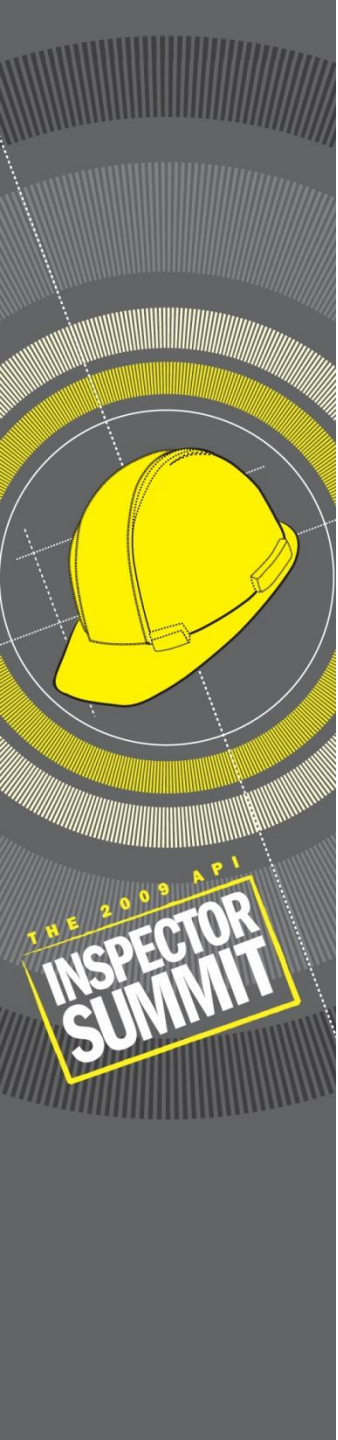


Protecting Your Investment with Refractory Inspection

by Jim Allen



Jim Allen – API 936 Level I IR

- Began working in the masonry and refractory trades in 1965 Bricklayers Local 7 Houston Texas.
 - Working specifically in refractory inspection for five years
 - Began inspection with Bob Beaver – PRI on the west coast.
 - PRI was purchased by Conam – Mistras Services in 2007

Current job

- COE of Refractory Inspection for Mistras Services - Conam
- Developing a complete refractory inspection training and recruiting program nation wide



Setting the Tone

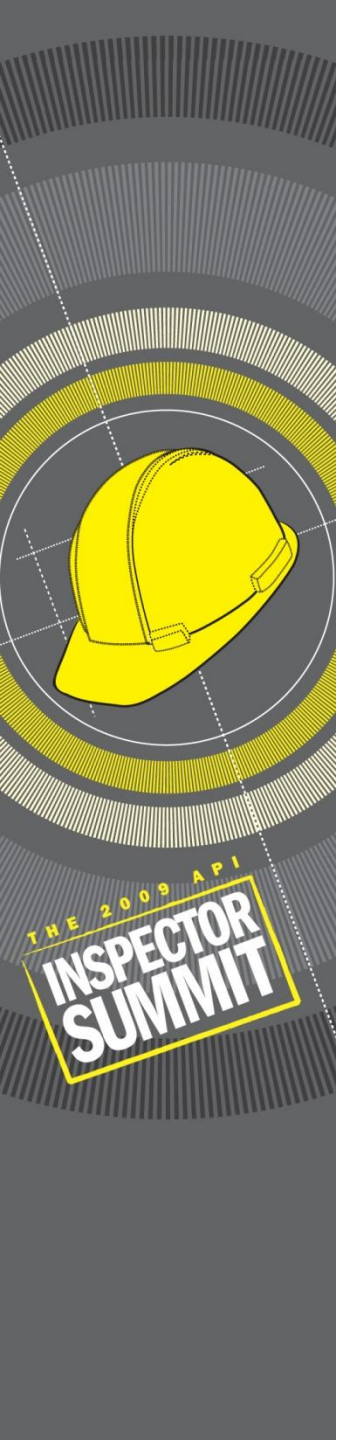
- Have a clear understanding of the purpose of refractory and how to inspect it.
 - Definition of Refractory
 - Steps of Refractory Inspection
 - Tools of the Trade
 - Pitfalls
 - Reporting



Setting the Tone

■ Sources

- Harbison-Walker "Petroleum & Hydrocarbon Processing Application Handbook" 2008
- Harbison-Walker "Handbook of Refractory Practice" 2005
- OSHA "Technical Manual on Petroleum Refining Processes"
- Sonny James "The fundamentals of Refractory Inspection with Infrared Thermography"
- API Recommended Practice 936 Second Addition



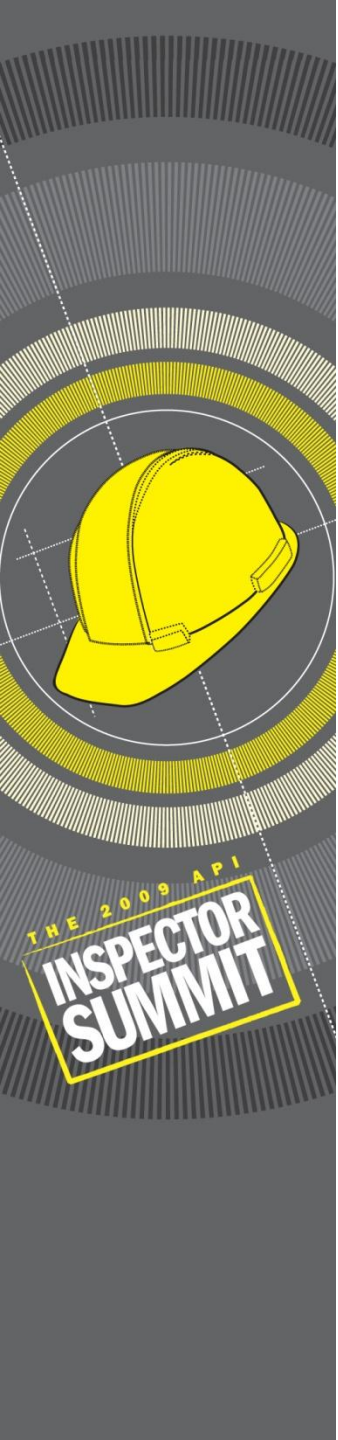
Definition of Refractory

Refractory – Latin *refractorious*

- Resistant to control
- Stubborn
- Resistant to change
- Substance resistant to heat

