



Safer, Faster, and Cost-efficient
NDE Services

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The Big Problem with Plant Inspections

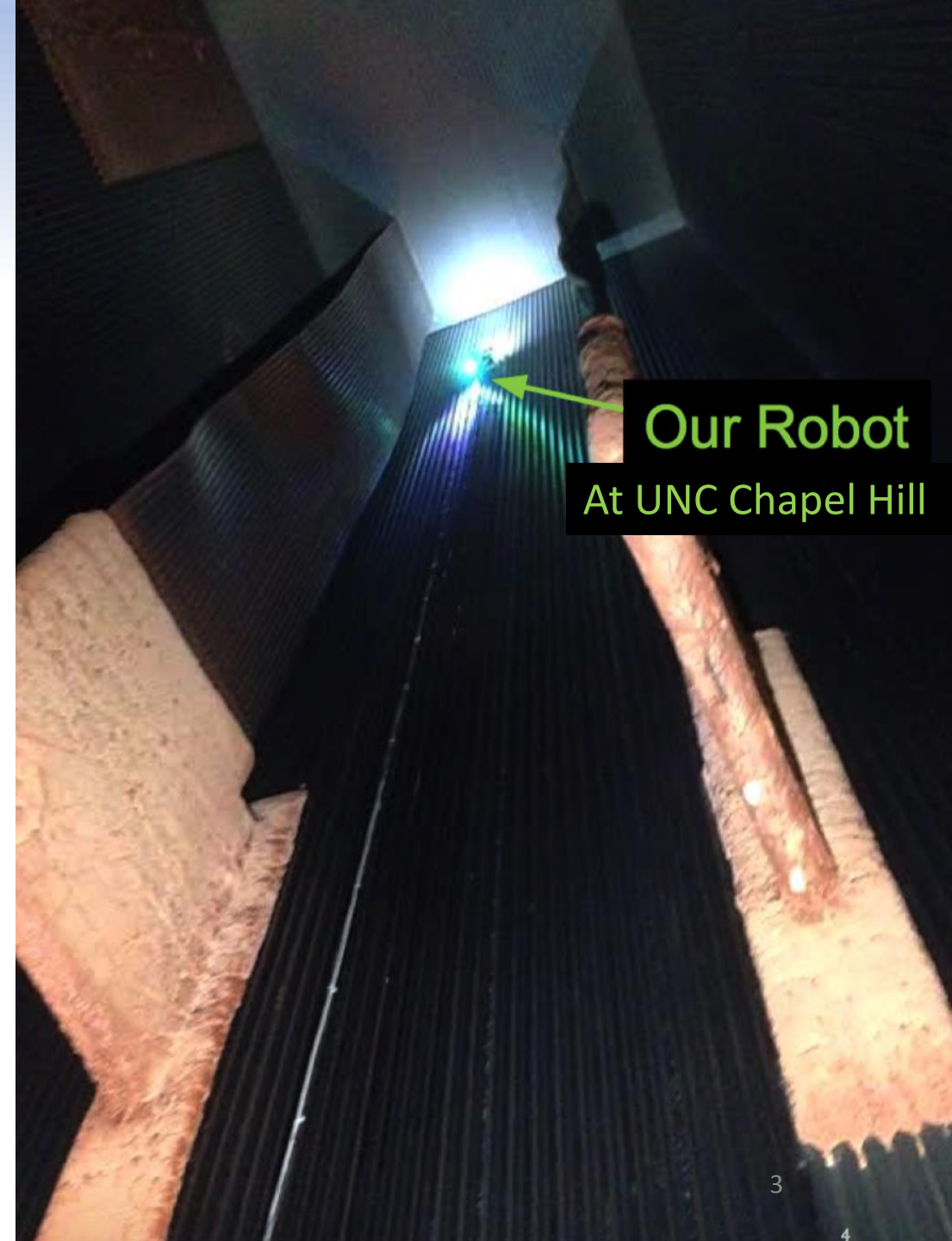
- **Downtime:** Inspections often take several days.
- **Costly:** It requires a team of inspectors and oftentimes expensive apparatus to access the boiler tubes.
- **Inaccurate:** Spot checking and human error result in poor information, damage to equipment, and forced outages.
- **Consistency:** Traditional inspections lack the ability to ensure the exact same locations are inspected from one outage to another and track changes in condition over time.

