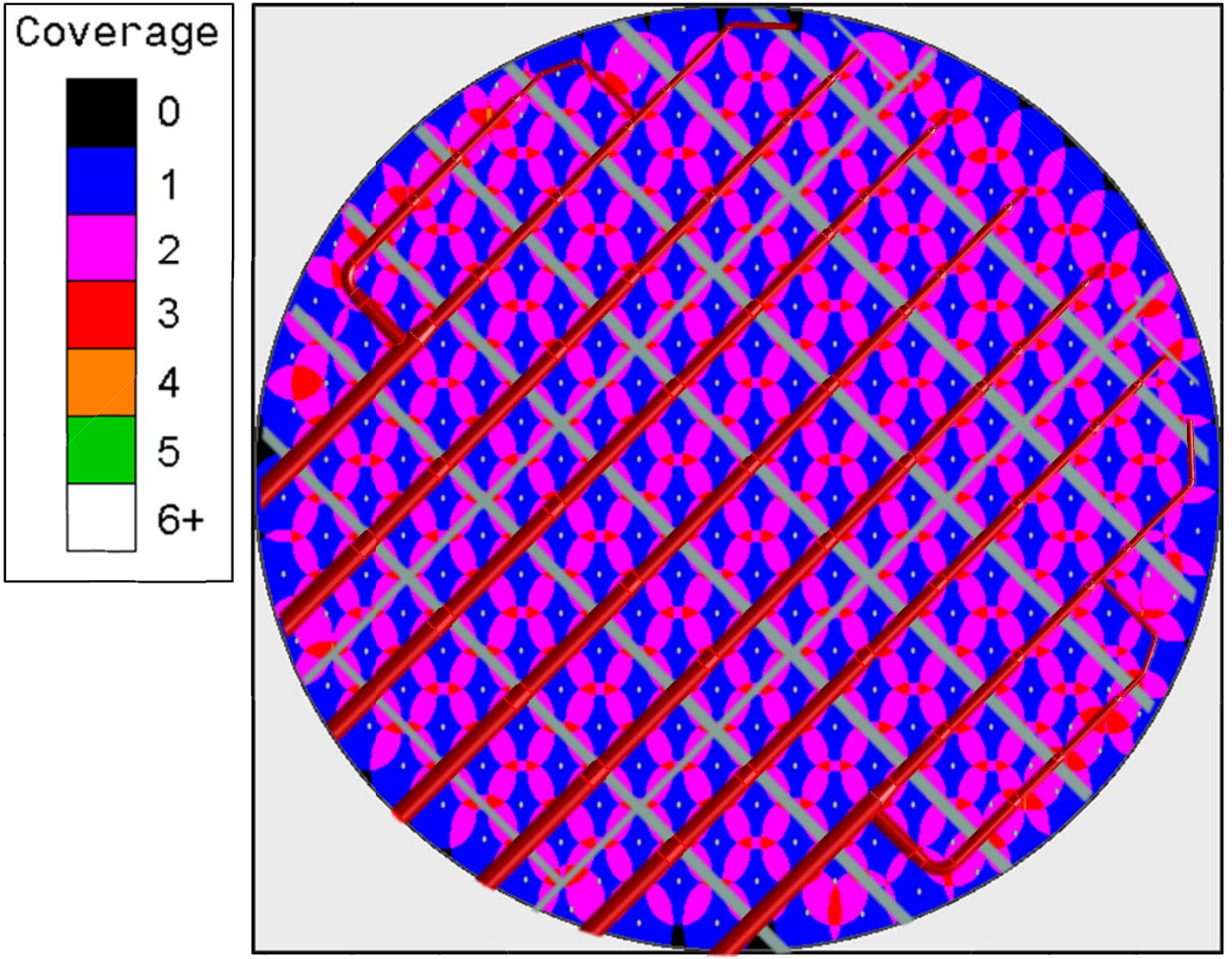
Comparison of SHC and DHC Spray Nozzles



Copyright © 2012 URS

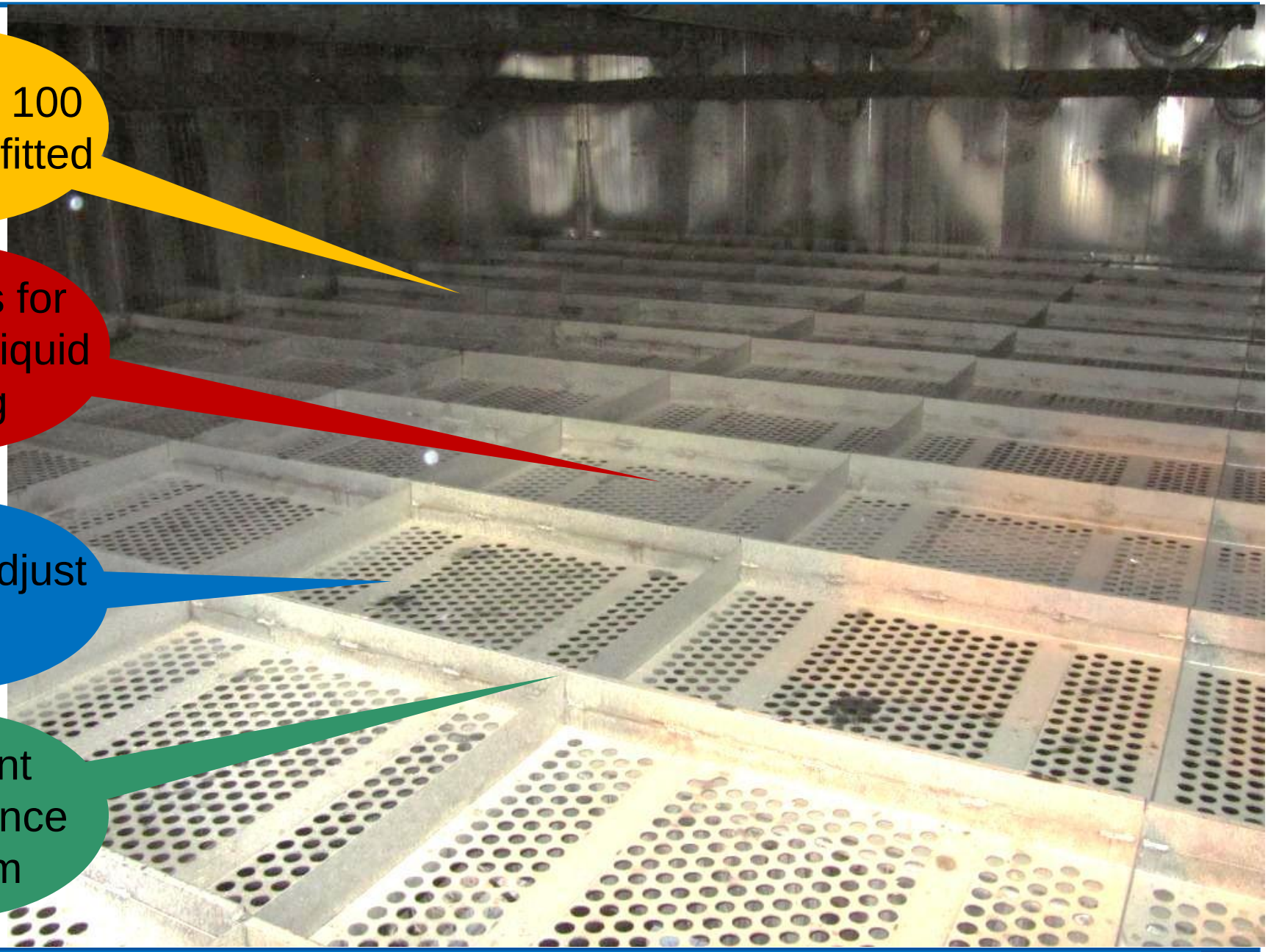
High Efficiency Spray Header

- 165 % spray coverage
- 120-degree spray nozzles
- No sneakage



Copyright © 2012 URS

High Efficiency Tray



Copyright © 2012 URS

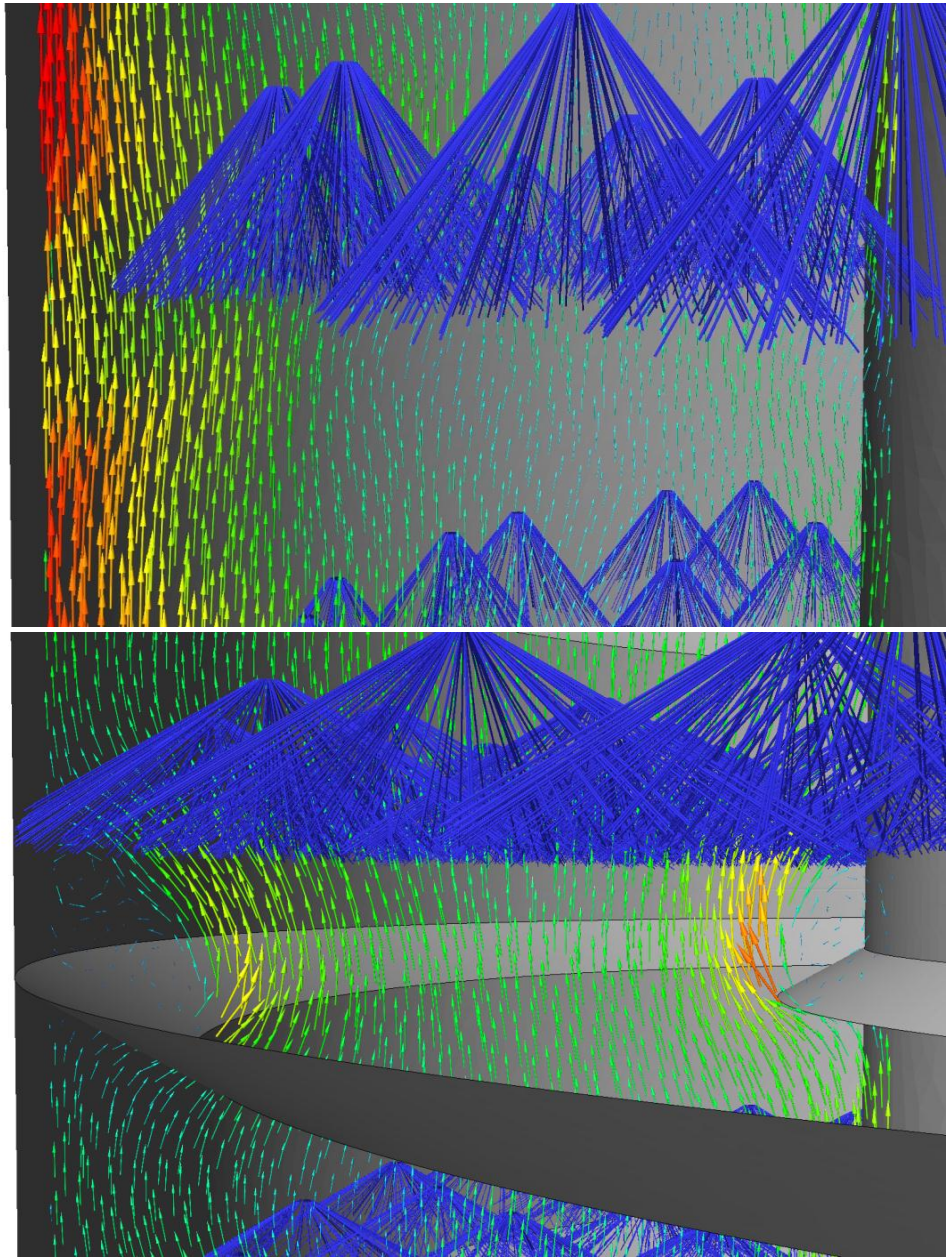
Trays

- Sieve Tray
  - Great SO_2 removal device
    - Same SO_2 removal as one spray header
    - One or two per absorber
  - Provides 50 Pa pressure drop