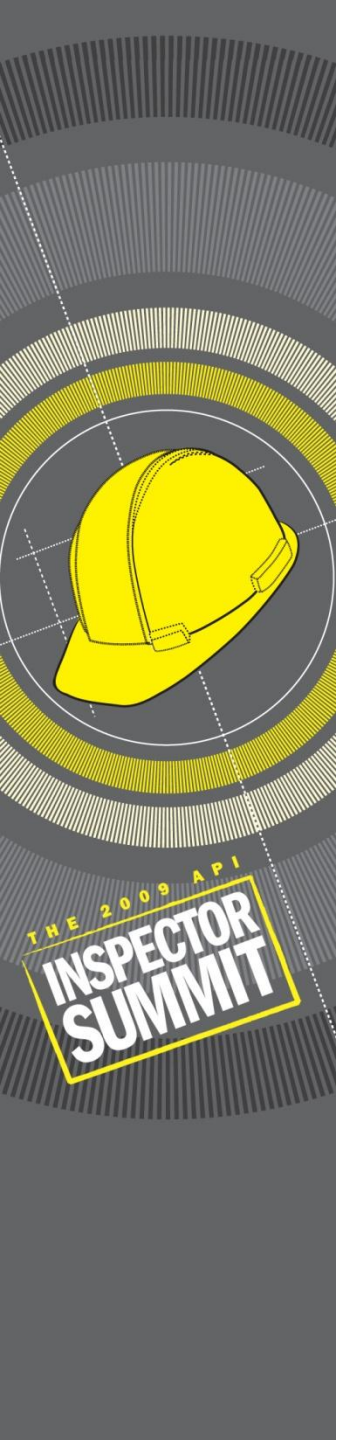
Types of Refractory as used in Petrochemical Environment

- Brick
- Castable
- Gunitite
- Plastic
- Ceramic Fiber



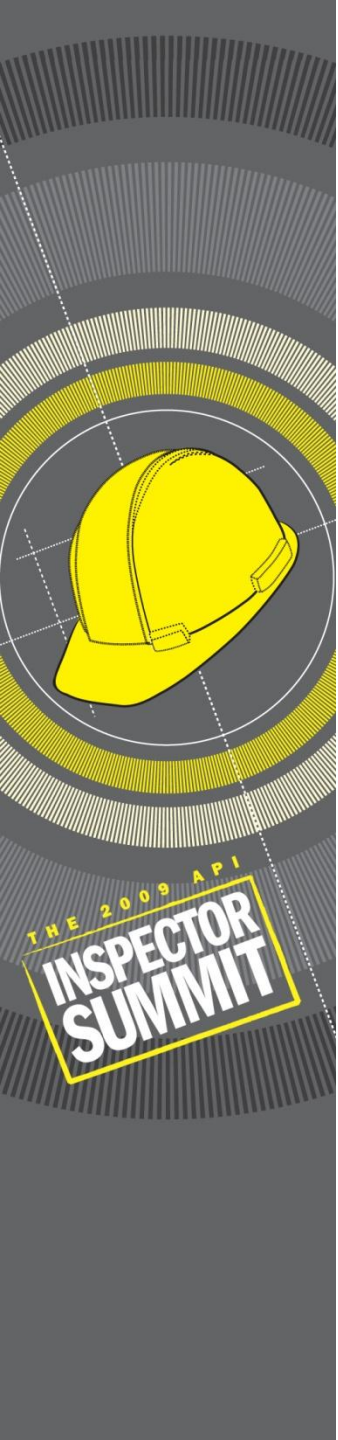
Purpose of Refractory

- To Insulate
- To Resist Abrasion
- To Protect from Erosion



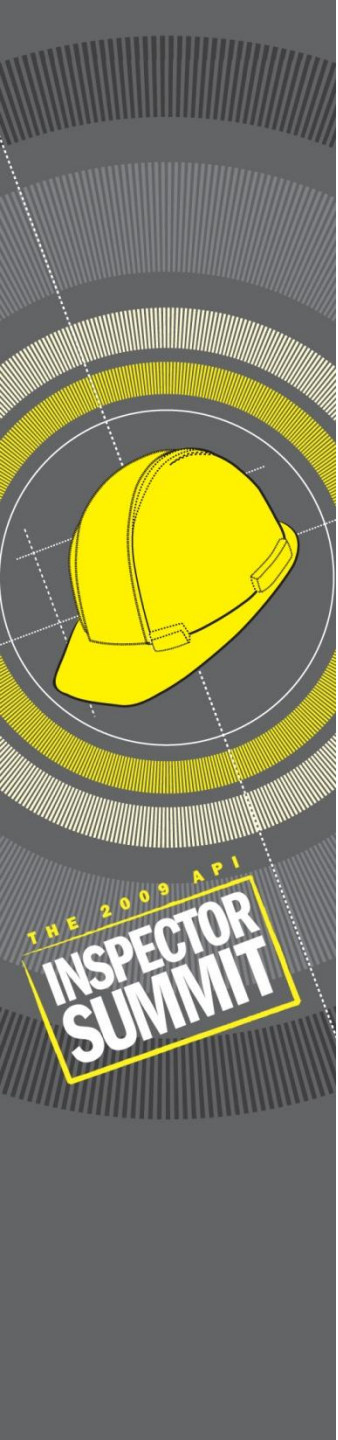
What's Involved in Refractory Inspection?

