REINHOLD ENVIRONMENTAL Ltd.

2017 NOx-Combustion-CCR Round Table Presentation

February 27 & 28, 2017, in Cleveland, OH / Hosted by FirstEnergy

Reinhold Environmental LTD.

Bottom Ash Handling

CCR Solutions

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CCR Solutions for Bottom Ash

Presentation Outline:

- Review the five basic types of bottom ash conversions.
- Review Case Study DRYCON™ project.
  - Project Drivers & Benefits
  - Design Parameters and Concept.
  - Basic Construction Schedule.
  - Key Equipment.
  - Shop Testing.
  - Site Construction Photos.
  - Project Update.

DRYCON™ is a registered trademark of Clyde Bergemann

Technologies Available for Bottom Ash Conversions

CCR Solutions for Bottom Ash

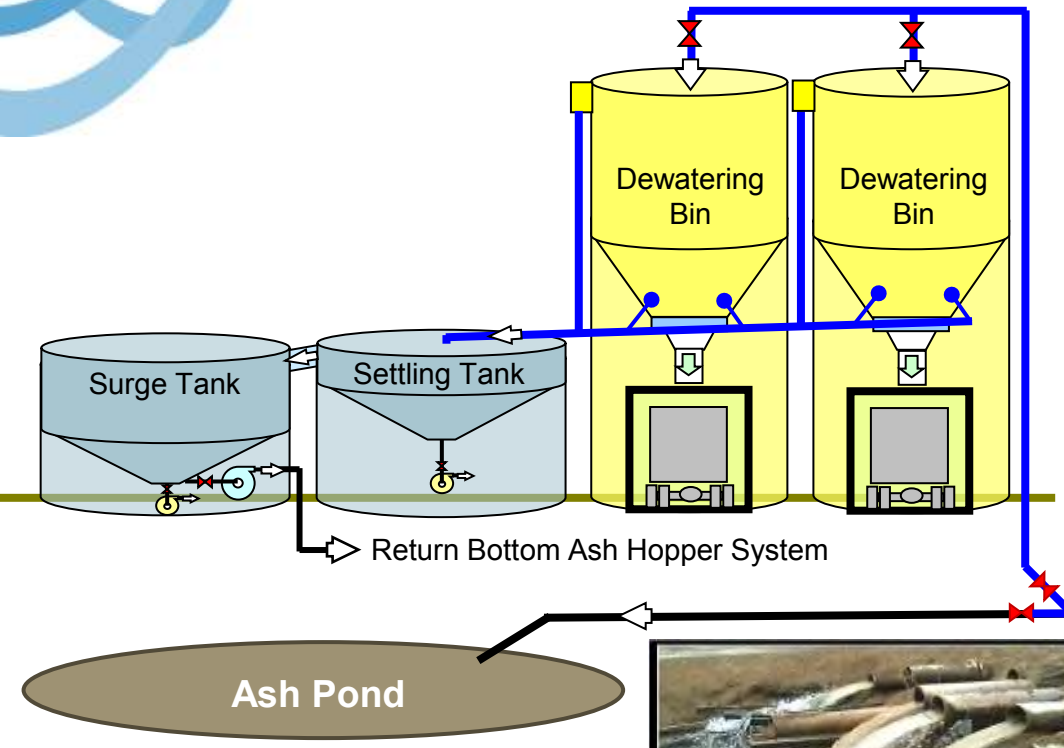
Below are some common bottom ash conversions technologies used for compliance with CCR or ELG regulations:

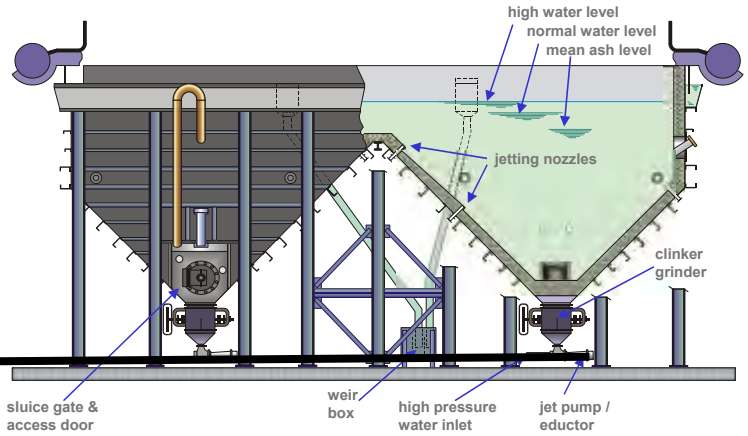
- 1) **Divert** the flow of the existing bottom ash slurry piping to new dewatering bins.
- 2) **Divert** the flow of the existing bottom ash slurry piping to a remote submerged scraper conveyor (RSSC) system (RMD Conveyor™).
- 3) **Replace** the bottom ash hopper system with a submerged scraper conveyor (SSC).
- 4) **Replace** the bottom ash hopper system with a dry ash mechanical conveyor (DRYCON™).
- 5) **Replace** the bottom ash hopper system with a dry ash pneumatic conveyor (DRYCON™ Hybrid).

DRYCON™ & RMD Conveyor™ are registered trademarks of Clyde Bergemann

CCR Solutions for Bottom Ash

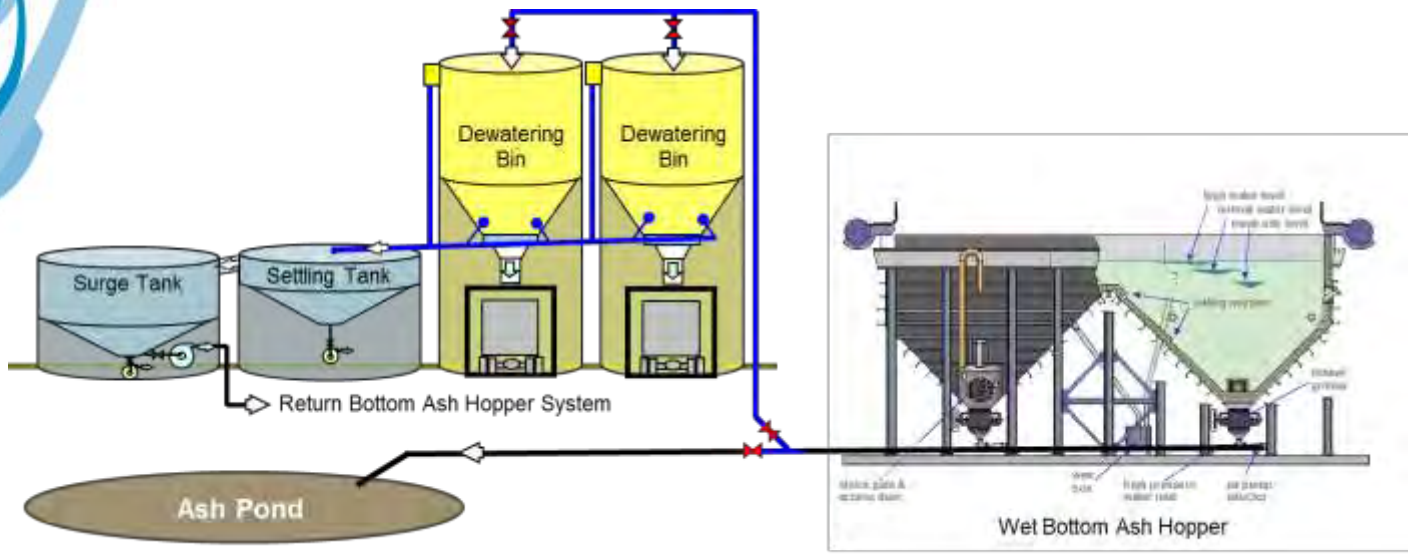
- **Option-1 Divert the flow of the existing bottom ash slurry piping to new de-watering bins.**