    - Correct gas distribution problems
    - Protects the inlet duct
    - Provides particulate removal
  - Flexible Design
    - High velocity – hexagonal
    - Low velocity - round
  - Can be used as Maintenance platform
  - Stays clean

Copyright © 2012 URS

Wall Rings

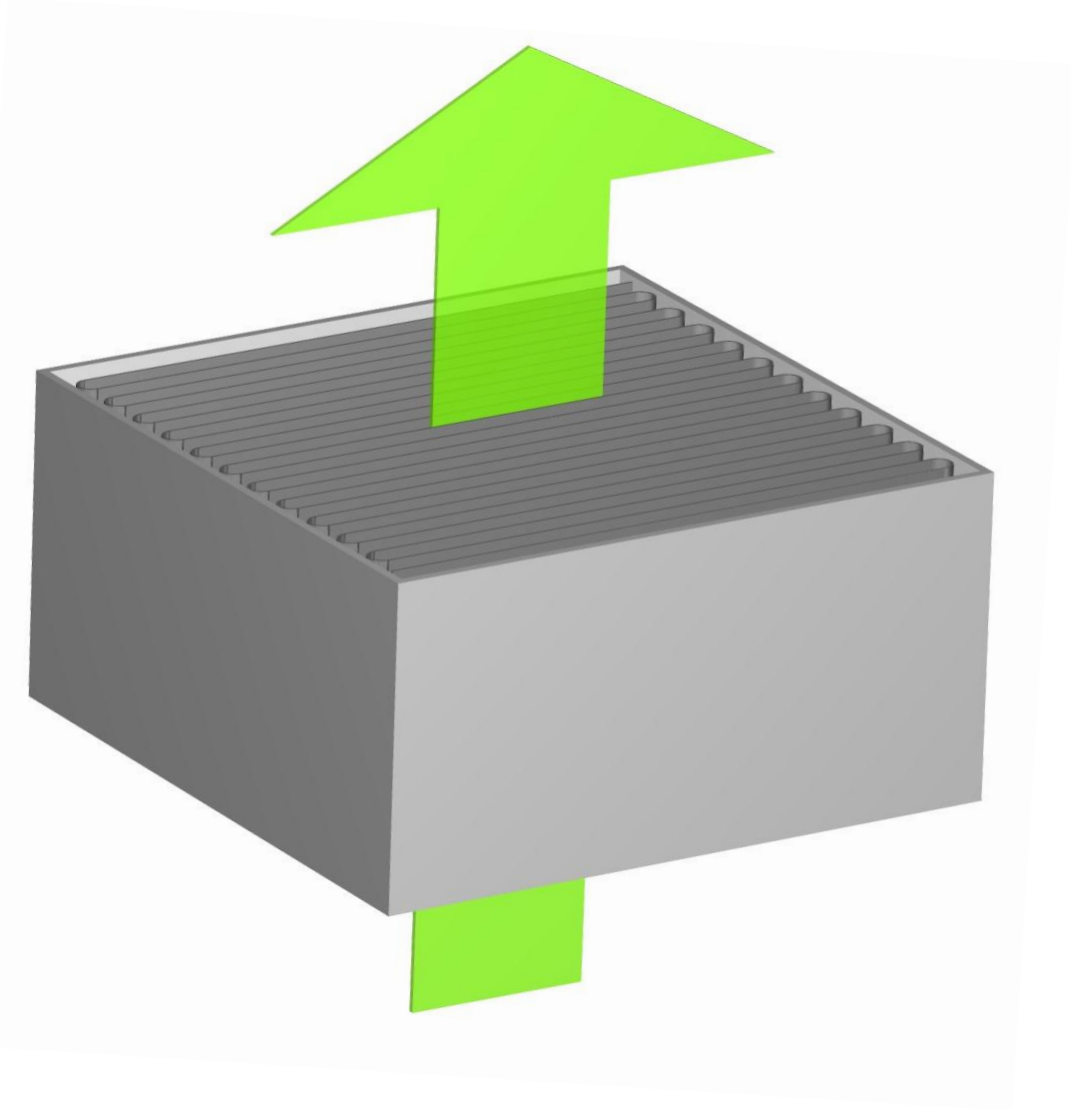
- Designed to compensate for low spray density and high gas flow along absorber walls
- Rings are especially effective in small and/or rectangular modules
- Protects liner from wall erosion