- Qualifying the Material
- Preview the Refractory Needs
- Review the Installation Procedures
- Qualifying the Installers
- Preliminary Inspection and Markup
- Repair Recommendations



What's Involved in Refractory Inspection? *continued*

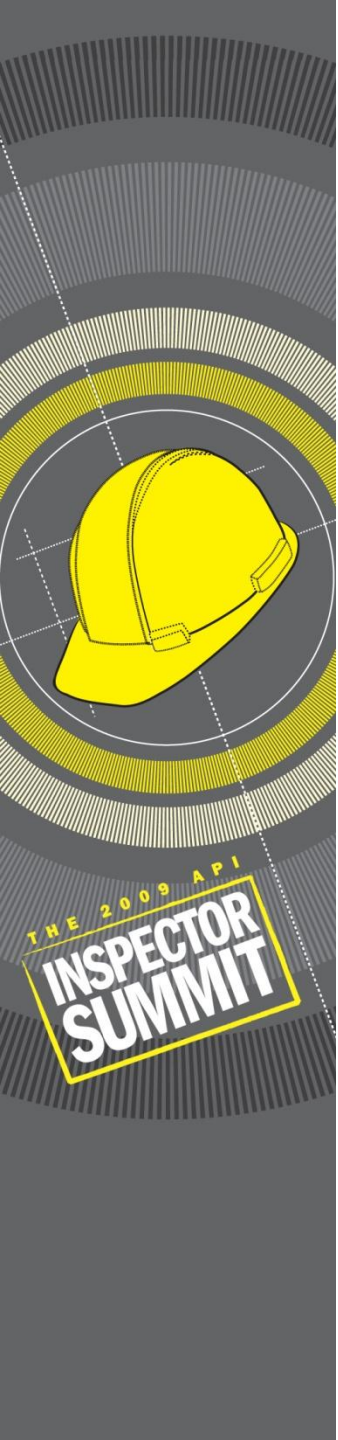
- Inspecting the Tear Out and Surface Preparation
- Anchor Layout and Welding
- Refractory Installation
- Sample Handling
- Dryout
- Turnaround Report



What's Involved in Refractory Inspection?

Qualifying the Material

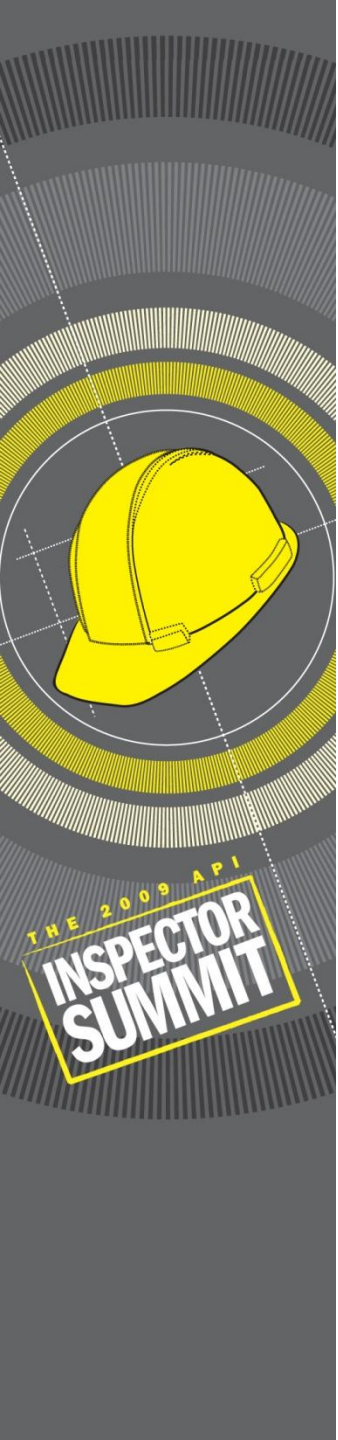
- Clients Discretion
- Very important
 - All Mixes are Not the Same
 - Percentages of Key Ingredients Can Vary
 - Bag Weights Can Vary
- Confidence in the Material Quality
 - You Can Concentrate on Installation
- Resolves Conflicts if Turnaround Samples Fail



What's Involved in Refractory Inspection?

Previewing the Refractory Needs

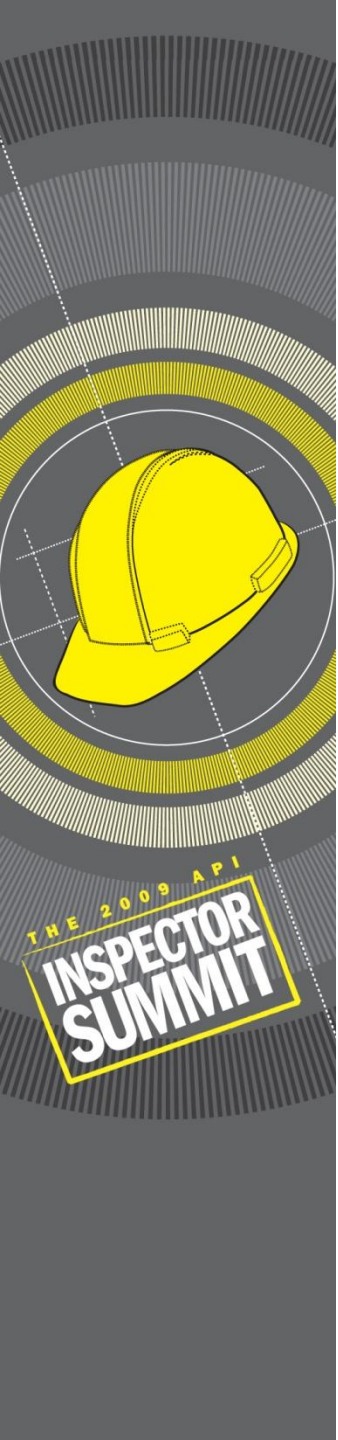
- What type of Sampling Does the Client Expect?
- Review the Infrared Scans (hopefully they are yours)
- Read the Vessels Inspection History
- Look at the Vessel Drawings



What's Involved in Refractory Inspection?

Review the Installation Procedures

- What are the Job Steps?
- Equipment to be Used
- Water Source
- Mixing Station Proximity to Work Site
- Welding Procedures
- Mixing Procedures
- Weather Prepared



What's Involved in Refractory Inspection?