Wet Bottom Ash Hopper

CCR Solutions for Bottom Ash

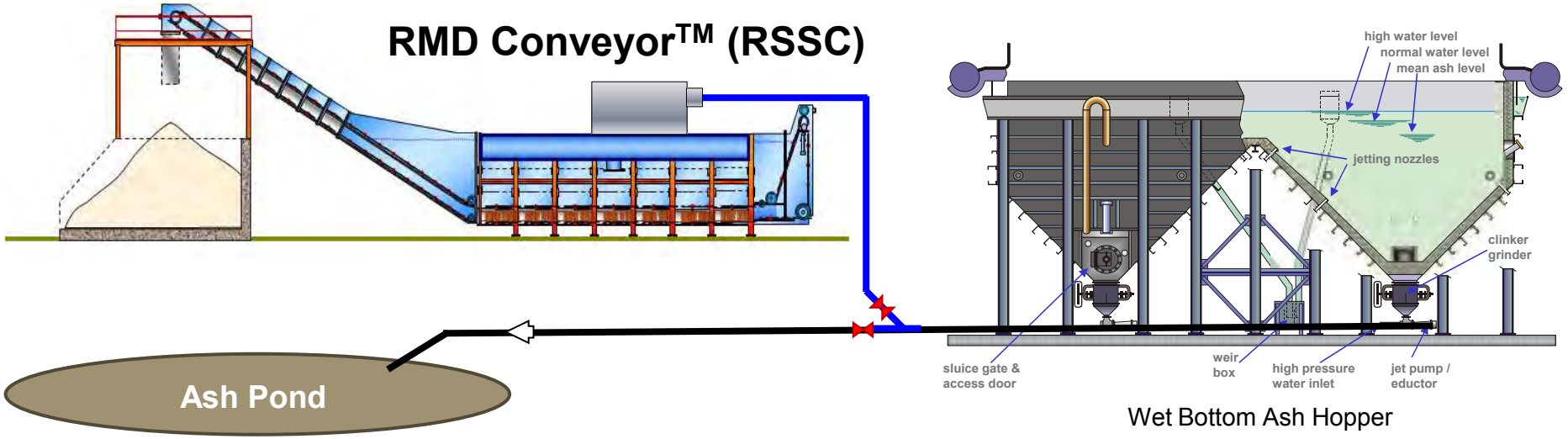


De-Watering Bin System

Advantages	Disadvantages
Little to NO outage	Not a dry system!
Original Ash Hopper Remains	Original Ash Hopper Remains
40 year old technology	40 year old technology
ZLD compliant	High Power Consumption
	Leaking Gates
	Plugged De-Watering Screens
	No Gain in Boiler Efficiency

CCR Solutions for Bottom Ash

- **Option-2 Divert the flow of the existing bottom ash slurry piping to a remote submerged scraper conveyor (RSSC) system (RMD Conveyor™).**



Wet Bottom Ash Hopper

RMD Conveyor™ is a registered trademark of Clyde Bergemann

Patent Pending

CCR Solutions for Bottom Ash

Bottom Ash Slurry Lines + **Modified SSC Technology** = **Dewatered Bottom Ash**

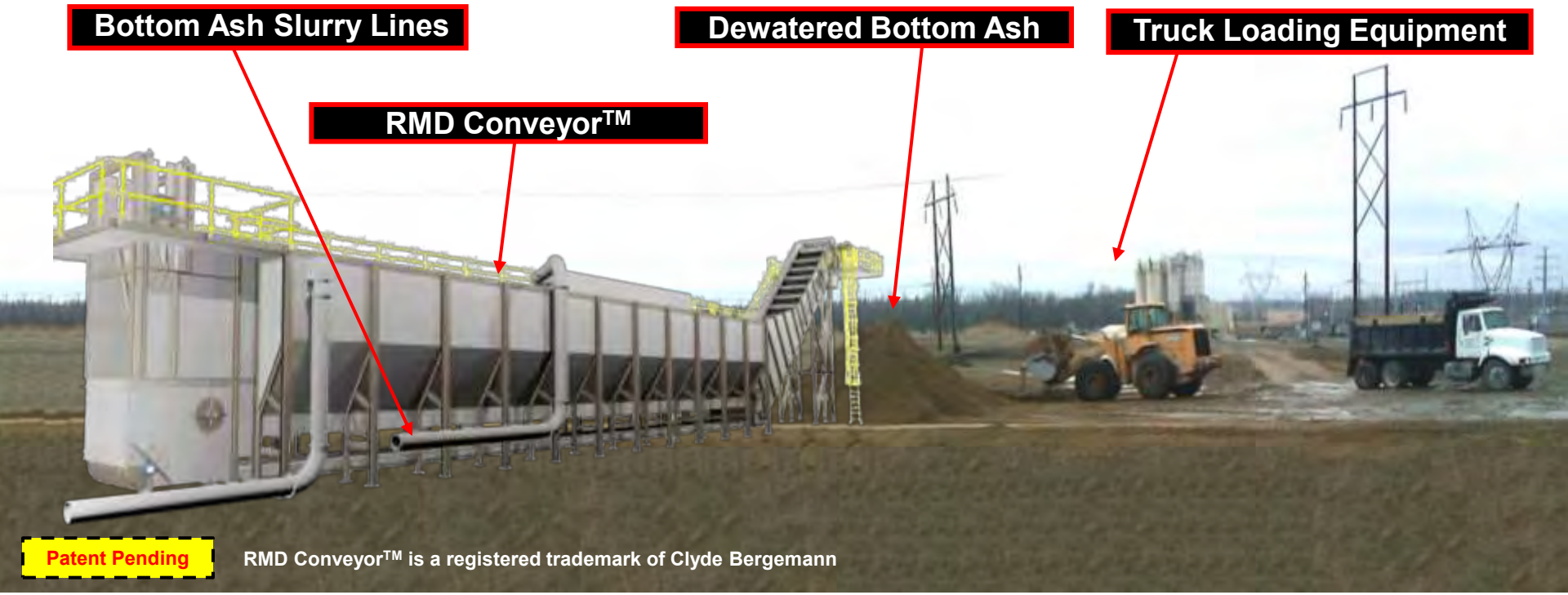
THE BASIC CONCEPT:

Divert **the existing bottom ash slurry line(s) to a unique Remote Submerged Scraper Conveyor (RMD Conveyor™) to provide a dewatered ash that can be handled, dust free, for removal. RMD Conveyor™ dewatered ash contains only 15-20% moisture.**

CCR Solutions for Bottom Ash

Remote Mechanical Dewatering Conveyor (RMD) Systems

Advantages	Disadvantages
Little to NO outage	Not a dry system!
Original Ash Hopper Remains	Original Ash Hopper Remains
Small foot print	High Power Consumption
ZLD compliant	

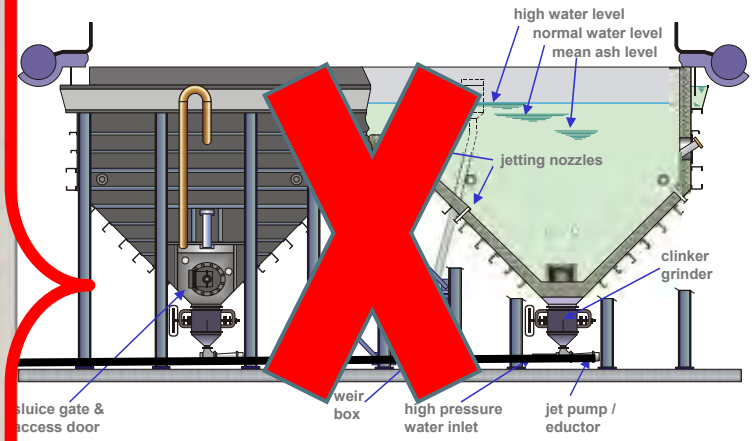


Patent Pending

RMD Conveyor™ is a registered trademark of Clyde Bergemann

CCR Solutions for Bottom Ash

- **Option-3 Replace the bottom ash hopper system with a submerged scraper conveyor (SSC).**



Wet Bottom Ash Hopper

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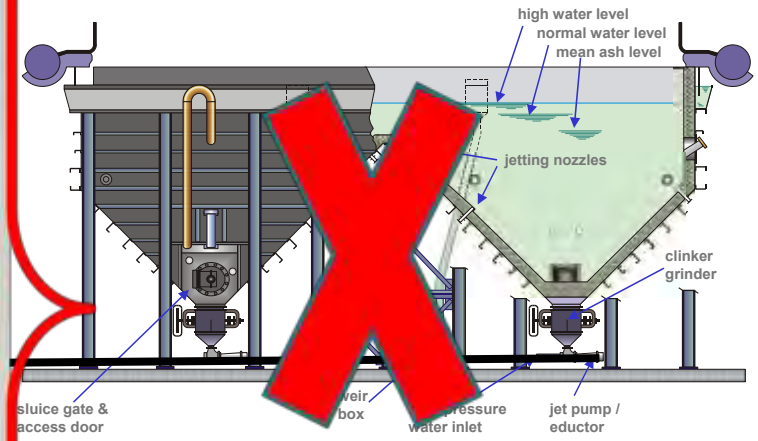
SSC Systems

Advantages	Disadvantages
Well established technology	Not a dry system
Minimal water usage	Major outage required
No other de-watering required	Can go 100% dry for same cost
	No Gain in Boiler Efficiency

CCR Solutions for Bottom Ash

- **Option-4 Replace the bottom ash hopper system with a dry ash bottom conveyor (DRYCON™).**