Solution

Wall Climbing Robots

Gecko Robotics provides complete **Ultrasonic**, **Coating**, and **Visual** inspections:

- ✓ In a fraction of the time,
- ✓ While reducing costs,
- ✓ 100% inspection coverage



Our Robot
At UNC Chapel Hill

Improving maintenance through robotics

- Customer specific inspection solutions
 - Erosion, Internal Corrosion, and other Degradation
 - Variation in structure & surface finishes
- Cloud based data storage
 - Track year over year inspections with online database and delta comparison



Case Study 1: Boiler Inspection with NO Scaffolding

Customer: Schuylkill Generating Station

Location: Pennsylvania

Boiler: 80MW CFB Combustion Engineering

Inspection Team: 3 inspectors + 1 robot

Inspection Time: 1 Shift (12hr)

Access: Sky Climber

POC: Gene Dale, Maintenance Manager



Gene's Challenge – Inspecting his boiler

- **Improvements necessary in 3 areas:**
 - Cost
 - Time
 - Inspection report accuracy and quality

“It was simple, we had to reduce time and costs for our outage.” – Gene

“We always want better deliverable results. I always wonder about the areas between the elevations where they [Traditional Handheld UT Team] inspect.” - Gene

Case Study 1: Robotic Solution

- Solutions to improve in 3 areas:
 - **Cost** – Our robots could save on scaffold (nearly \$100k) and still match the cost of traditional inspections (\$30k).
 - **Time** – Our robots could complete the inspection in 1 shift. Typically, with scaffold in place, this took them 5 shifts.
 - **Inspection report quality** – Our robots would inspect ~100% of the boiler walls collecting over 2 million data points. Previous inspections at Schuylkill captured <1% (or 5k data points).

Case Study 1: Performing the Inspection

- Performed an Ultrasonic & Visual inspection with **100% Wall Coverage**
- Provided inspection report with thickness readings at **every ½ foot elevation**
- Inspection revealed **5 critical areas** where grind, weld, and coating repairs were needed

Height	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6	Tube 7	Tube 8	Tube 9	Tube 10	Tube 11
35.5'	(	187	185	192	197	194	194	194	199	163	174
35'	(	188	184	194	198	191	193	198	202	168	172
34.5'	(	195	187	192	193	194	190	194	202	191	194
34'	(	194	194	197	192	192	185	191	200	194	191
33.5'	(	197	196	198	191	190	174	194	199	194	194
33'	(	196	196	197	194	191	172	195	196	196	195
32.5'	(	195	195	197	194	191	170	184	196	191	193
32'	(	191	194	194	190	188	160	179	184	184	193
31.5'	(	192	194	194	192	188	167	175	170	177	177
31'	(	192	194	195	195	170	165	170	170	170	196
30.5'	(	194	191	193	184	174	156	166	174	174	191
30'	(	198	194	195	170	180	152	156	159	163	177
29.5'	(	193	195	194	174	152	156	144	163	167	170
29'	(	194	174	192	170	149	145	139	145	149	152
28.5'	(	176	176	194	174	149	139	137	141	146	146
	TUBE #	2	3	4	5	6	7	8	9	10	11
	MIN	176	174	187	170	149	139	137	141	146	146
	MAX	198	196	198	202	202	199	198	208	196	196
	AVG	191	189	194	190	183	173	179	183	175	181

Color Coding:

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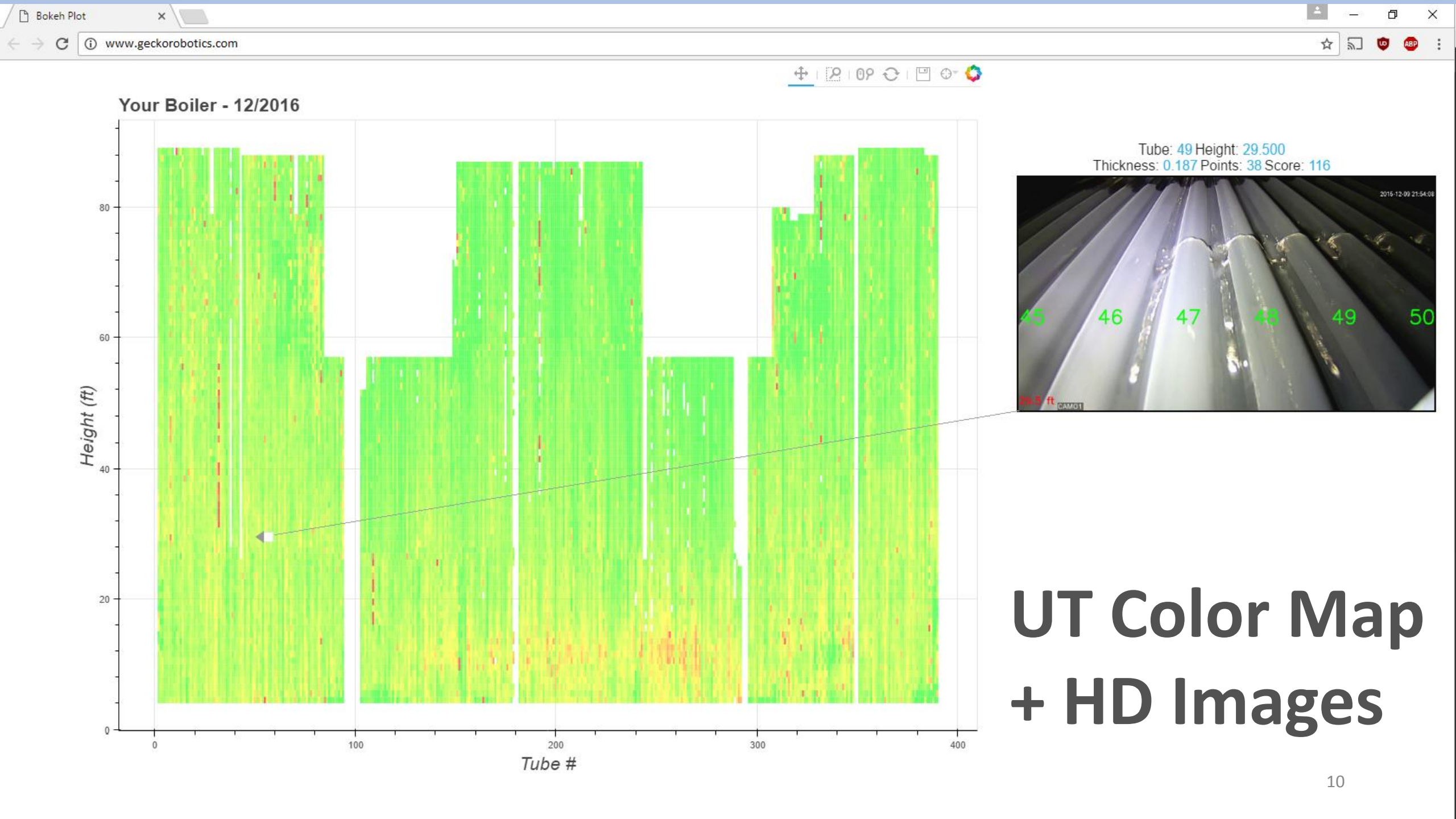
141 - 180