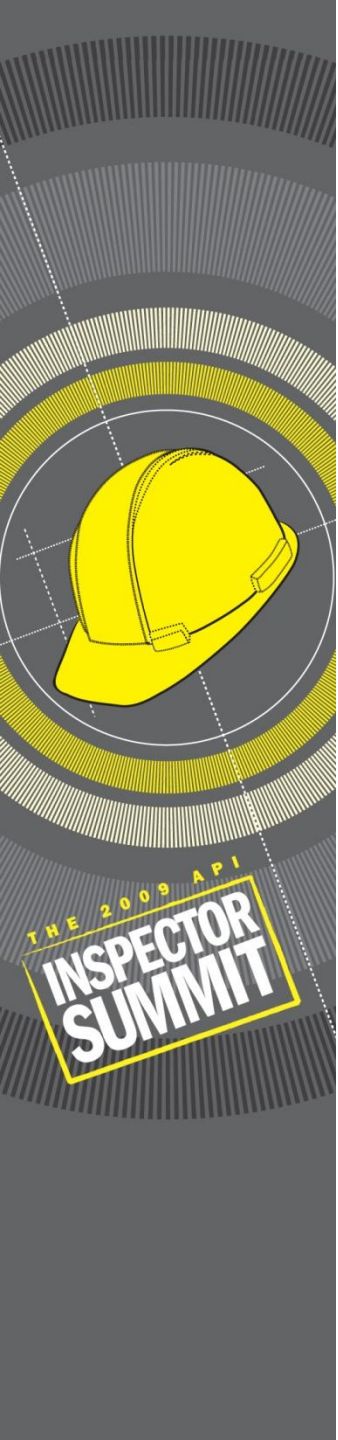
Qualifying the Installers

- Why

- Competency Level
- Observe Equipment Use and Installer Technique

- How

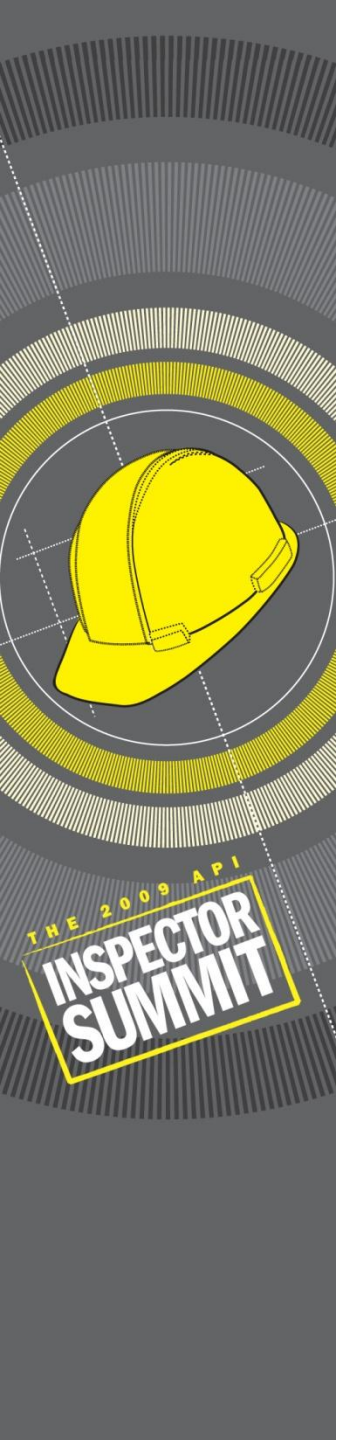
- Simulate Working Conditions
- Gunning a Panel
- Ramming a Sample
- Mock Up of a Casting



What's Involved in Refractory Inspection?

Preliminary Inspection and Mark Up

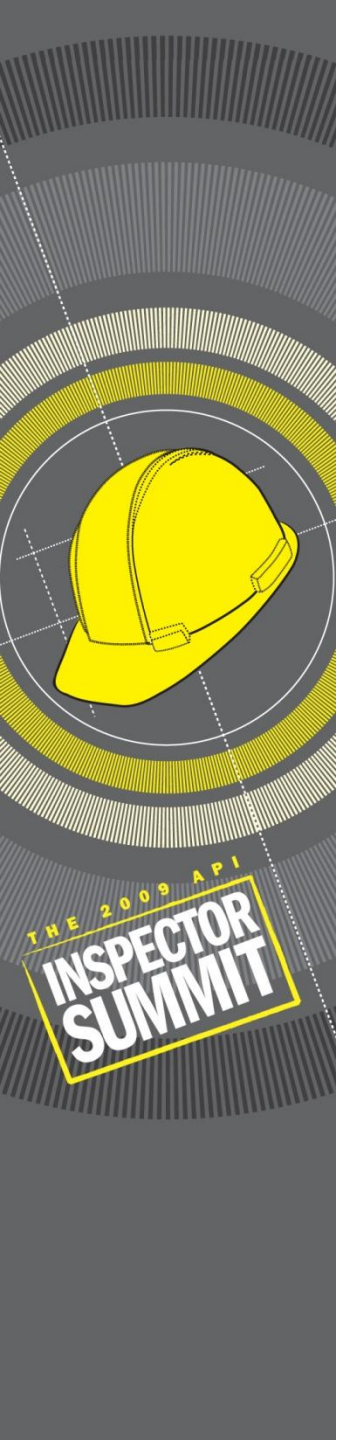
- What is the Client Wanting?
 - What Length of Run are they Expecting?
 - What are the Future Plans for the Vessel?
 - Are There Any Operational Changes Planned?
- Accessibility
 - Safety! Safety! Safety!
 - Scaffolding to All Areas
 - Looks Can be Deceiving



What's Involved in Refractory Inspection?