Wet Bottom Ash Hopper

DRYCON™ is a registered trademark of Clyde Bergemann

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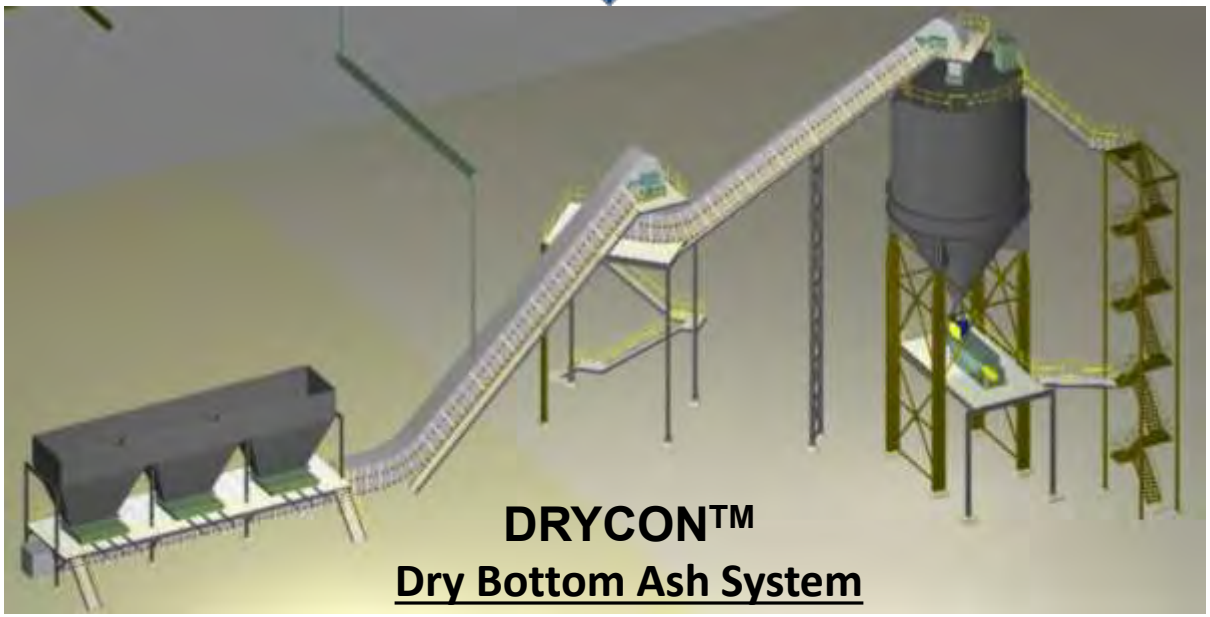
DRYCON™

The patented, proven dry bottom ash handling system

- No water requirement for ash cooling and conveying
- Increased boiler efficiency, reduced coal usage and CO emissions
- Increased ash quality & value

CCR Solutions for Bottom Ash



DRYCON™

Dry Bottom Ash System

Advantages	Disadvantages
Established technology	Major outage required
Zero water usage	Needs clear path from under boiler
Reduced Maintenance	
Complete pond elimination	
Gain in Boiler Efficiency	
Reduce LOI in bottom ash	
Reduced power consumption	

Dry Bottom Ash Conversion Project

DRYCON™

Case Study

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POWER

BUSINESS AND TECHNOLOGY FOR THE GLOBAL GENERATION INDUSTRY

Official Publication of: ELECTRIC POWER CONFERENCE & EXHIBITION

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April 8, 2011

Clyde Bergemann Power Group awarded contract for first DRYCON™ dry bottom ash systems in the U.S.

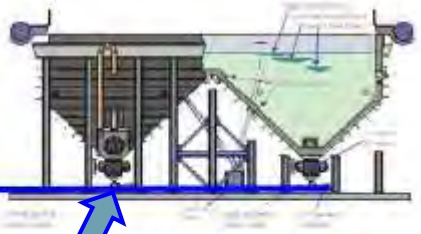
Press Release

Atlanta, GA/USA, April 2011

Clyde Bergemann Power Group Americas headquartered in Atlanta/GA has been awarded a contract to supply both the engineering and equipment to convert the existing wet bottom ash removal system of Seminole Electric's two 650 MW coal fired units located in Palatka, Florida to a dry system utilizing its DRYCON™ technology. The contract will be executed by Clyde Bergemann Delta Ducon (CBDD), the Group's business unit for ash handling . . . .

DRYCON™ is a registered trademark of Clyde Bergemann

CCR Solutions for Bottom Ash



EXISTING WET BOTTOM ASH SYSTEM

30+ Year Old Design

High Power Consumption

Leaking Gates

Plugged De-Watering Screens

CCR Solutions for Bottom Ash

BASIC SYSTEM DESIGN AND OPERATING PARAMETERS

Bottom Ash Conveying:

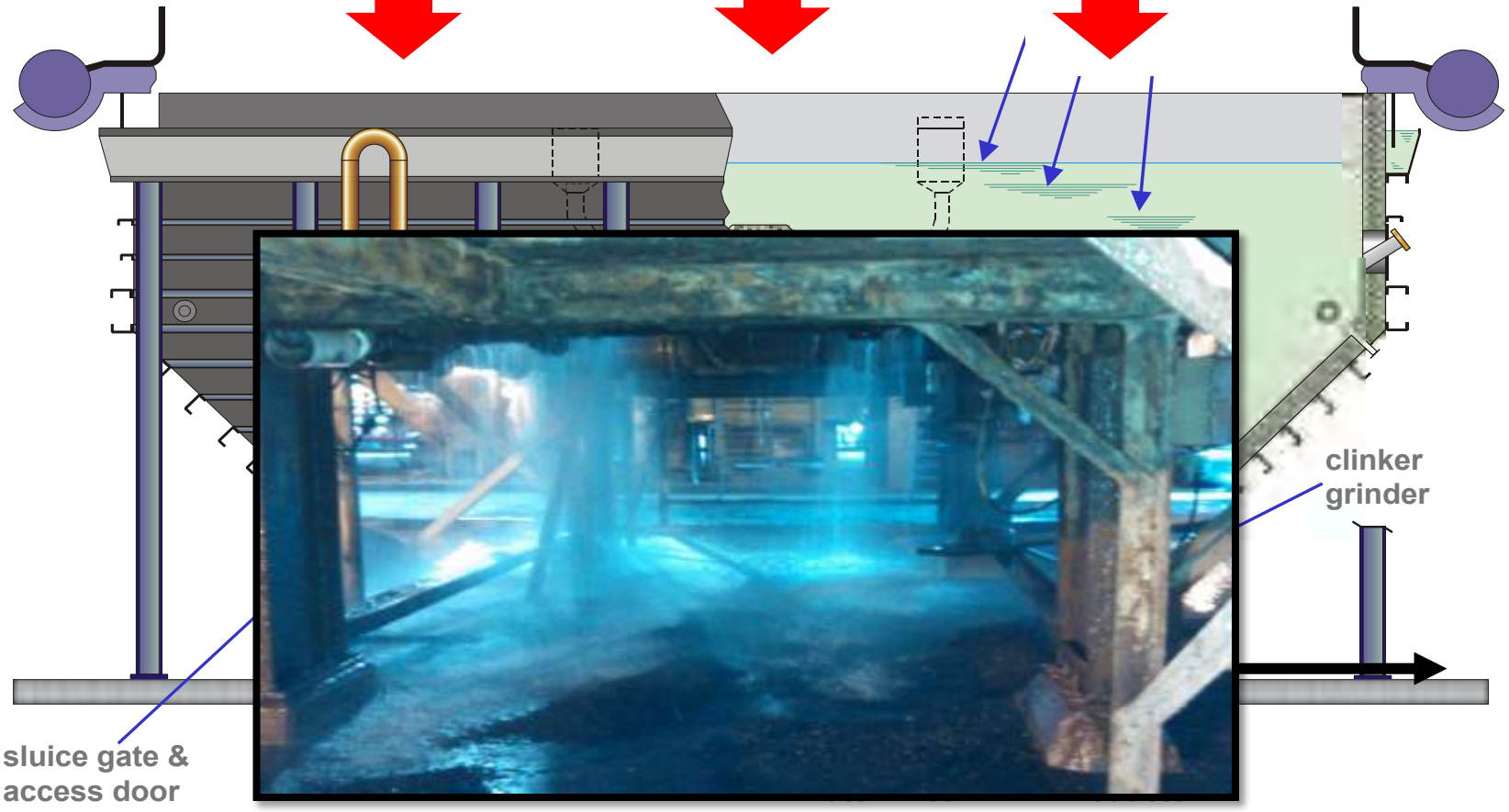
Material Conveyed..... Bottom Ash
Material density..... 65 PCF
Maximum ash temperature..... 1780 Degrees F.
Conveying Rate (max.)..... 40 TPH
Conveying Rate (nominal)..... 10 TPH
Ash Generation Rate (@MCR)..... 4.28 TPH
DRYCON™ Mechanical Drive, 11 kW ..... 15 HP
Chain Speed..... 4.92 FPM

Economizer Ash Conveying:

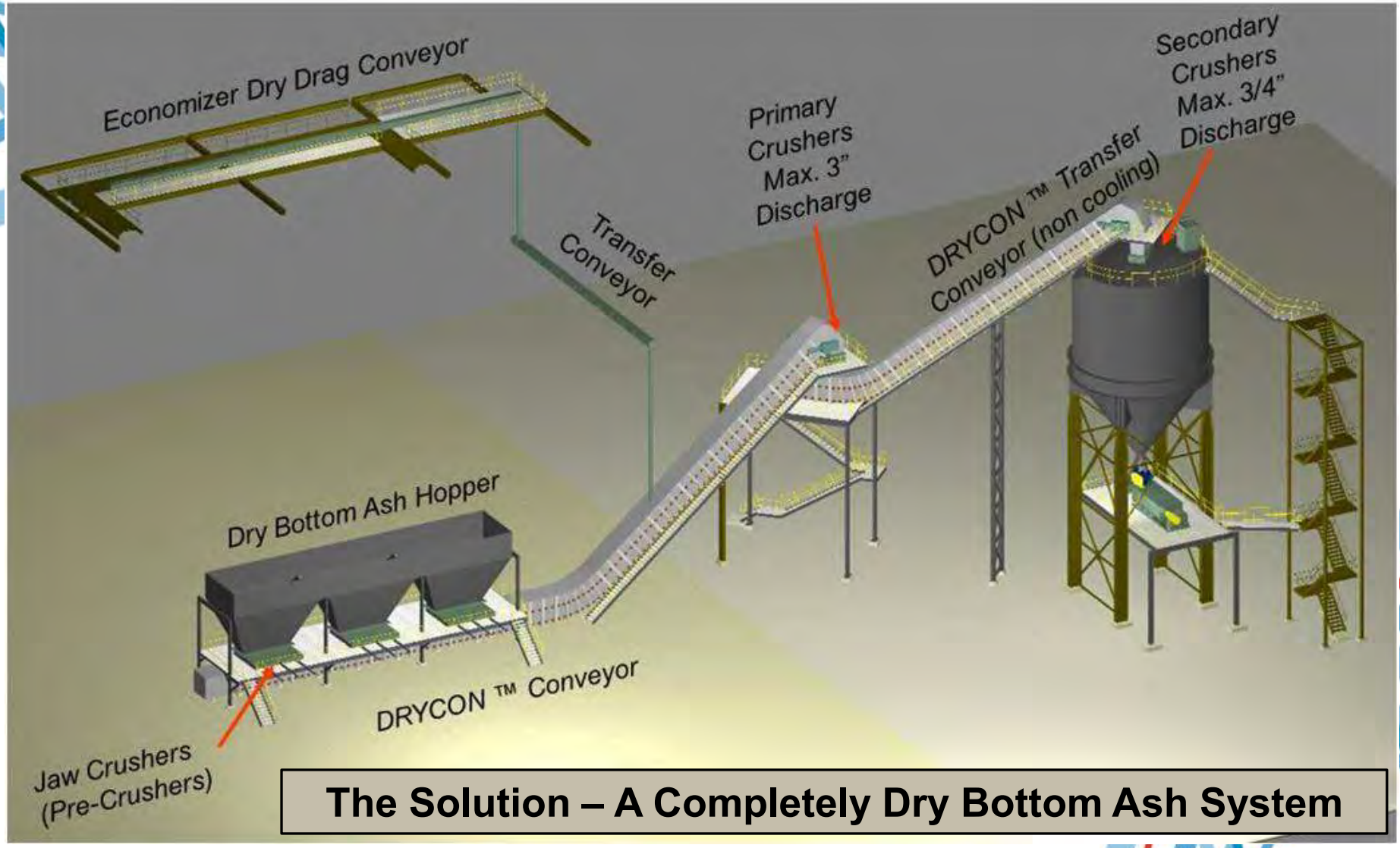
Material Conveyed..... Economizer Ash
Material density..... 45 PCF
Maximum ash temperature..... 745 Degrees F.
Conveying Rate (max.)..... 7 TPH
Conveying Rate (nominal)..... 2 TPH
Ash Generation Rate (@MCR)..... 1.28 TPH
Mechanical Drive ..... 3 HP