Copyright © 2012 URS

Gore SPC Hg Control System

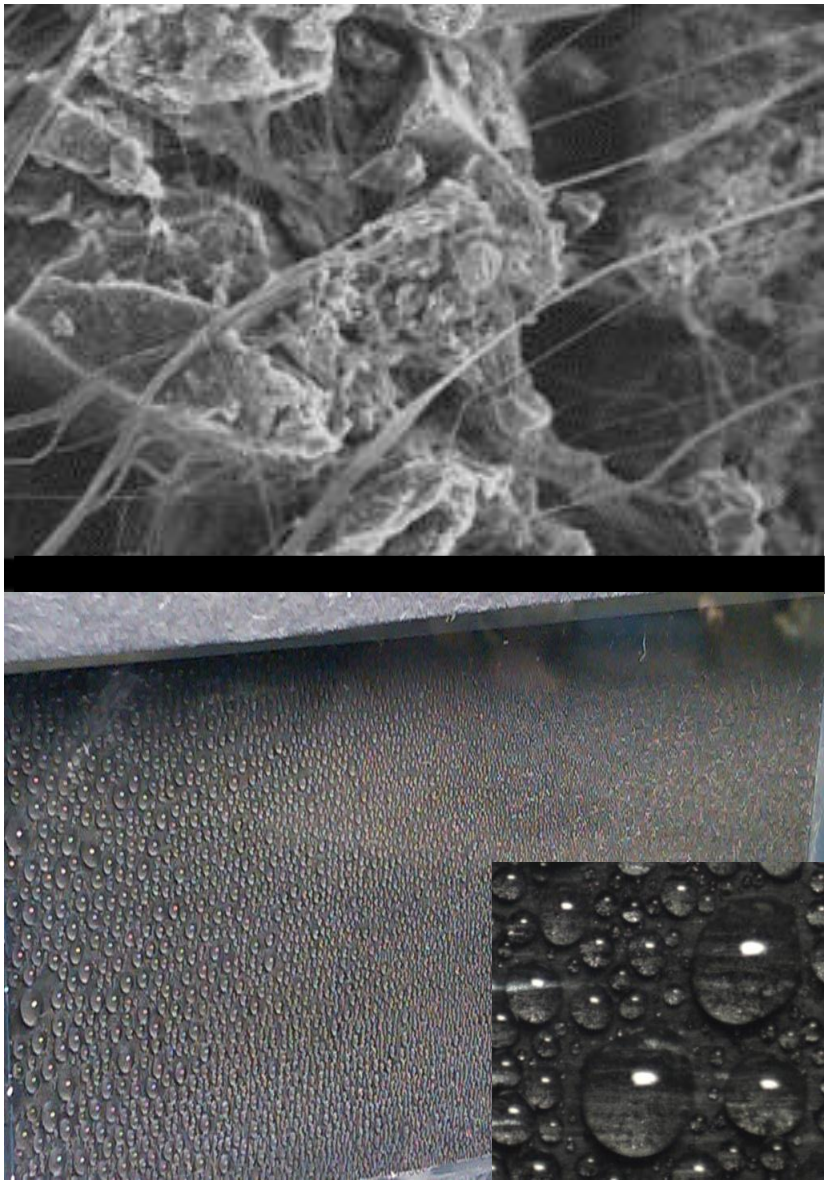
- Fixed Sorbent Technology
  - Located downstream of ME
  - Life expectancy multiple outage cycles.
- Pros
  - Low cost technology
  - Up to 90+ percent Hg removal
  - Up to 60+ percent SO_2 removal
  - Not sensitive to Hg concentration
  - Removes both ionic and elemental Hg
  - Not sensitive to Hg speciation
  - No additives to inject into the boiler
  - No activated carbon injection
  - No impact on the fly ash
  - No concerns regarding Hg reemission



Copyright © 2012 URS

Gore SPC Hg Control technology

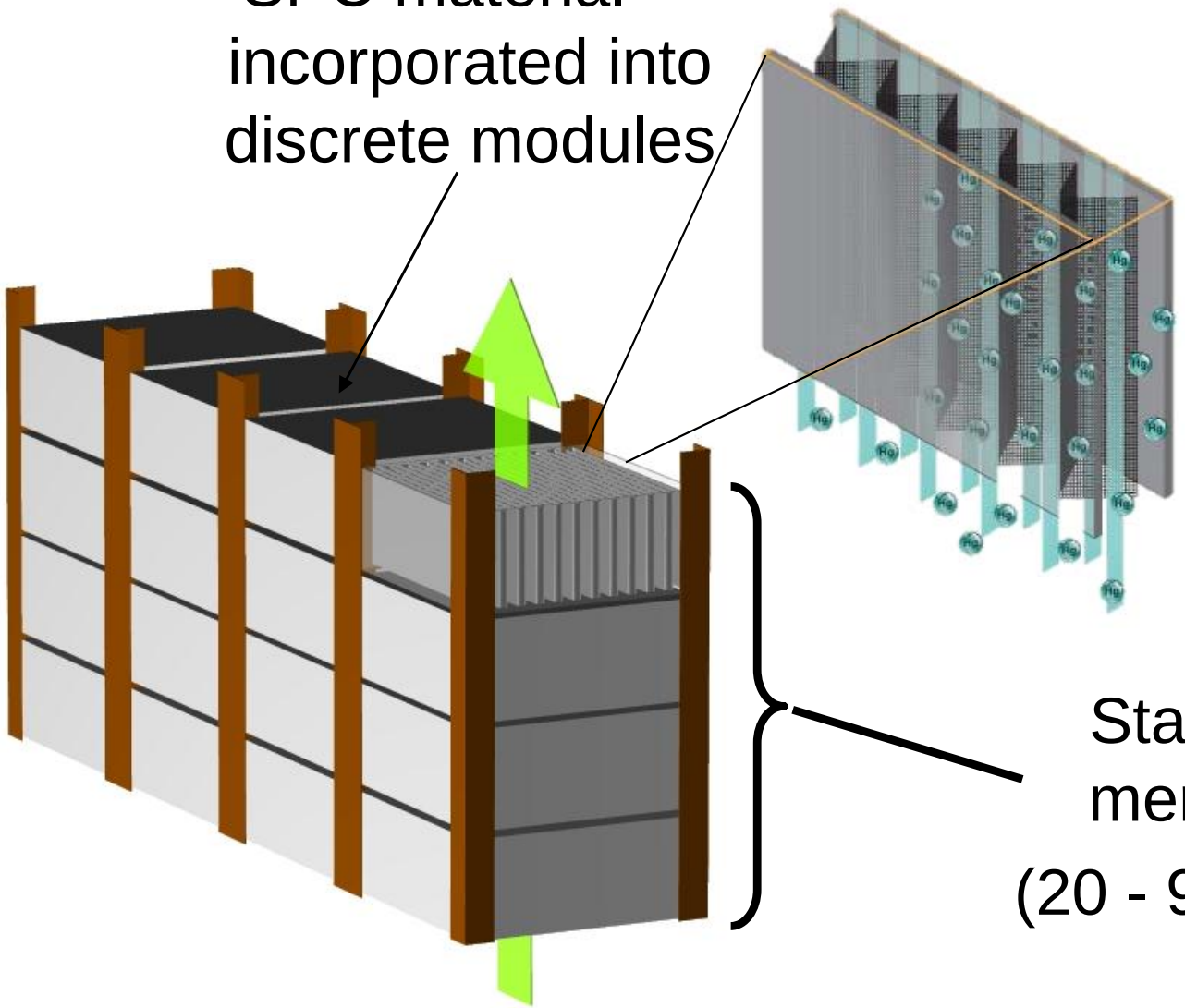
- Fixed Bed Sorbent Polymer Composite (SPC) material
  - 1 ft wide tape of composite fluoropolymer membrane
  - Modularized
- Unique physical-chemical nature of the SPC material
  - Efficiently captures both elemental and oxidized mercury Hg
  - SO_2 is converted into sulfuric acid and expelled to SPC material's outer surfaces
  - Very high capacity for mercury storage
  - Does not require regeneration