Preliminary Inspection and Mark Up *cont.*

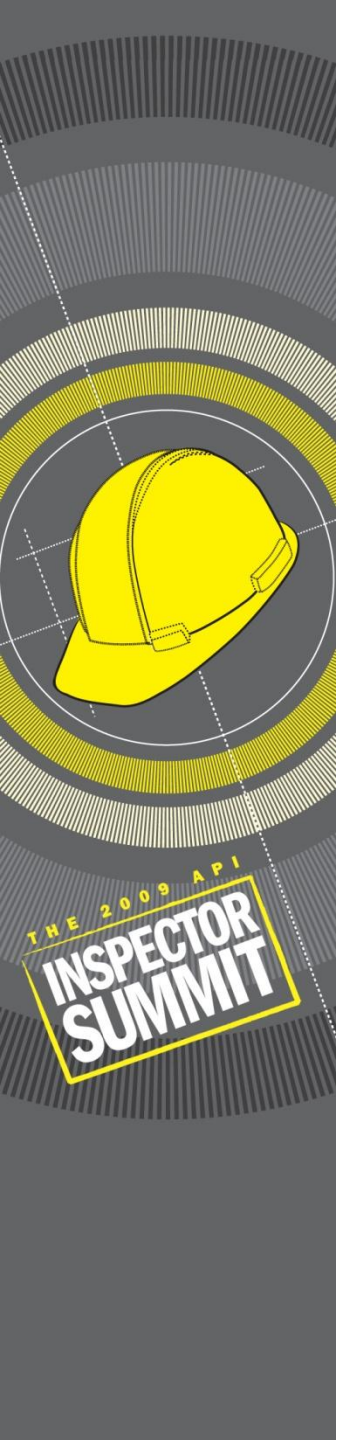
- Actual Inspection
 - Do a Walk Through if Possible
 - Remember the Hot Spots on IR Scan
 - Be a Detective
 - Hammer Test
 - Mark Precisely
 - Take Notes
 - Take Pictures



What's Involved in Refractory Inspection?

Repair Recommendations

- Surface Prep
- Type and Pattern of Anchors
- Welding Electrodes
- Type of Material
- Material Thicknesses
- Application Technique
- Hold Points for Inspection
- Approximate Square Feet
- Curing



What's Involved in Refractory Inspection?

Tear Out and Wall Preparation

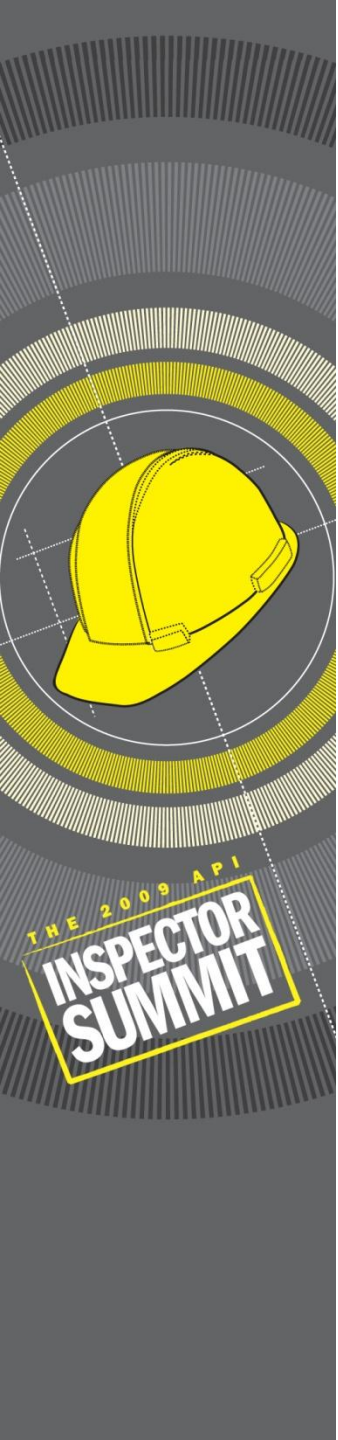
- Don't Confine Yourself to Your Marks
 - Additional Defective Refractory may be Exposed
 - Tear Out Can Cause Adjacent Refractory to Dislodge
- Key the Repair Areas
- Check the Surface Preparation
 - You Want it Clean



What's Involved in Refractory Inspection?

Anchors

- Anchors are Vitally Important
- Select proper size and Metallurgy
- Select Proper Layout for Application
- Is Pre-Heat Needed?
- Use the Correct Electrode
- Check the Welding
 - Visual
 - Hammer Test
 - Bend

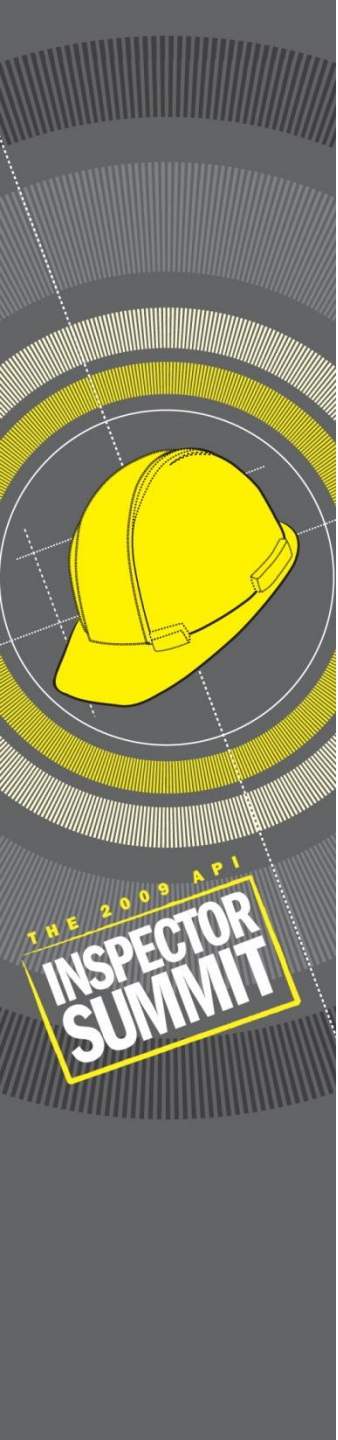


What's Involved in Refractory Inspection?

Refractory Installation

• Watch the Installation

- Check the Forms
- Is the Application Area Clean?
- Watch for Rebound
- Is the Timing Correct
 - Time Between Batches
 - Time From Mix to Use
- Is Curing Compound Being Applied



What's Involved in Refractory Inspection?