CCR Solutions for Bottom Ash

Water Impounded Bottom Ash Hopper



CCR Solutions for Bottom Ash



The Solution – A Completely Dry Bottom Ash System

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SCHEDULE - PREOUTAGE

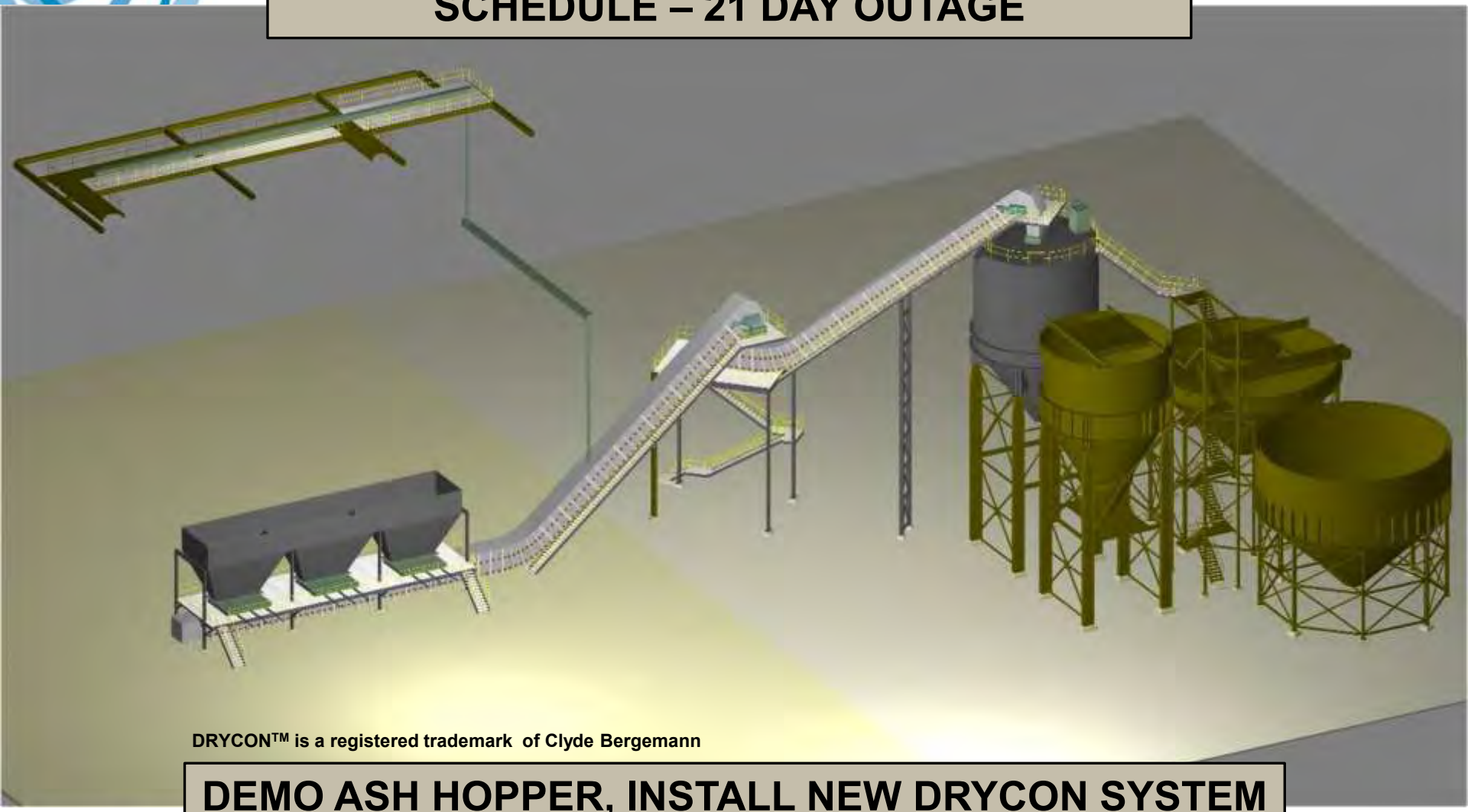
EXISTING WET SYSTEM BIN

SCHEDULE - PREOUTAGE

DEMO DEWATERING BIN, INSTALL NEW DRY SILO

CCR Solutions for Bottom Ash

SCHEDULE – 21 DAY OUTAGE



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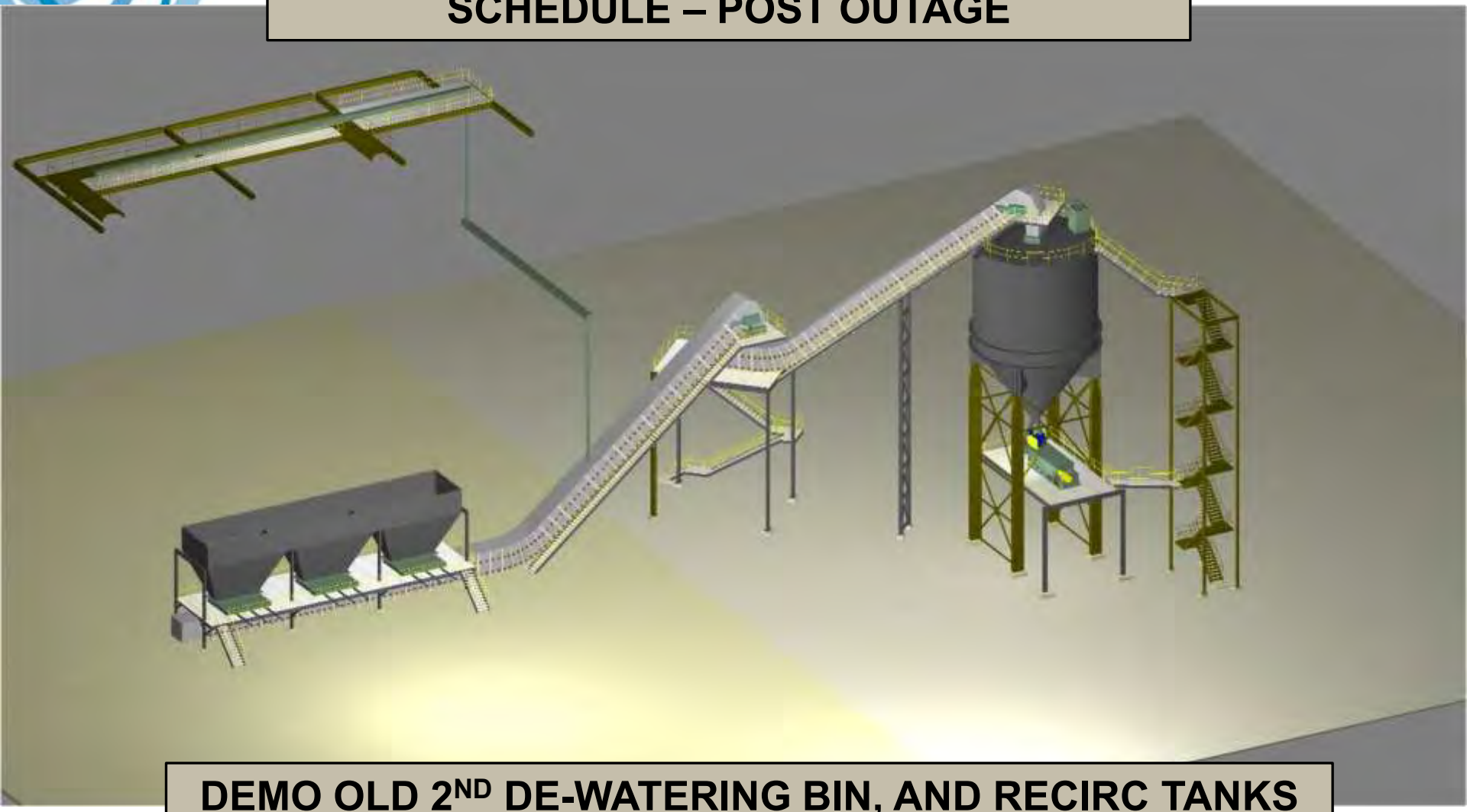
DEMO ASH HOPPER, INSTALL NEW DRYCON SYSTEM

SCHEDULE – POST OUTAGE



DEMO OLD 2ND DE-WATERING BIN, AND RECIRC TANKS

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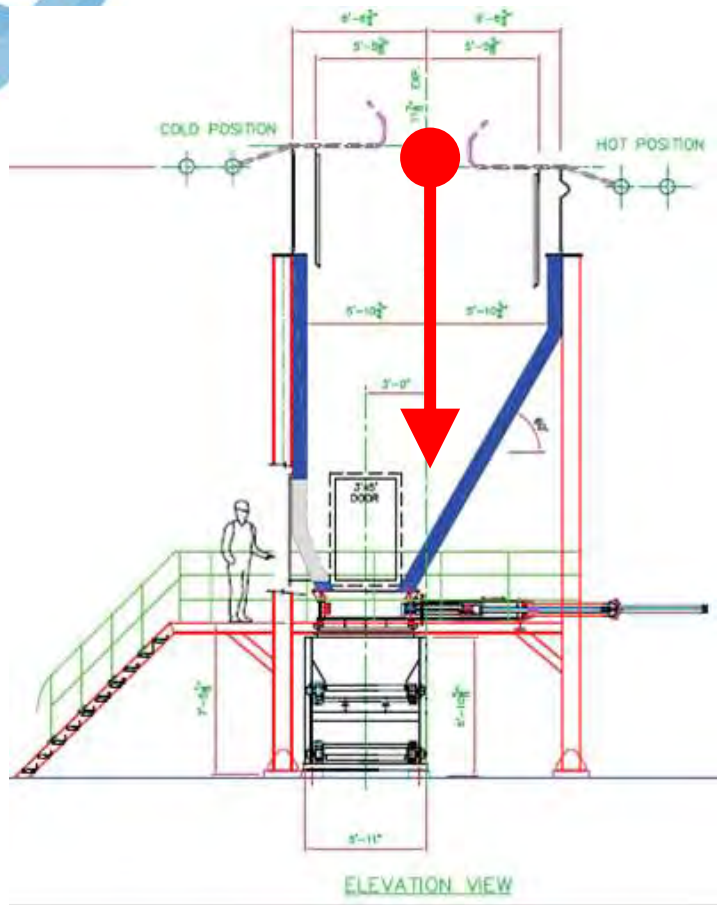
DESIGN, FABRICATION & TESTING



OFFSET HOPPER & JAW CRUSHER

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Live Camera Shot from inside "Hopper C" of the new dry bottom ash hopper.

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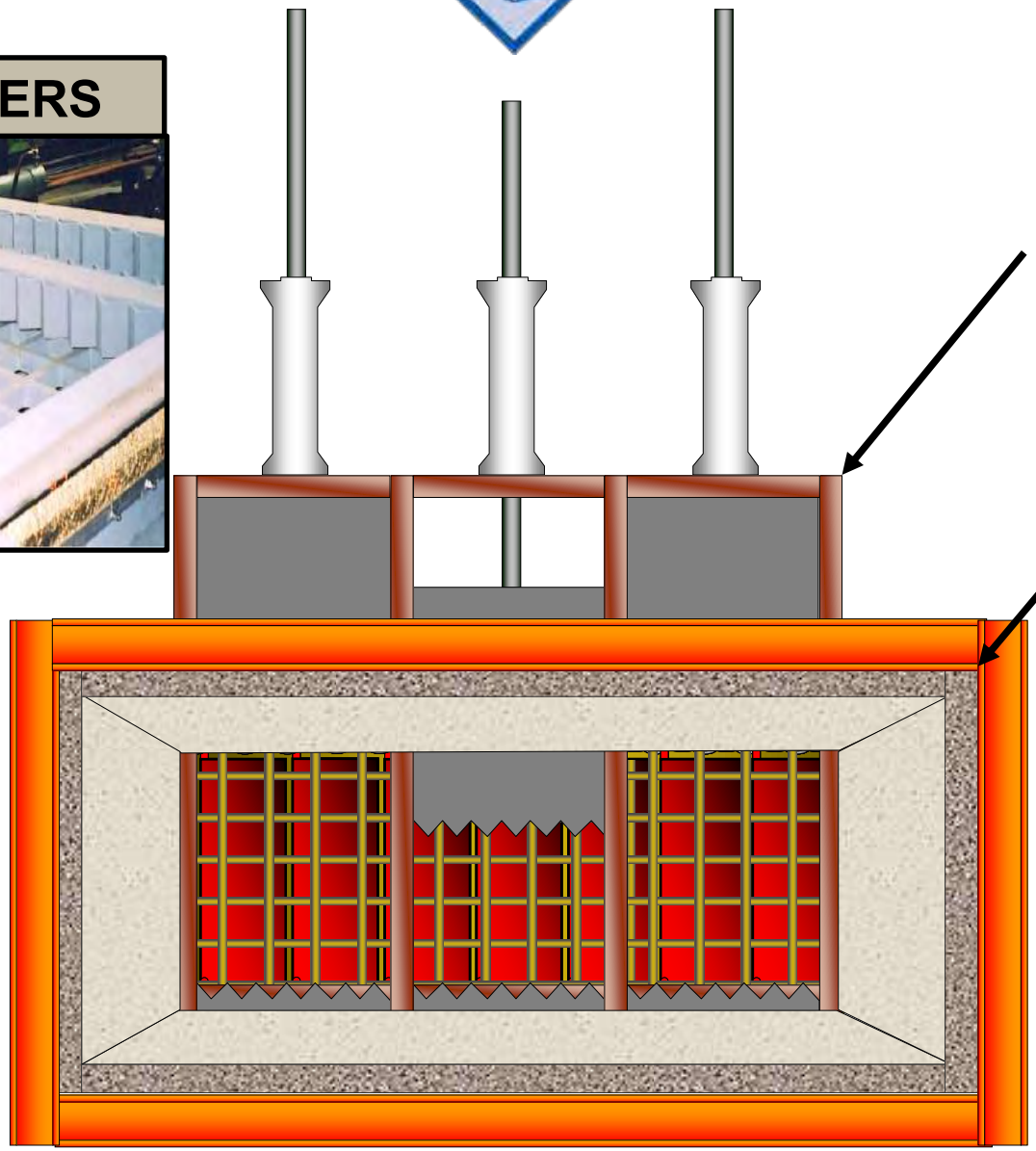
JAW CRUSHERS



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Live Camera Shot from inside "Hopper C" of the new dry bottom ash hopper.