Copyright © 2012 URS

Modular Structure

SPC material incorporated into discrete modules



Gas Flow

Open-channel design provides low pressure drop

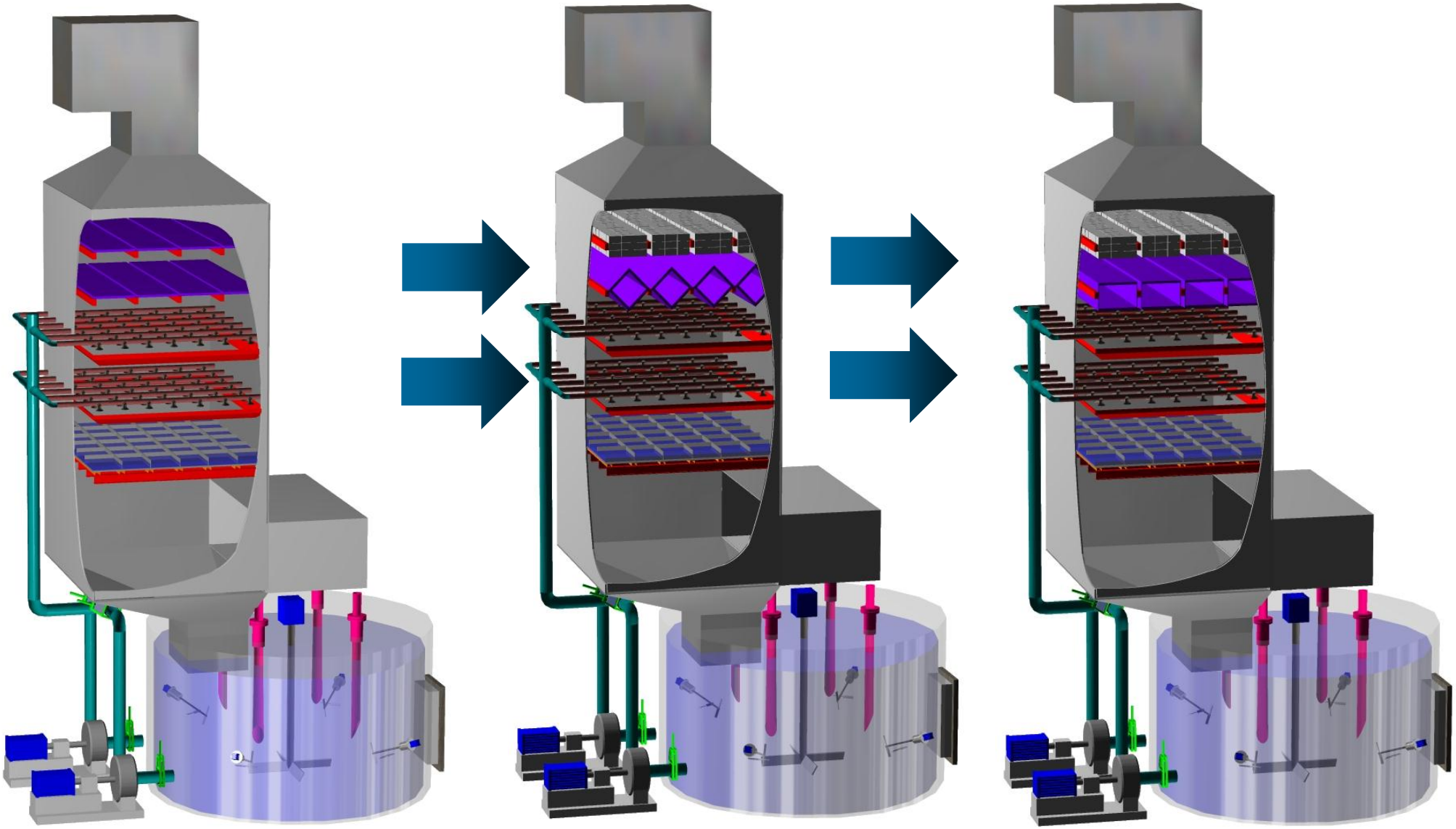
Hg is strongly bound to SPC material

Stack height determines mercury removal efficiency

(20 - 95+ percent Hg removal possible)