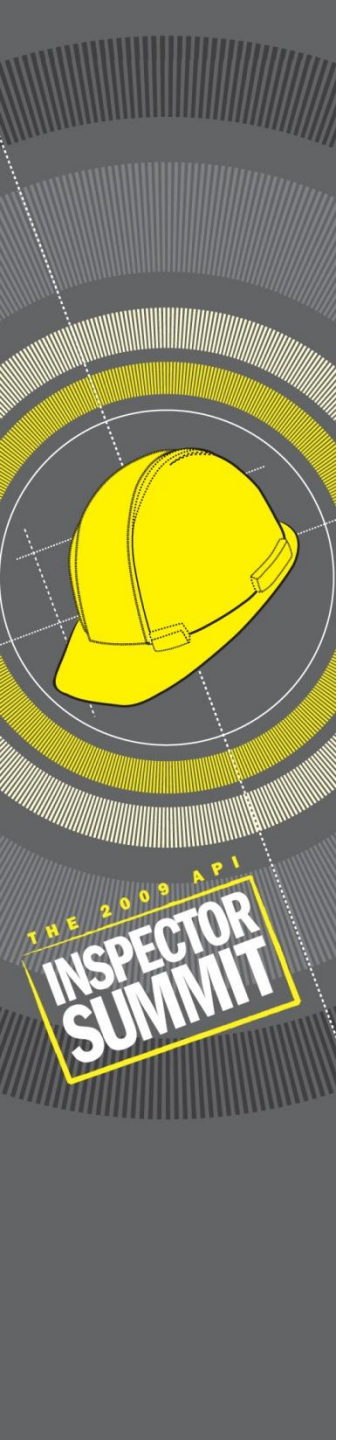
Refractory Installation – *continued*

•Watch the Mixing

- Is the Mixer Clean
- Does the Crew Have Written Mixing Procedures for the Material and Do They Understand Them?
- Are They Using the Correct Material
- Are the Batch Numbers and Production Dates Correct?
- Is the Water Amount Correct
- Is the Mixing Time Correct?

•Check Mixing Logs

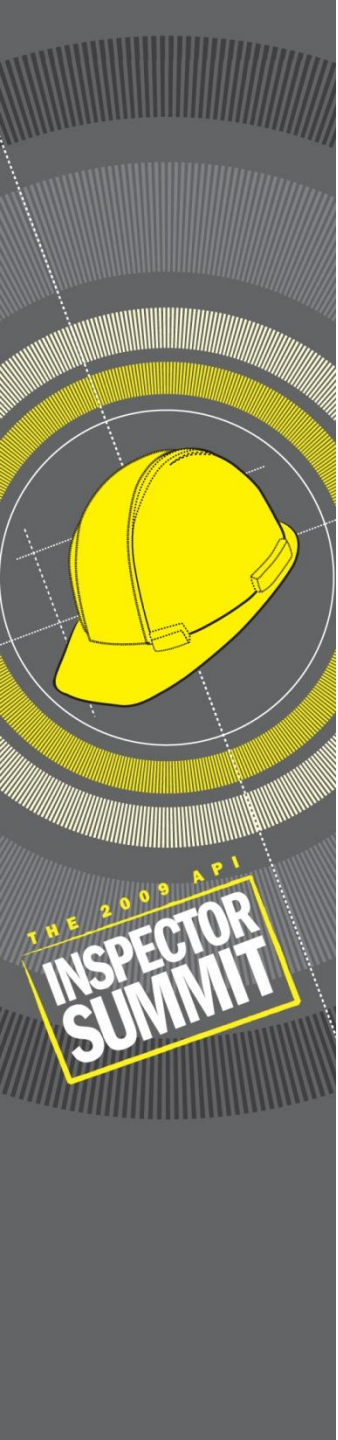
- Just Check Them



What's Involved in Refractory Inspection?

Refractory Installation – *continued*

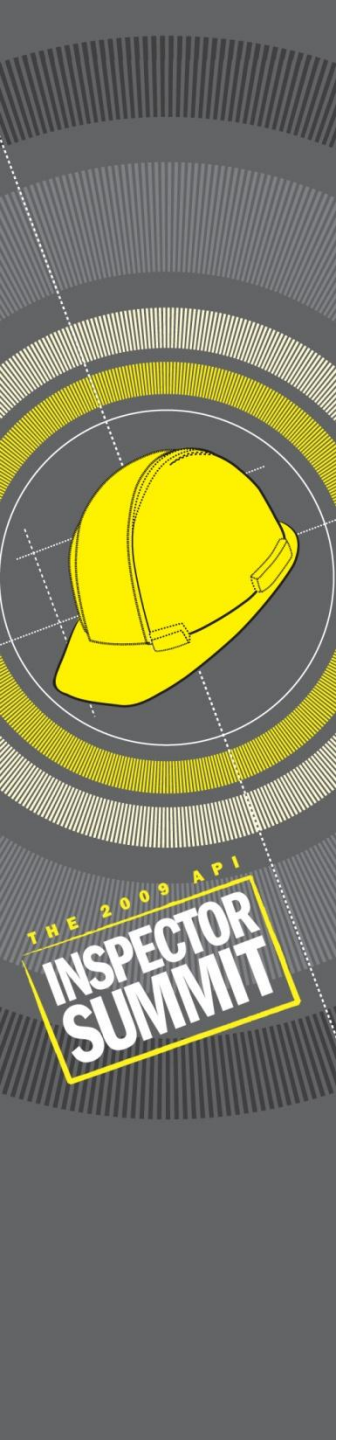
- **Sample Handling** – What Does the Client Want?
 - Are Samples Being Taken?
 - Are The Proper Size and Number of Samples Being Taken?
 - Are They Labeled?
 - Are Sample Locations Being Tracked?
 - Who is Responsible for Sending Samples for Testing and at What Frequency?
 - Monitor the Test Results