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CONSTRUCTION PHOTOS

CRUSHER WITH SEGMENTED ROLLS

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DESIGN, FABRICATION & TESTING

FULL SHOP ASSEMBLY & TESTING

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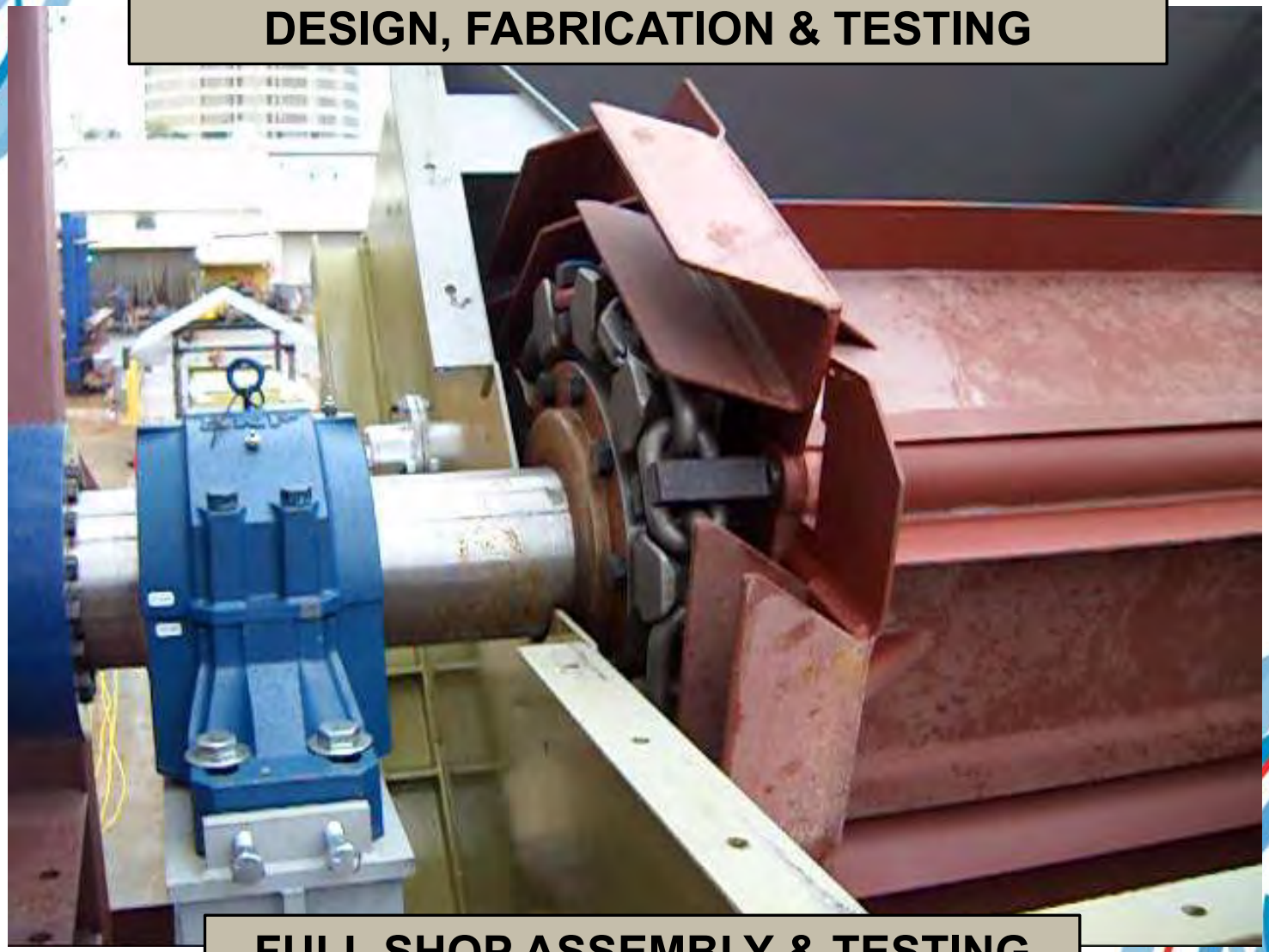
DESIGN, FABRICATION & TESTING



FULL SHOP ASSEMBLY & TESTING

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CONSTRUCTION PHOTOS

DRY ASH HOPPER SEGMENTS

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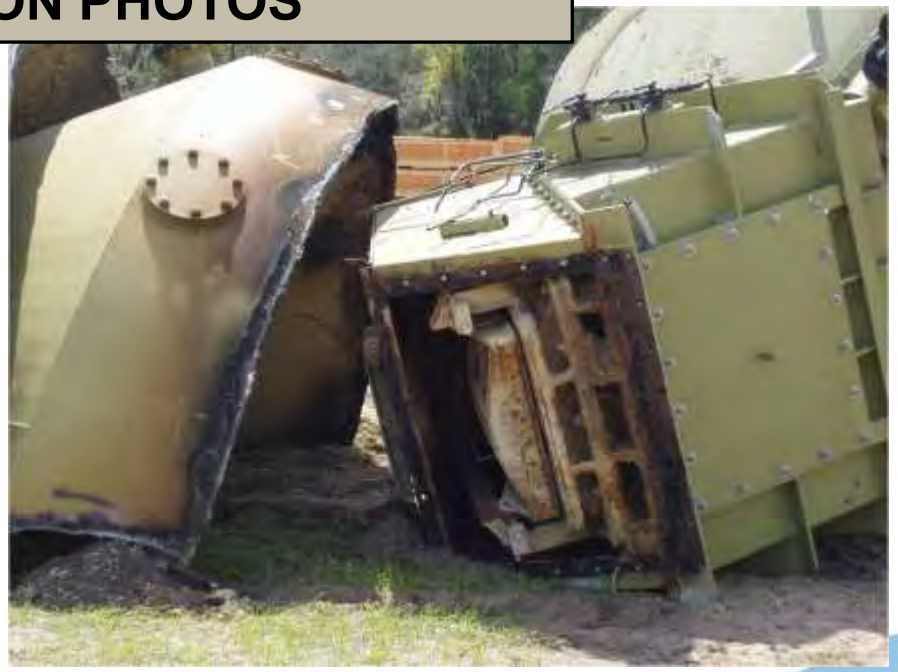
CONSTRUCTION PHOTOS