181-260

Case Study 1: The Deliverable

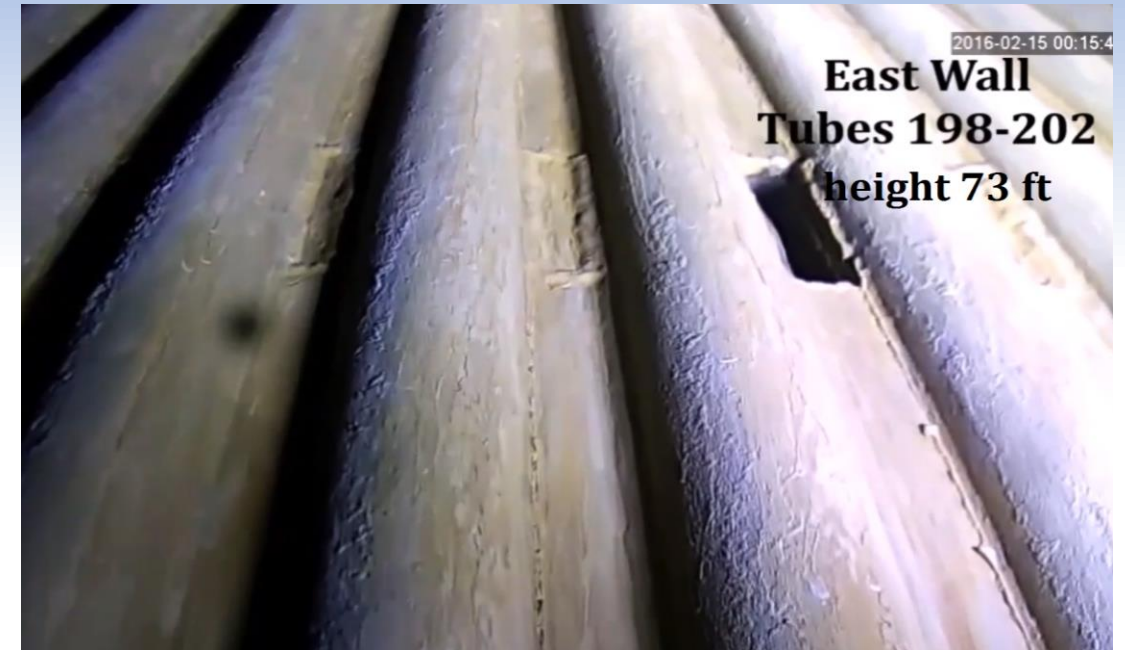
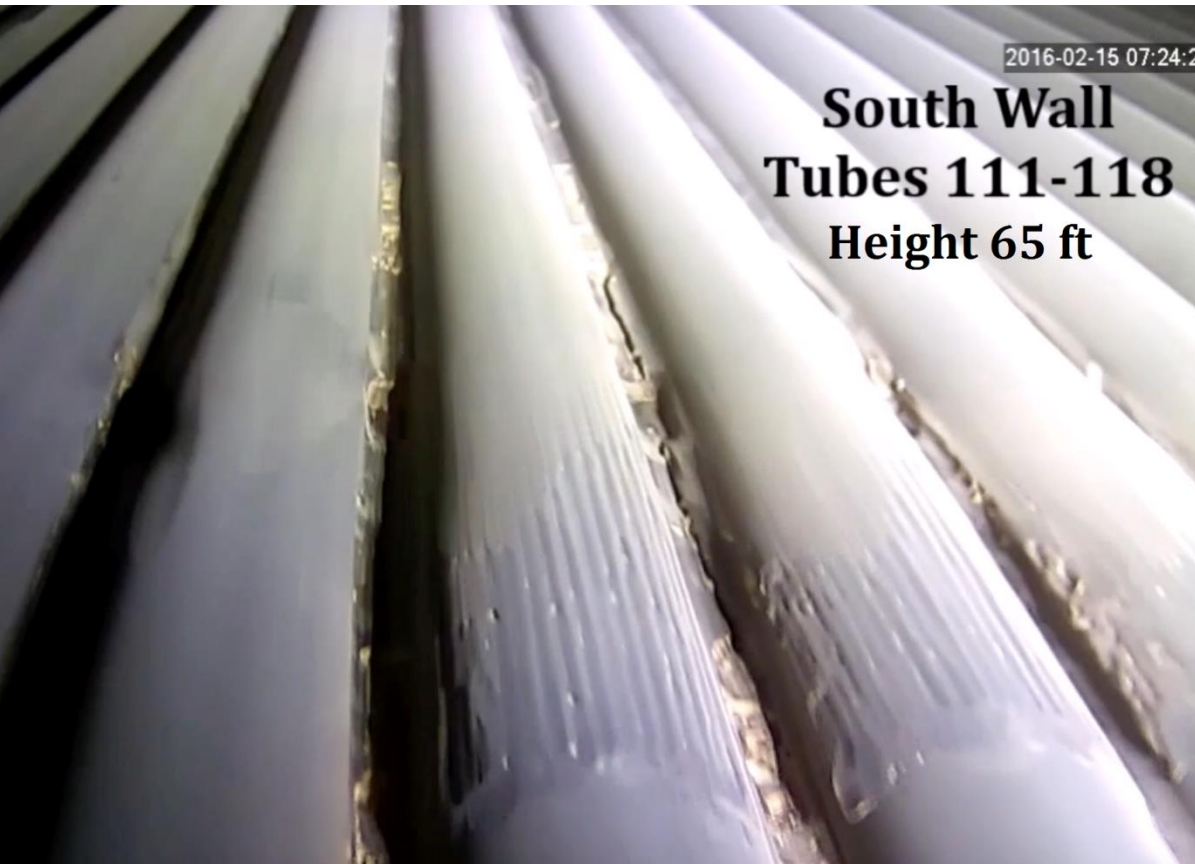
What Gene received:

- ✓ Cloud based storage for easy retrieval and sharing (next slide)
 - a) 3-D map of thickness readings
 - b) HD visual images
- ✓ Traditional Excel document



Case Study 1: HD Visual Inspection

- Real-Time, HD Video and detailed images of issues are mapped throughout boiler



Case Study 1: Schuylkill Results

1. Cost Savings: **80.5% total savings**

Traditional Inspection Cost: \$39,000 & \$100K+ in scaffold

Gecko Inspection Cost: \$27,000

2. Time Savings: Reduced inspection time by **3 days**

Saved 2 days on the inspection + 2 days for scaffolding setup/tear down

3. Better Insight: **Targeted repairs** were made using Sky-climbers

“Gecko Robotics provided me with an unparalleled inspection report in a fraction of the time and cost of any other inspection to date.”