Copyright © 2012 URS

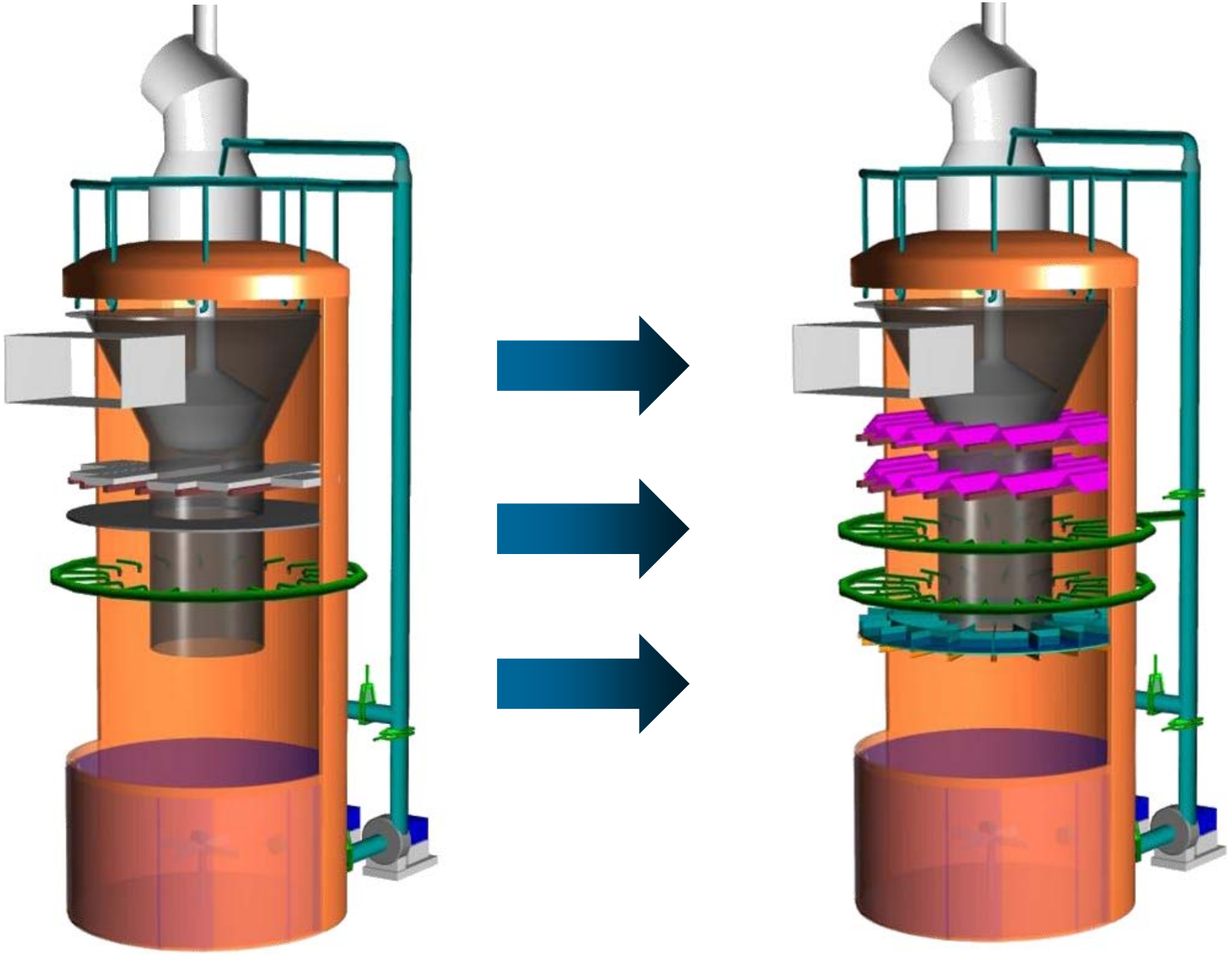
Typical Installation



Unmodified DV210 FlexIpeak

Copyright © 2012 URS

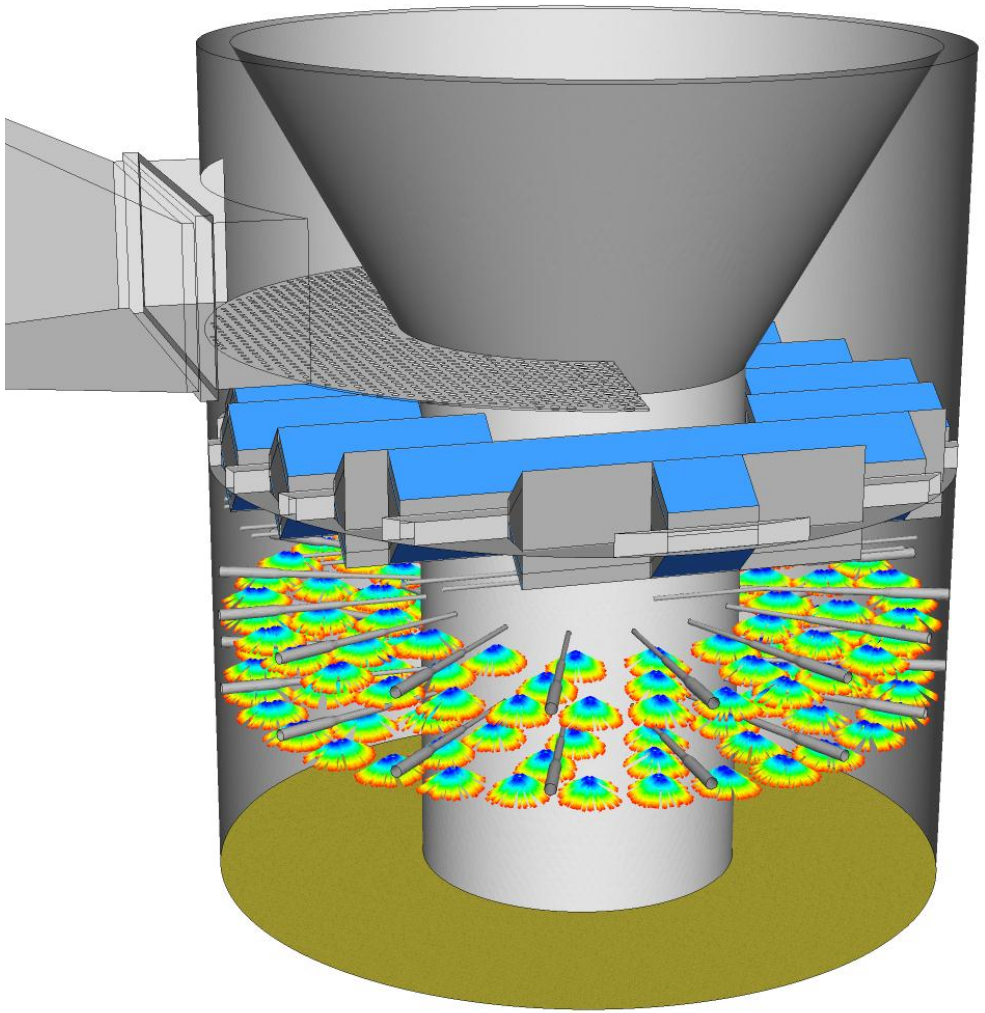
Venturi Fly Ash Scrubber



Copyright © 2012 URS

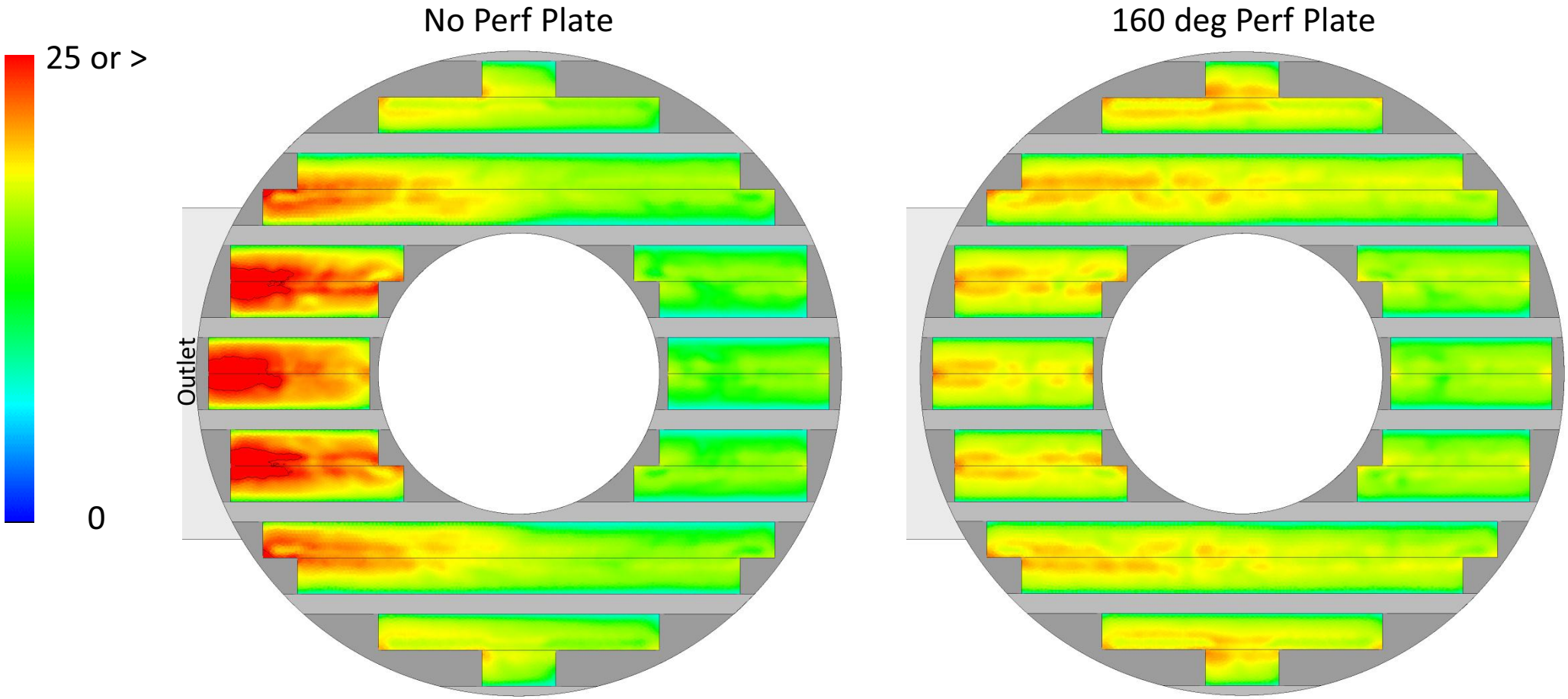
Upgrade Approach and performance

- Background
  - CEA scrubber
  - 1985
  - Medium sulfur coal
- Approach
  - Tray
  - Spray header
  - DHC spray nozzles
  - DV210 mist eliminator
  - Perforated plate
- Performance
  - Increased SO_2 removal from 80 percent to 98 percent
  - Decreased particulate emissions