OLD DE-WATERING BIN DEMO

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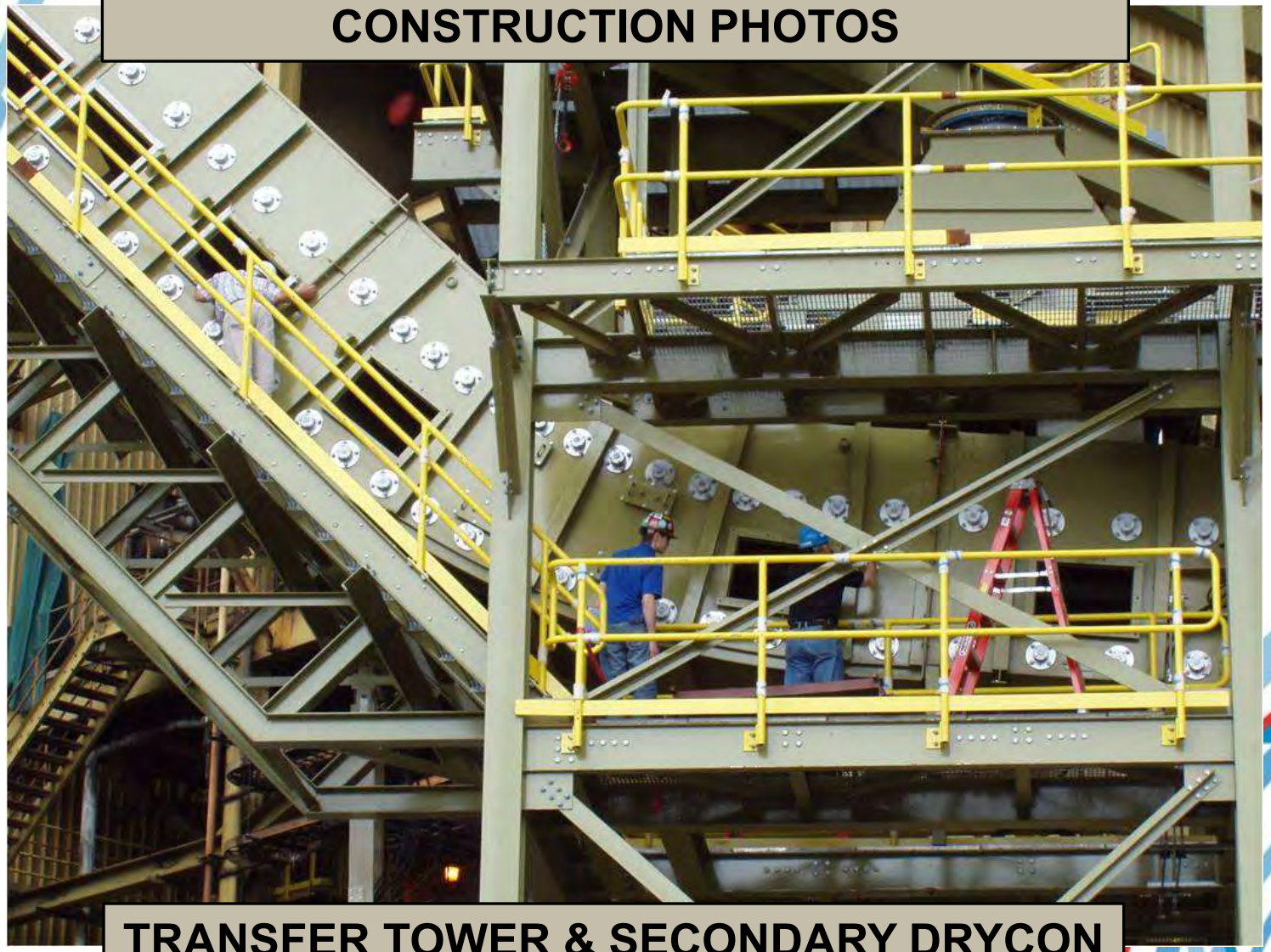
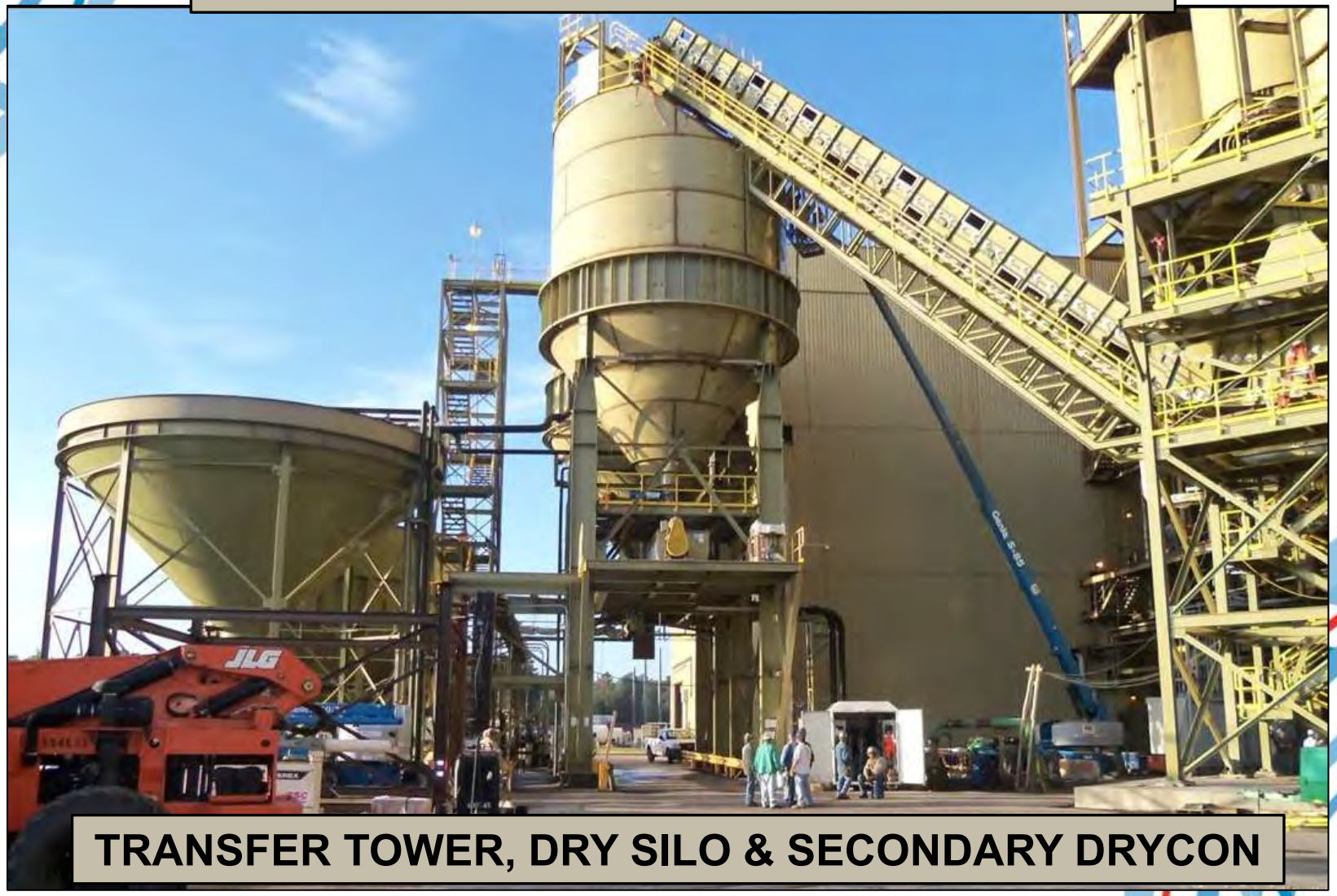
CONSTRUCTION PHOTOS



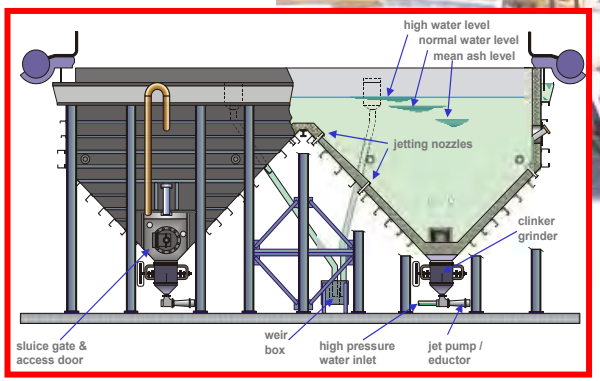
TRANSFER TOWER & SECONDARY DRYCON

CONSTRUCTION PHOTOS



TRANSFER TOWER, DRY SILO & SECONDARY DRYCON

CCR Solutions for Bottom Ash



“Out with the Old” wet bottom ash hopper.

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“In with the New” dry bottom ash system.

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CCR Solutions for Bottom Ash

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CCR Solutions for Bottom Ash

DRYCON - Dry Bottom Ash System Status:

- Unit 2 - back on line April 22, 2012
- Unit 1 - back on line November 23, 2012
- DRYCON™ inspection and start-up is complete.
- All Project Guarantees were made:
  - ✓ Elimination of water.
  - ✓ Reduced power consumption.
  - ✓ Reduced LOI.
  - ✓ Reduced bottom ash temperatures.
  - ✓ Reduced operating and maintenance costs.

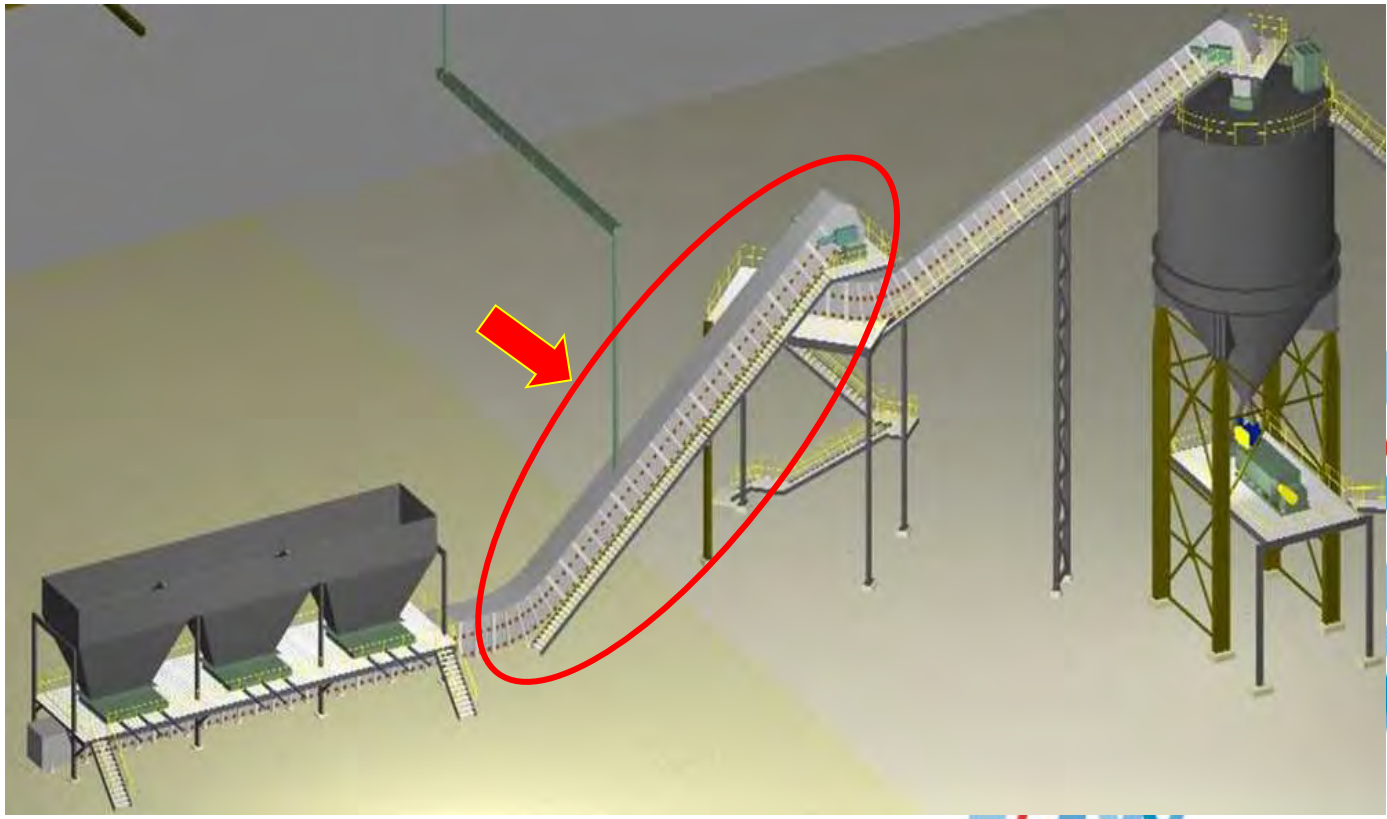
DRYCON™ is a registered trademark of Clyde Bergemann