- Gene Dale, Operations Manager

Case Study 2:

UNC Chapel Hill

Location: North Carolina

Boiler: 30MW CFB Combustion Engineering

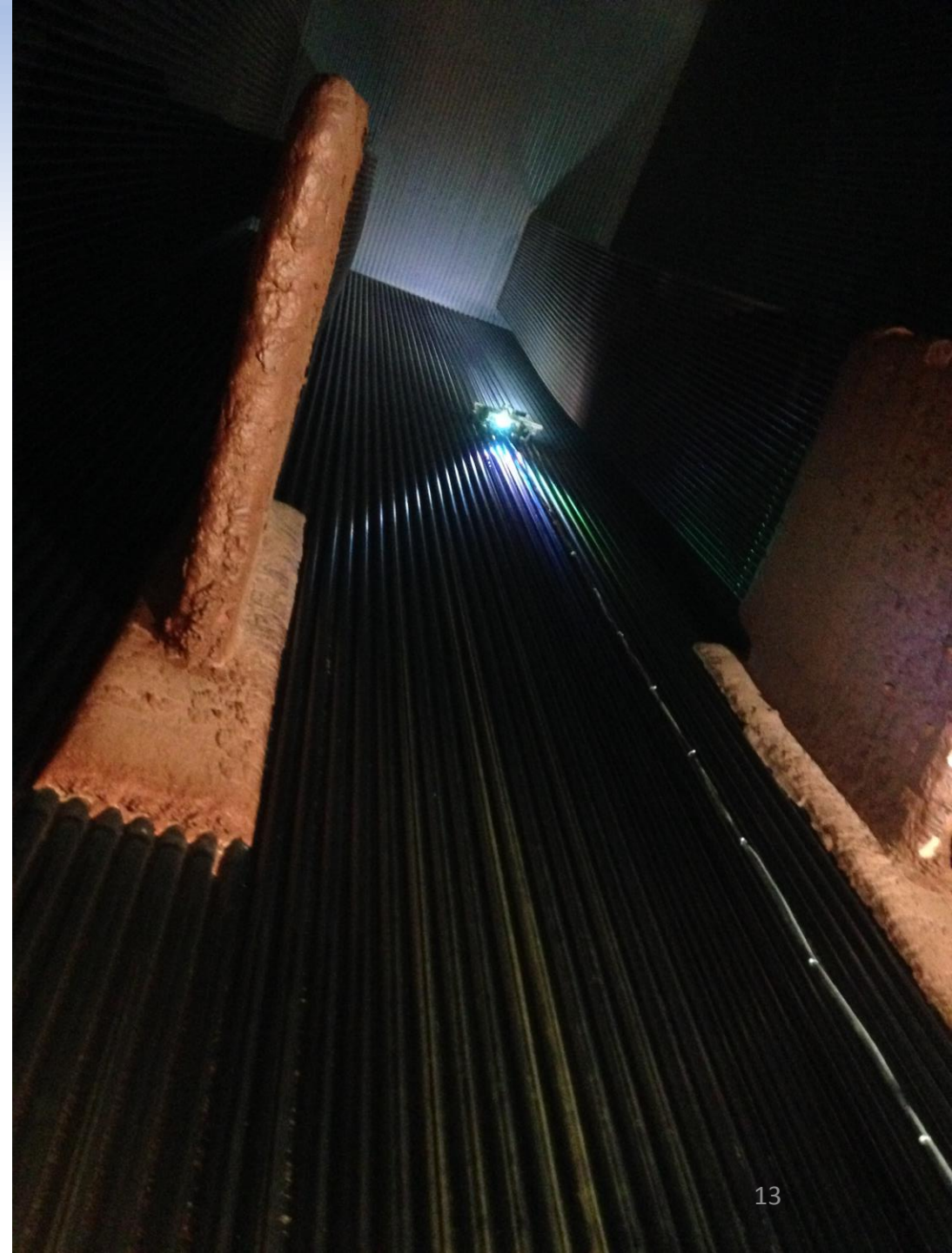
Inspection Team: 3 inspectors + 1 robot

Inspection Time: 2 Shifts

Access: Scaffold to the refractory/tube interface

POCs: Bill Lowery, Plant Manager

Glenn Hahn, Maintenance Manager



Case Study 2: Chapel Hill Results

- The inspection was completed in 2 shifts, with total costs under \$30k.
- The inspection reports showed some wear patterns from initial stages of erosion but there were no major issues to be repaired.
- UNC Chapel Hill used us for both their spring and fall outages.