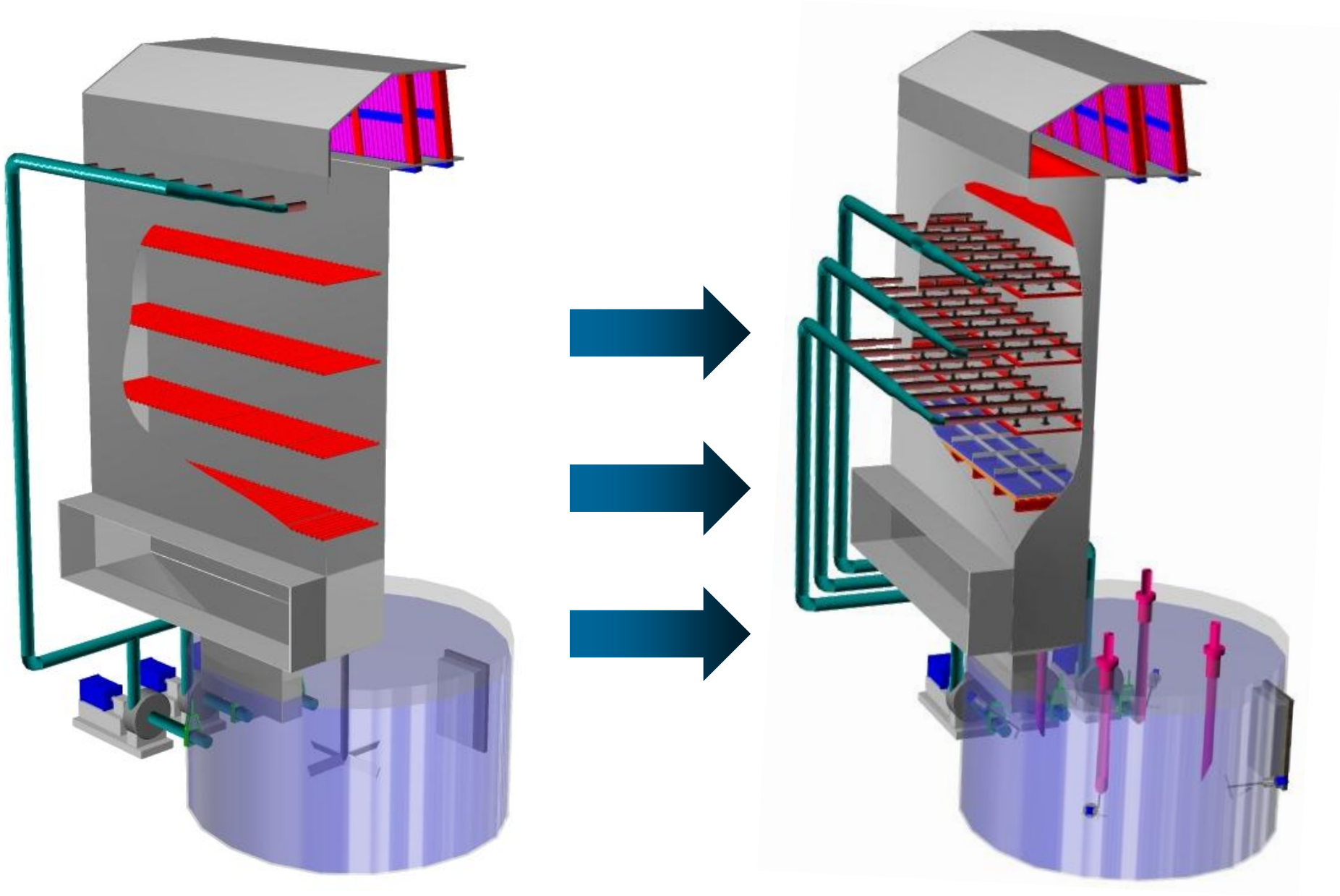
Copyright © 2012 URS

Mist Eliminator Gas Distribution



Copyright © 2012 URS

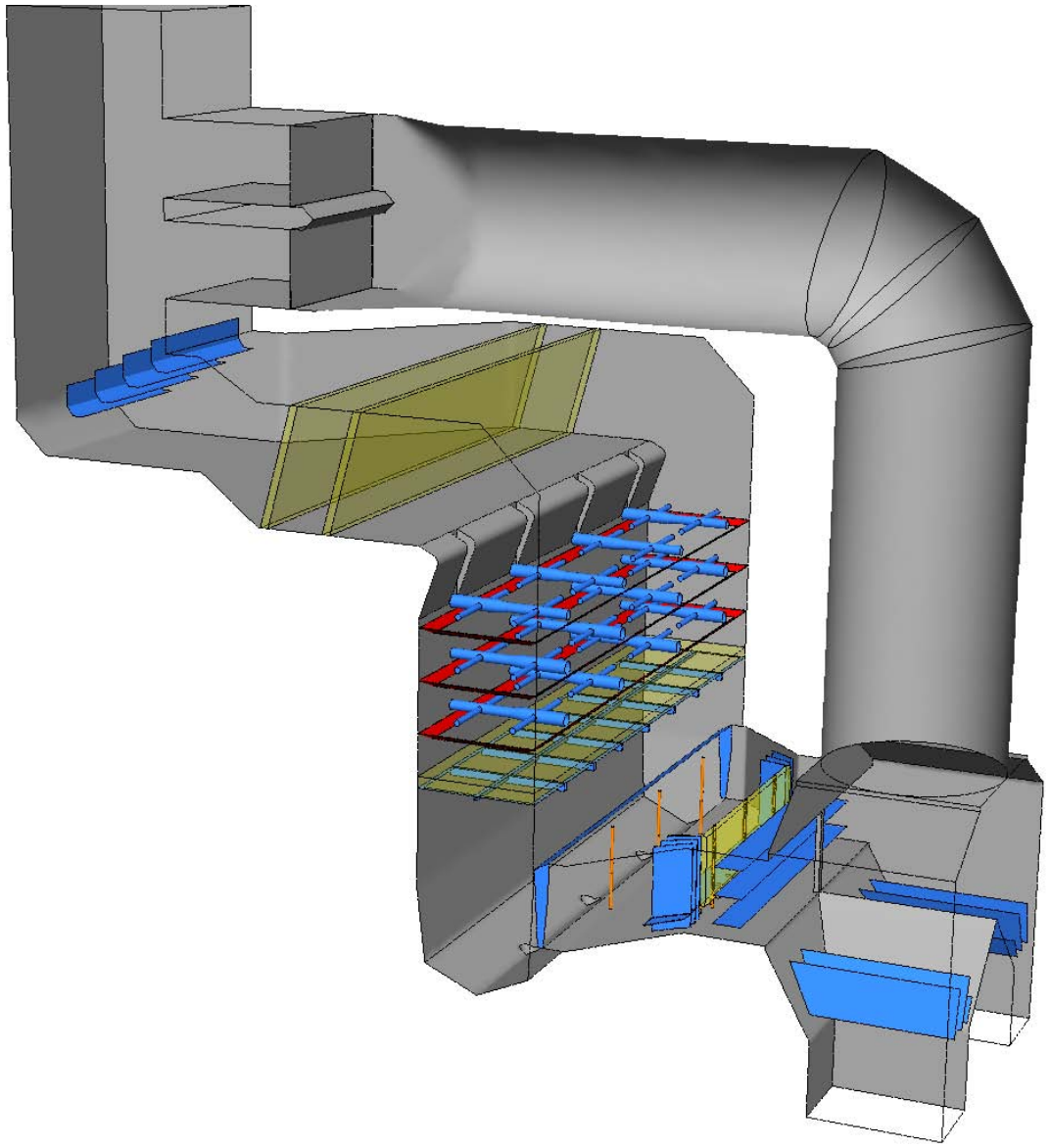
Rod Scrubber



Copyright © 2012 URS

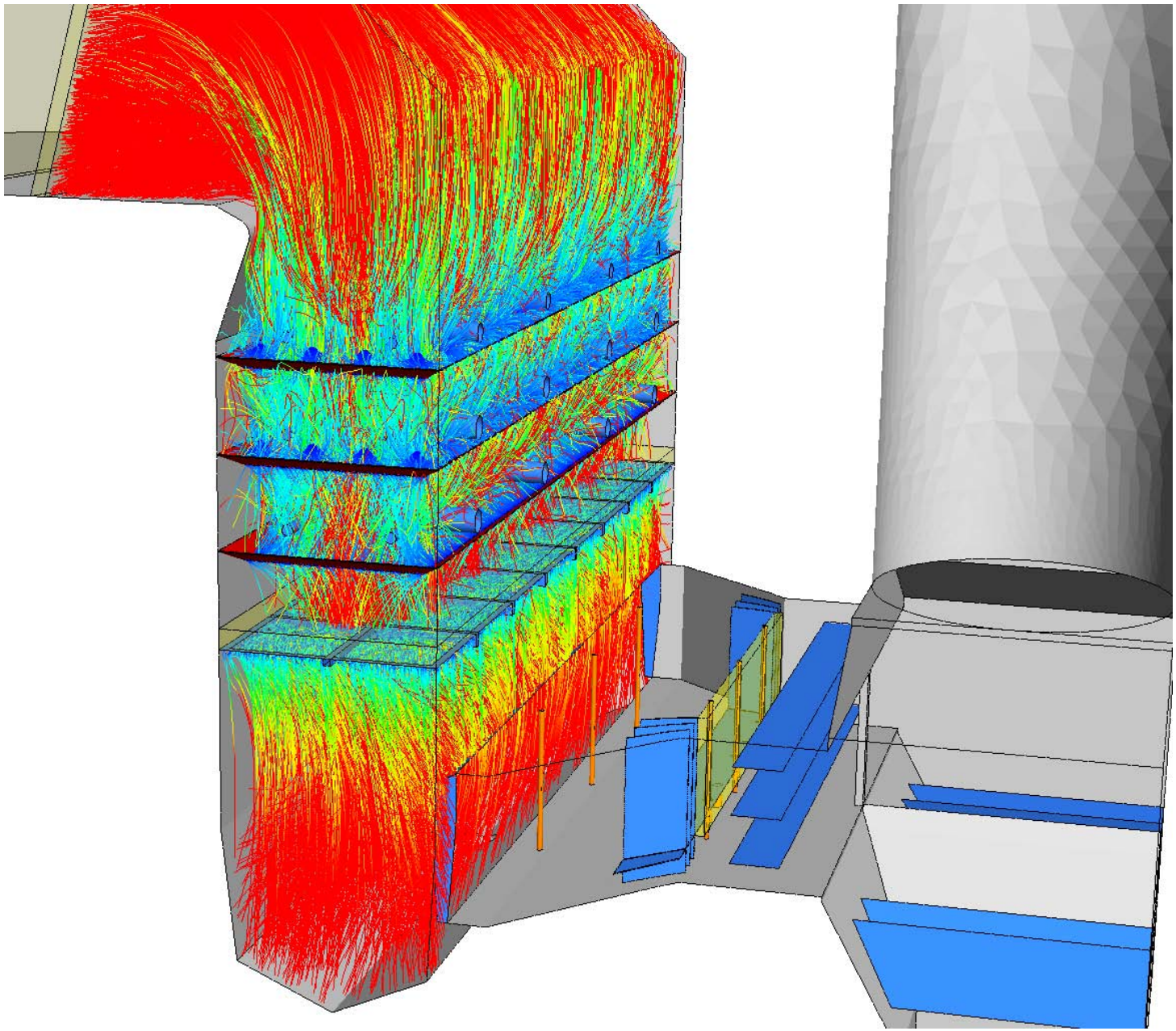
Upgrade Approach and performance

- Background
  - Riley scrubber
  - 1980
  - Medium sulfur
- Approach
  - New recycle pumps
  - Hexagonal tray
  - Spray header
  - DHC spray nozzles
  - 15 degrees slanted mist eliminator
- Performance
  - Increased SO_2 removal from 50 percent to 98 percent
  - High quality gypsum