Dryout

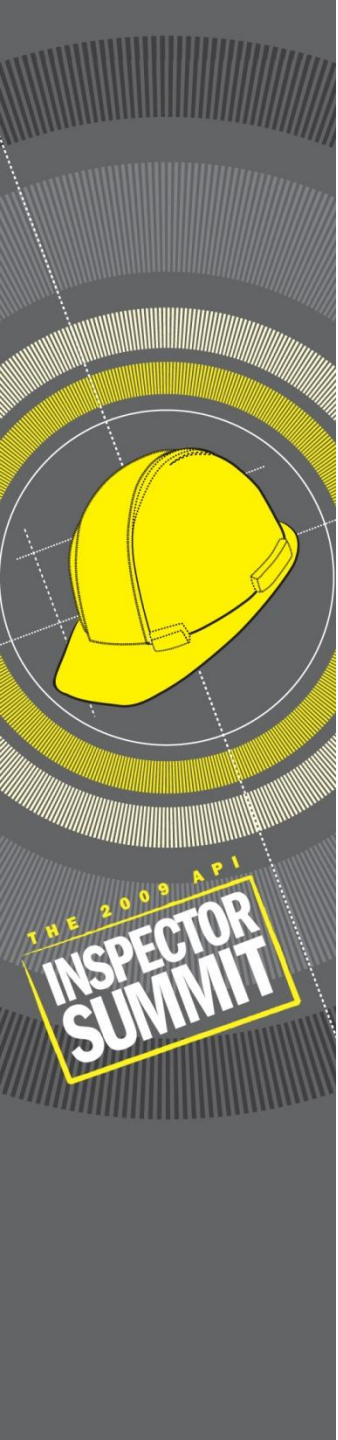
Who Does the Dryout Schedule?

- Contractors Responsibilities
- Inspections Responsibilities
- Plants Responsibilities



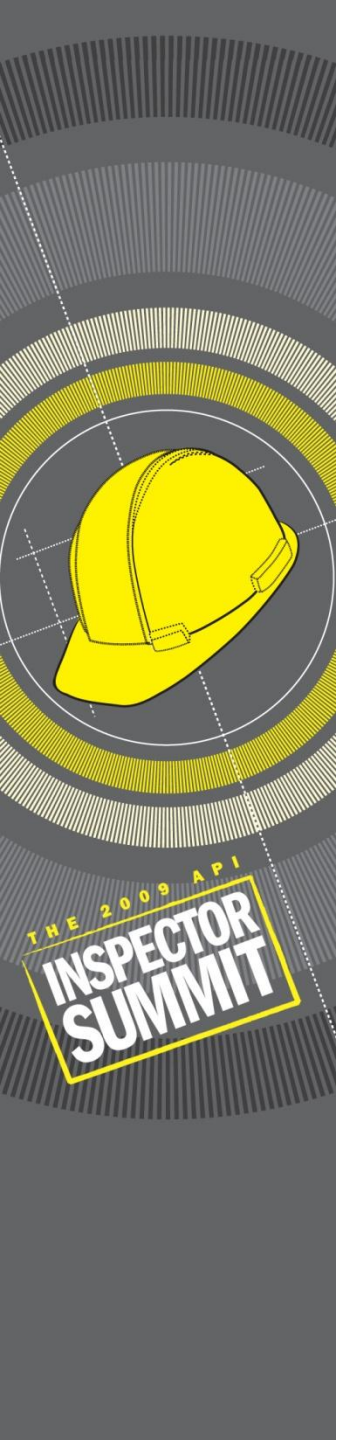
Pitfalls

- Not enough inspectors
- Conflicts Between TA Planning, Inspections and Operations
- Uncooperative Contractor
- Pressure to Close



Reporting

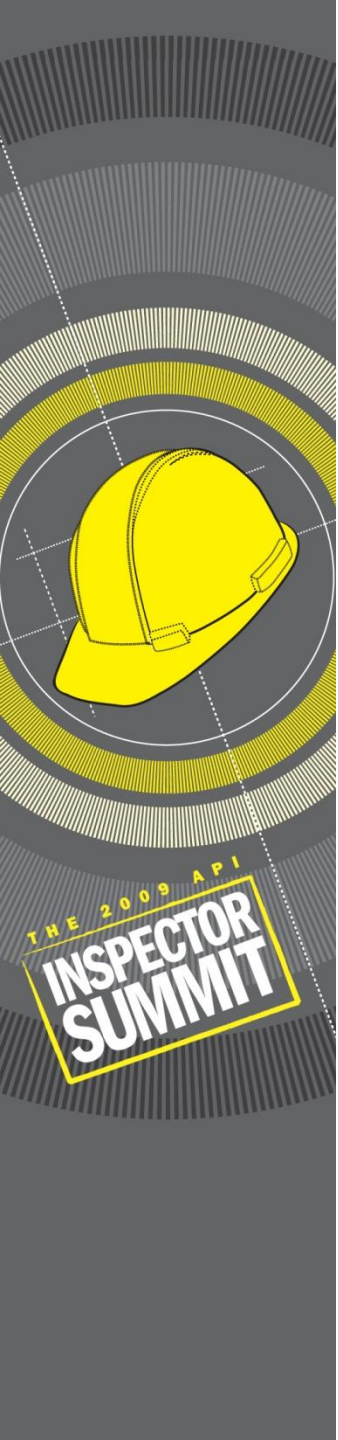
- Start Reports Early
- Brief History of the Vessel
- What Did You Find
- What Work Was Done
- What Can be Anticipated
- Drawings
- Pictures
- Presenting the Report to the Client