Case Study 3: Boiler Inspection with Scaffolding

Customer: Ingredion

Location: Illinois

Boiler: 110MW Foster Wheeler

Inspection Team: 5 inspectors + 2 robots

Inspection Time: 1.5 Shifts (16hrs total)

Access: Full Scaffolding



Scaffold clearance 7"

Case Study 3: Ingredion Results

Manual inspection vs Robotics inspection

- 110MW CFB Boiler with Scaffold on entire boiler

- **Manual Inspection company:**

- **Coverage:** 1 angle at 90°, every 7 feet, every tube = **<1% boiler coverage**
- **Time:** 8 inspectors, 6 shifts
- **Cost:** Full Scaffold (\$150k) + inspection team (\$50k) = **\$200k**

- **Robotic Inspection:**

- **Coverage:** 3 angles (90° & +/- 30 °), every inch, every tube = **100% boiler coverage**
- **Time:** 2 Robots, 5 inspectors, 1.5 shifts = **4x faster (not including scaffolding time)**
- **Cost:** \$40k = **80% Cost reduction**

“We have been convinced and have committed to using Gecko for the foreseeable future.” – Plant Manager

How it Works

How it Climbs:

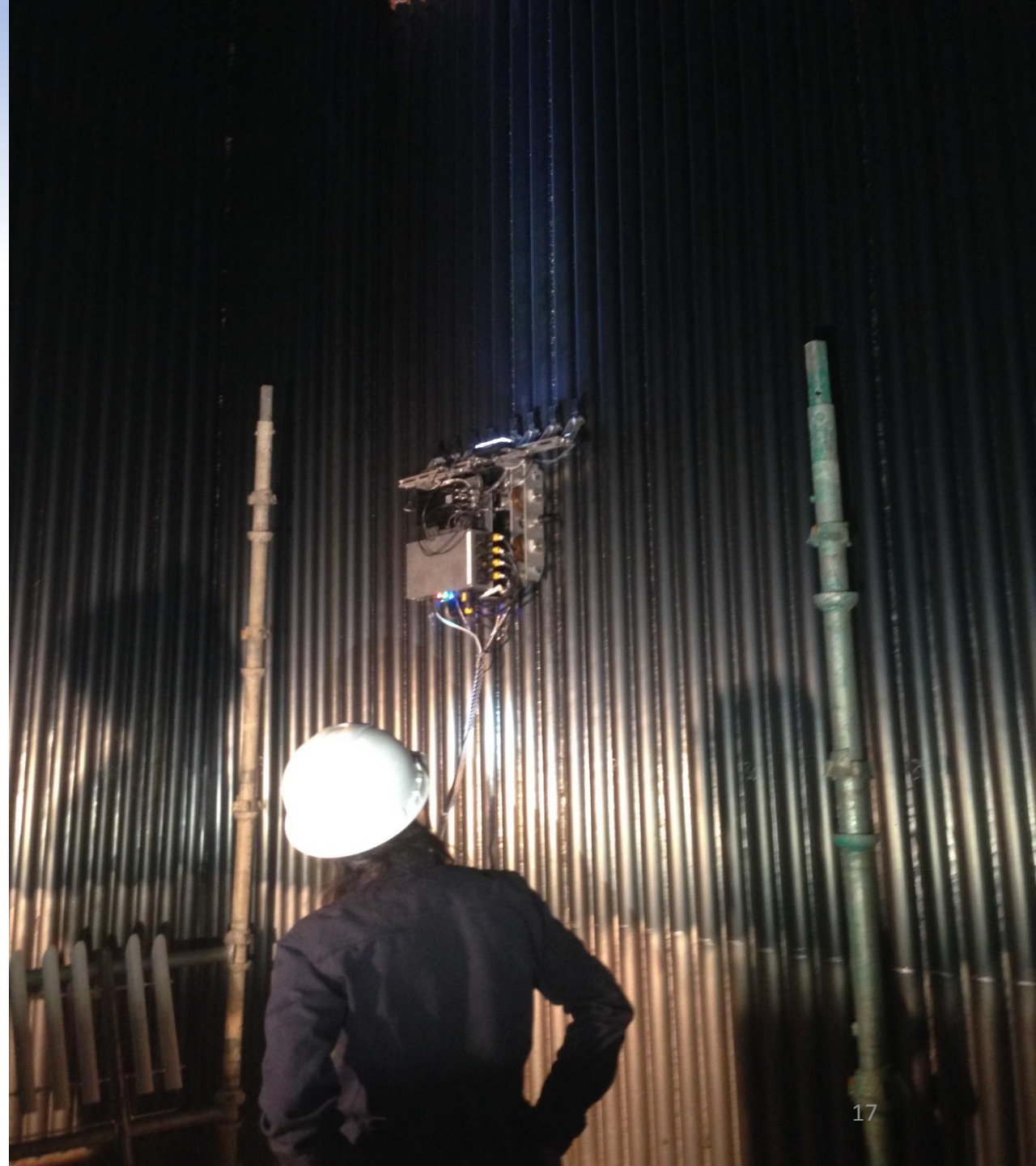
- Unique **hardware** design and magnetic adhesion