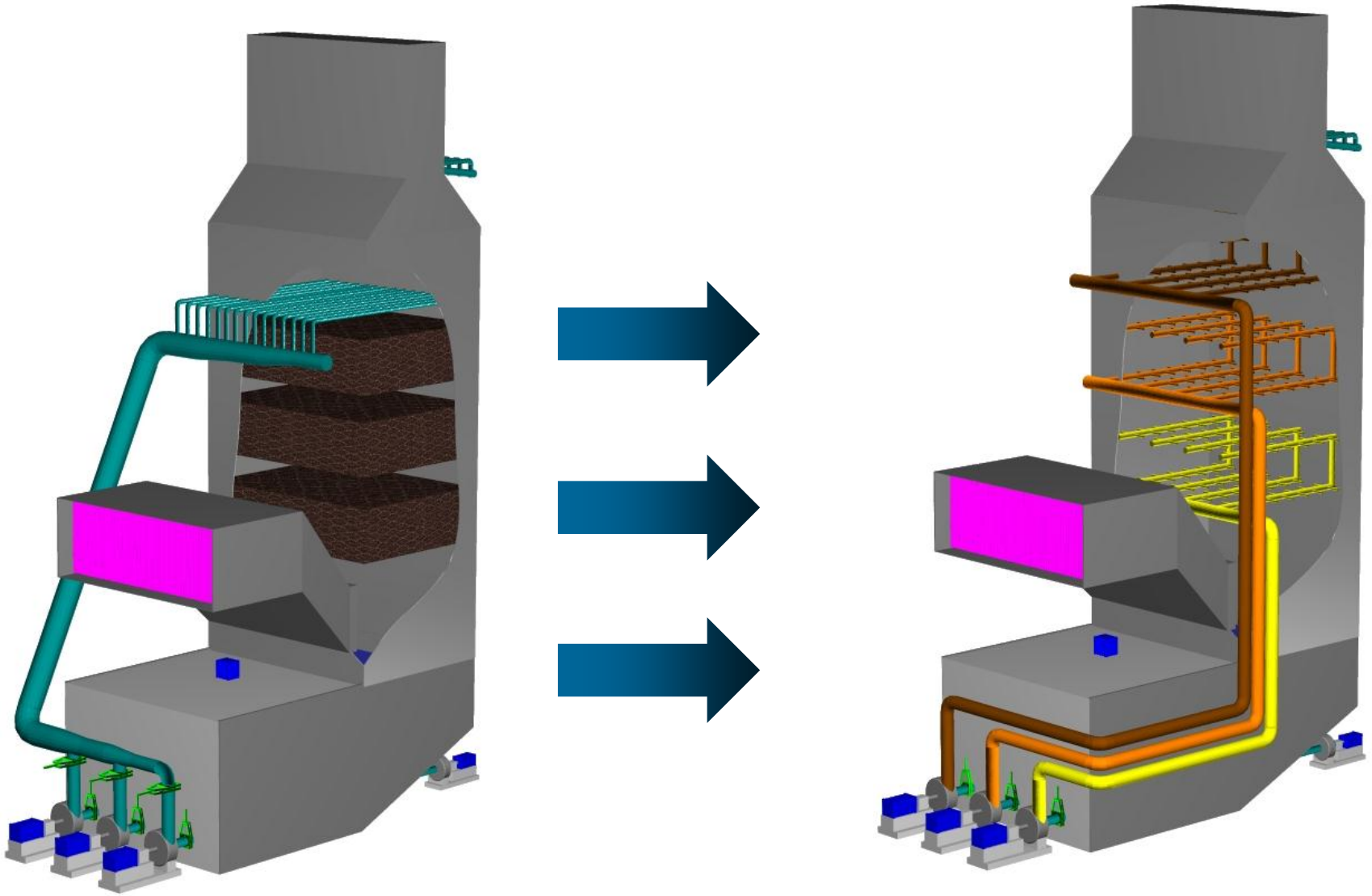
Copyright © 2012 URS

Slurry Droplet Trajectories



Copyright © 2012 URS

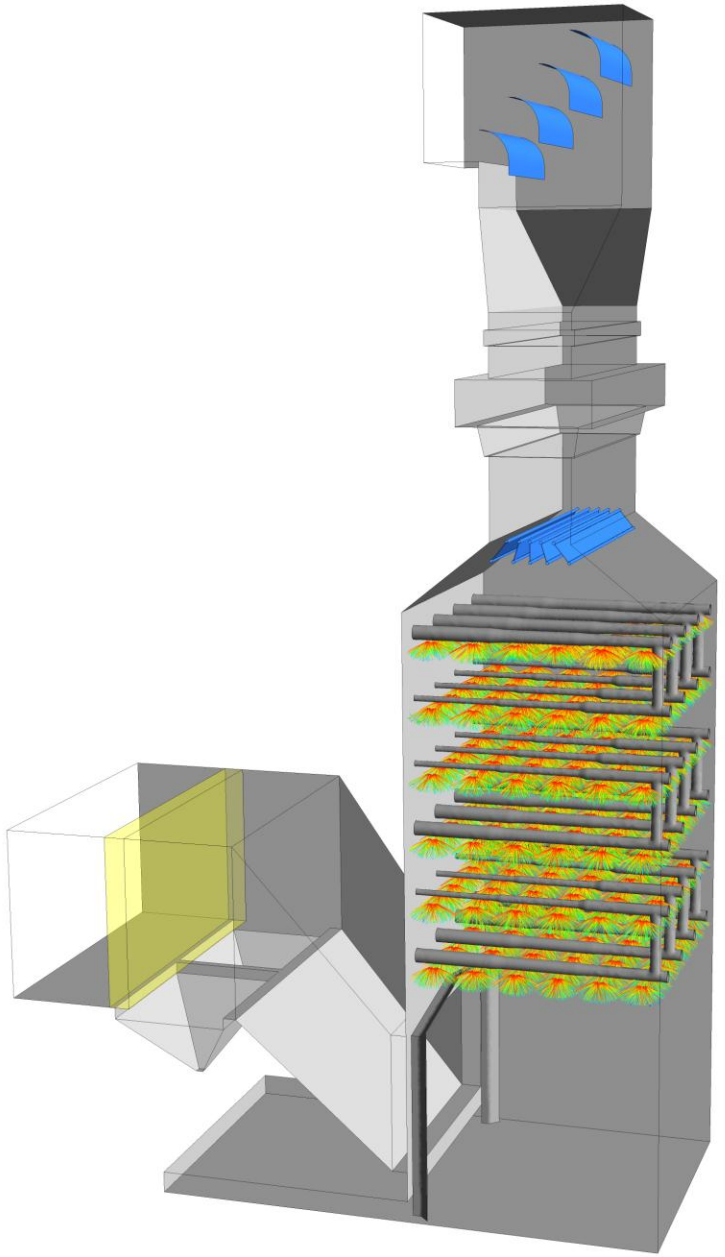
Co-current Packed Scrubber



Copyright © 2012 URS

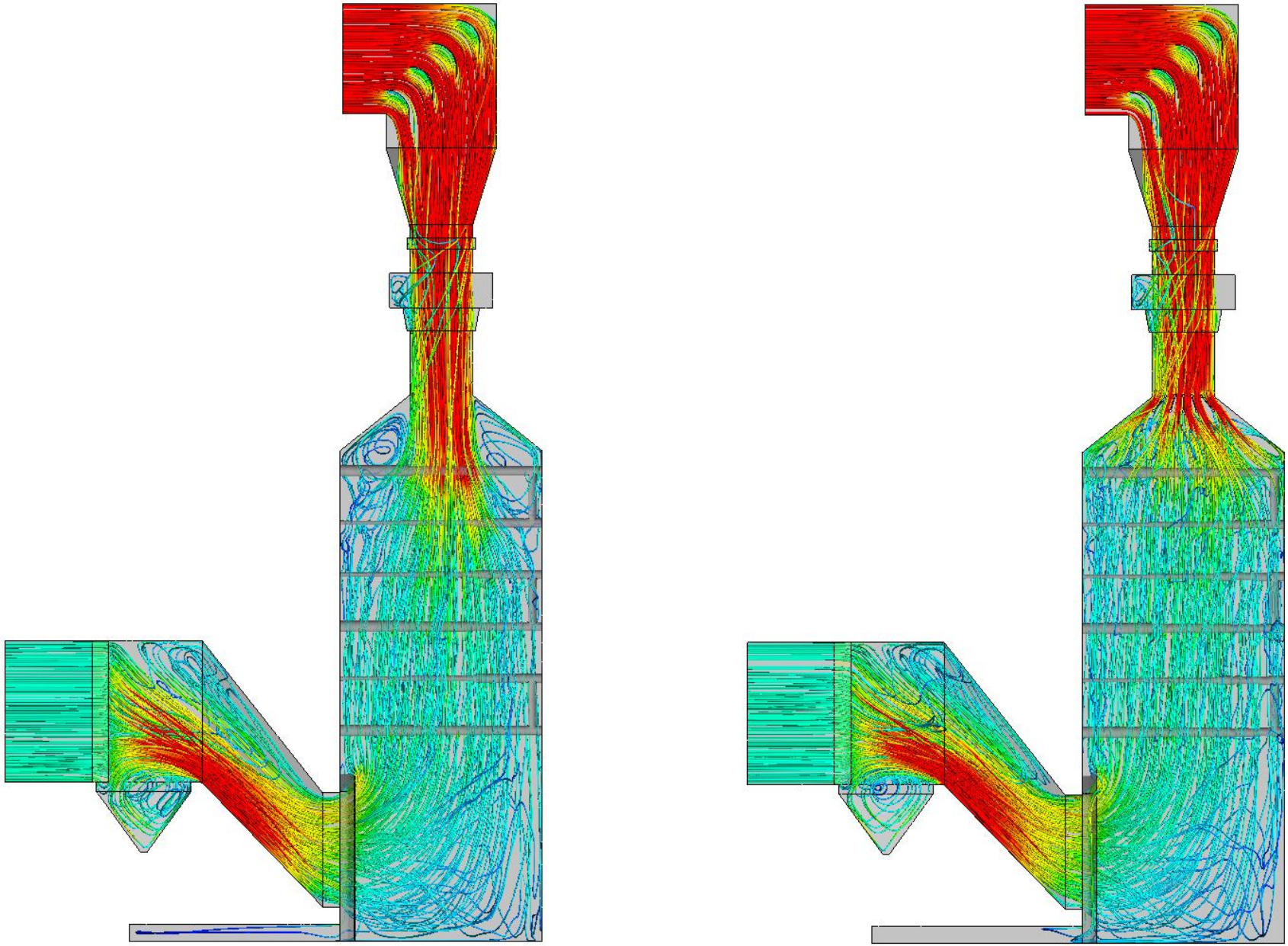
Upgrade Approach and performance

- Background
  - MHI Scrubber
  - 1975
  - High sulfur coal
- Approach
  - New recycle pumps
  - Replaced packing with co-current spray headers
  - DHC spray nozzles
  - Two-stage mist eliminator
  - Forced Oxidation
- Performance
  - Increased SO_2 removal from 90 percent to 99 percent
  - High quality gypsum
  - Pressure rise



Copyright © 2012 URS

Inlet Duct Gas Distribution



Copyright © 2012 URS