Bad Weld



Good Weld



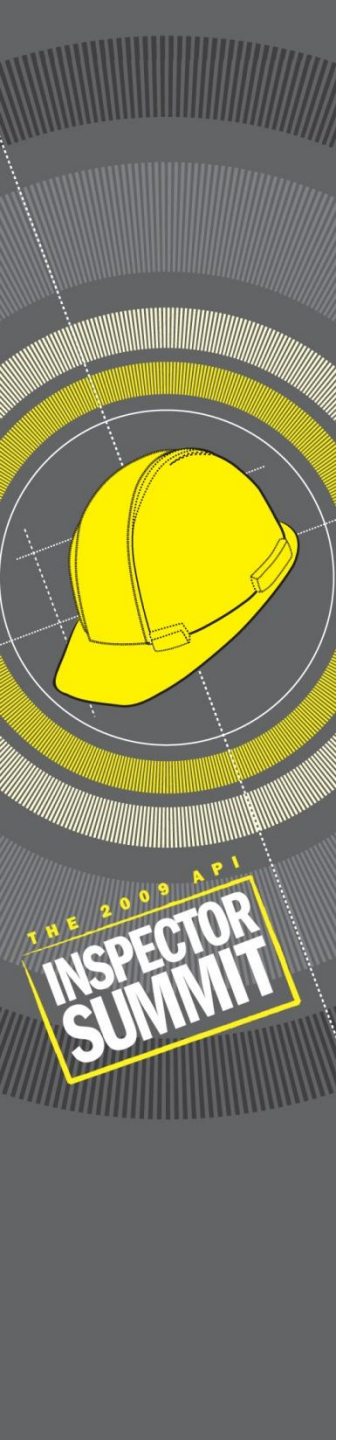
What Caused This. Look Up



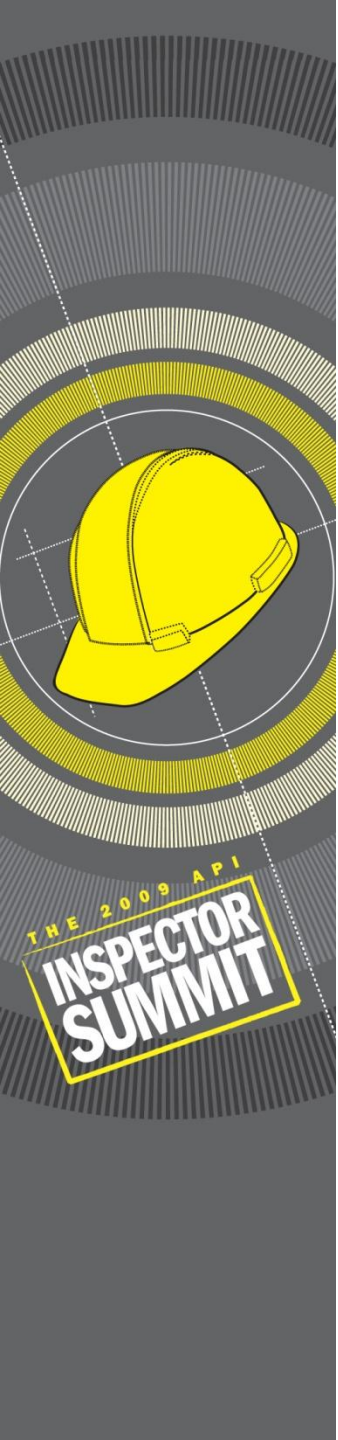
Reaction Furnace Brickwork



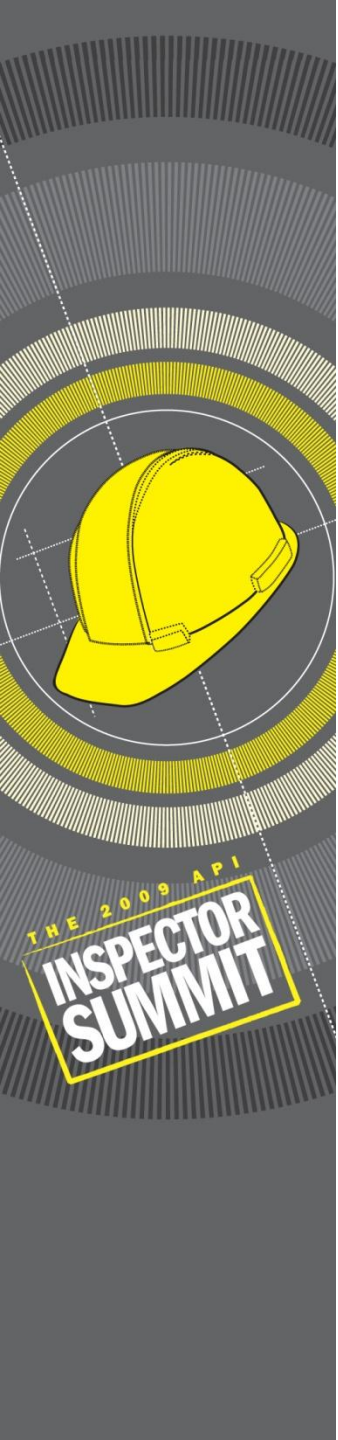
Nozzleman Qualification



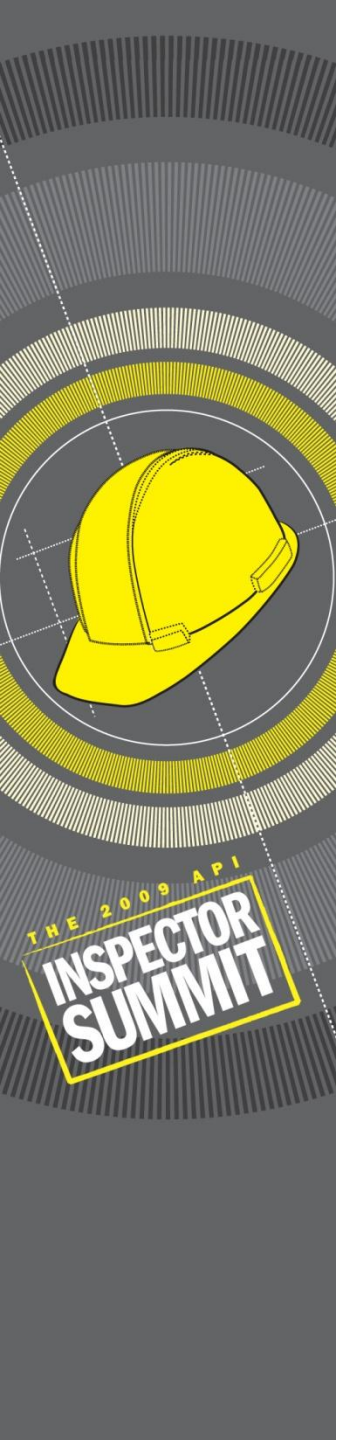
Night Crew Gun Operation



Sometimes Looks are Deceiving



A Clue that all is not well up top



It's not always fun



Questions ???

Jim Allen

COE Refractory Inspection