How it Inspects:

- Patented **Ultrasonic** probes
- Magnetic induction probes
- HD live **video** feed

How it Analyzes Data:

- Gecko Robotics **Software**



Inspection Methods

Ultrasonic Tube Thickness Measurement

- Detects multiple forms of degradation
 - Tube Leaks
 - Erosion
 - Corrosion
 - Pitting
- 8 ultrasonic sensors scanning 8 tubes at once
- 3 angles on each tube
- Calibrated measurement readings every inch

Magnetic Lift-Off Coating Thickness Measurement

- Magnetic Induction (pull-off)
- Detect thickness between 0 - 60 mils
- Ability to measure thickness before and after coating is applied
- 8 probes scanning 8 tubes at once
- Calibrated measurement readings every inch

High Density Video Record Of Wall Conditions

- HD photos indexed and easily accessible by a click of the mouse on a map of the wall
- Video recording is done simultaneously with the thickness measurements

Technical Specs

- Inspects **8 tubes** per run
- Climbs at **60ft/min**
- **Thickness** readings every 6"
- Inspect different **angles**
- L x W x H 20" x 12" x 6" inches
- Weight 24.5 lbs
- Over **400lbs** of adhesion force
- Climbs over ½ **weld caps**
- Climbs over 5/16 **overlay/buildup**



Robot scanning tubes with only 7 inches of clearance between scaffolding

How we help Campus and Downtown Systems



Availability

- **Quick mobilization 2 inspectors + robot**

- Can inspect with and without scaffolding (**\$ Savings**)
- 30 minutes setup time once onsite



Safety

- **Remote robot handling reduces liability**

- Eliminate workplace injury and OSHA incidents (**\$ Savings**)



Speed

- **5x Faster than human inspection**

- Reduces Inspection Outage Time (**\$ Savings**)
- Data coverage at 60ft / min (8 tubes per run)



Coverage

- **100% Coverage, highly accurate Ultrasonic**

- Isolate issues and target repairs (**\$ Savings**)
- Traditional Excel spreadsheet
- HD visual inspection (tubes and membrane leaks)