CCR Solutions for Bottom Ash

DRYCON™ Technology:

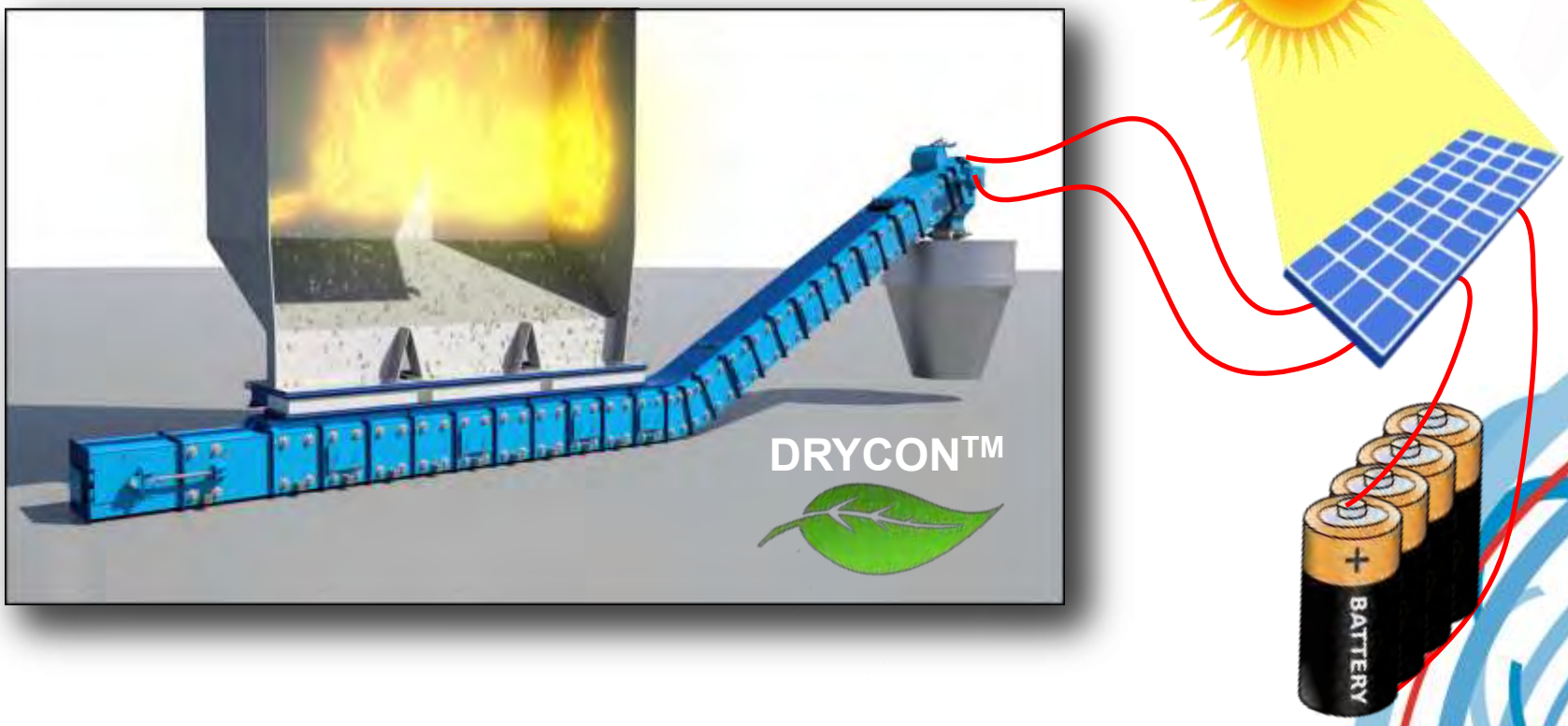
Advantages	Disadvantages
Established technology	Major outage required
Zero water usage	Needs clear path from under boiler
Reduced Maintenance	
Complete pond elimination	
Gain in Boiler Efficiency	
Reduce LOI in bottom ash	
Reduced power consumption	

DRYCON has many advantages however what happens when you don't have a clear path out from under the boiler?



DRYCON™ Hybrid

What is it?



hy·brid

Definition: a thing made by combining two different elements; a mixture.

DRYCON Hybrid

Proven DRYCON cooling know how : Proven vacuum conveying technology

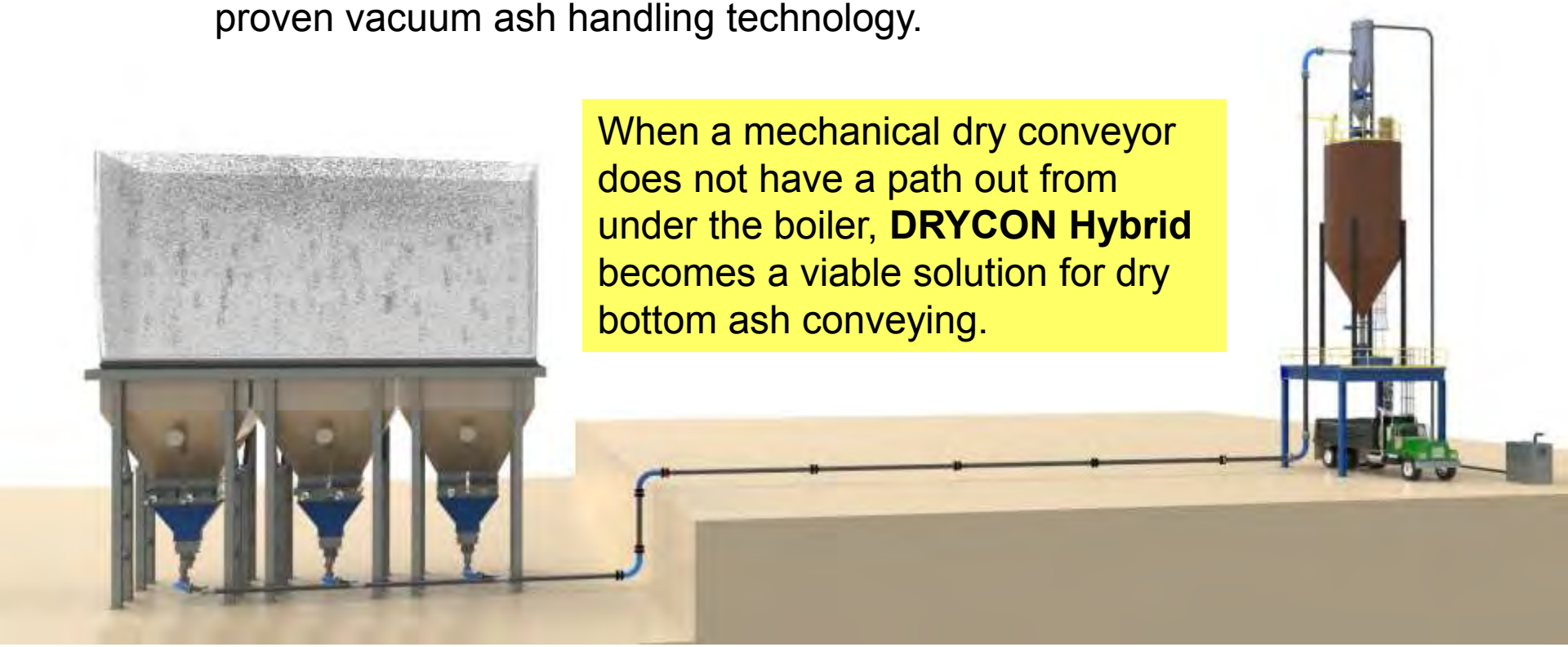
CCR Solutions for Bottom Ash

- **Option-5 Replace the bottom ash hopper system with a dry ash bottom pneumatic conveyor (DRYCON™ Hybrid).**

DRYCON™ Hybrid System:

DRYCON Hybrid features the same dry bottom ash handling equipment that has been used in over **140** **DRYCON** units and combines it with proven vacuum ash handling technology.

When a mechanical dry conveyor does not have a path out from under the boiler, **DRYCON Hybrid** becomes a viable solution for dry bottom ash conveying.



Thank you for your time and attention!

Ron Grabowski
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