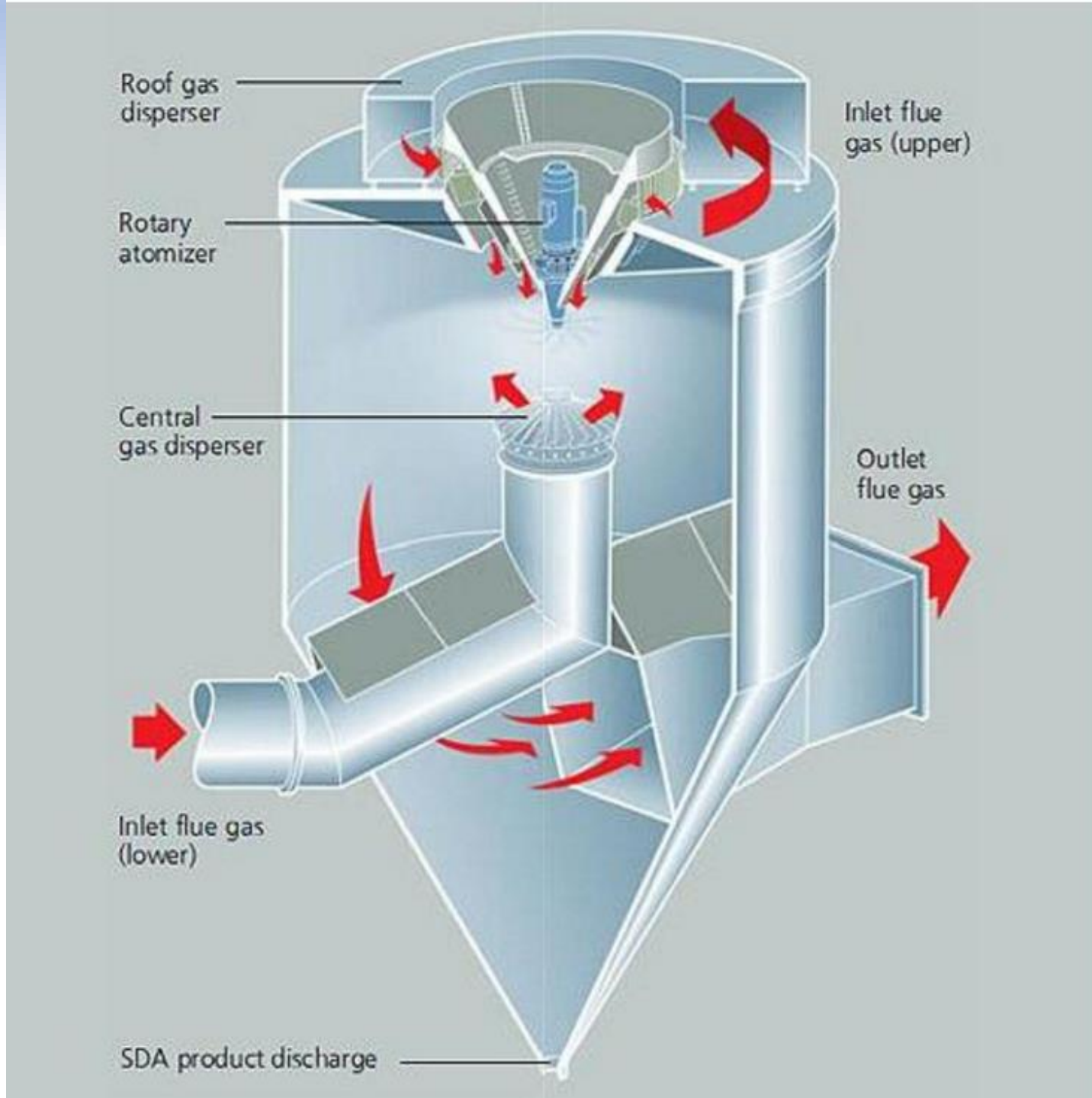
Spray Dryer Absorber

Access:

- Magnetic climbing adhesion to interior of SDA

What it Inspects:

- Ultrasonic, coating, and visual inspection of flue gas inlets, walls, welds



Tank Inspections

Access:

- Magnetic climbing adhesion to interior or exterior of tanks

What it Inspects:

- Ultrasonic and visual inspection of tank floor, tank shell, tank roof, annular ring, welds



Pipe Inspections

Access:

- Horizontal Crawler through piping / tunnel

What it Inspects:

- Ultrasonic thickness measurements and HD visual inspection

Requirements: 1' diameter.
1.5' diameter with 90° turns.

High Energy Steam Pipe



Circulating Water Tunnel



Frequently Asked Questions

- Q: What is the sonic couplant that is used? And how much is required?
- A: Tap water, about 1 quart per minute. Water provided by Gecko portable tank and pump or directly from a plant water line.

- Q: What other plant utilities are required?
- A: Single Phase 120 Volts AC, 20 Amps

- Q: How about a hole watch?
- A: We can use the plant's or arrange for our own.

- Q: How is the inspection completed and robotic crawler operated?
- A: 1 inspector operates the robot and a 2nd inspector reviews the inspection data as it is collected on our computer platform.

- Q: Can you take readings at multiple angles?
- A: Yes, the probes are adjusted and traverse the wall for each angle – usually on the center face, and +/- 30 degrees off center.

- Q: Are the coating thicknesses measured on the same traverse as the tube thicknesses?
- A: No, the ultrasonic probes are changed out for magnetic induction probes. Both sets of readings are overlaid in the same deliverable to display both tube thickness and coating thickness measurements.



We are ready to work with you



- **5x** Faster
- **100%** Inspection Coverage
- **Safest** Inspection
- Average 50% **cost reduction** per inspection



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Located in Pittsburgh, PA