INSTRUCTION of ASH HANDLING SYSTEM
1. Ash Accumulation Points
2. Classification by Transfer Method of Ash Handling System
3. Type of Bottom Ash Handling System
4. Type of Fly Ash Handling System
5. KC Global Network
6. Reference List
1. Ash Accumulation Points

- **Bottom Ash (Bed Ash)**: 10~20%
- **Economizer Ash**: Upto 5%
- **Air Preheater Ash**: Upto 5%
- **ESP Ash**: Upto 90%

**Typical Ash Distribution**
2. Classification by Transfer Method of Ash Handling System

- **Mechanical Conveying**
  - SDCC, DAC, Screw/Drag/Apron/Belt Conveyor, Bucket Elevator, etc.

- **Pneumatic Conveying**
  - Positive Pressure
    - Medium Phase
  - Negative Pressure
    - Vacuum

- **Hydraulic Conveying**
  - Hydro-Ejector, Slurry Pump, HCSD, etc.
3. Type of Bottom Ash Handling System

- Water Impounded Type
- Submerged Drag Chain Conveyor (SDCC)
- Dry Ash Extraction Conveyor (DAC)
# 3. Type of Bottom Ash Handling System

## 3.1 Comparison of Bottom Ash System

<table>
<thead>
<tr>
<th>Wet Type</th>
<th>Dry Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydraulic (Water Impounded) Type</strong></td>
<td><strong>Submerged Drag Chain Conveyor</strong></td>
</tr>
<tr>
<td><img src="schematic.png" alt="Schematic" /></td>
<td><img src="schematic.png" alt="Schematic" /></td>
</tr>
</tbody>
</table>

### Characteristics

- **Bottom Ash produced in 8 hours (1 Operator shift) is transported in 1.5 hours periodically**
- **Bottom ash is stored in storage hopper for 8 ~ 12 hours, ground by a Clinker Grinder, and then transported to ash transport tank via Hydro-Ejector**
- **Seawater is continuously supplied to cool down the water in the bottom ash storage hopper below 60°C**
- **Bottom ash is transported either continuously or periodically and Trough can store upto 4 hours bottom ash produced from boiler operation**
- **Plant water / service water is continuously supplied to cool down the water in the trough below 60°C**
- **Conveyor is operated at low speed around 6m/min**
- **Bottom ash is transported either continuously or periodically and Ash hopper can store upto 8 hours bottom ash produced from boiler operation**
- **Cooling air is continuously supplied to cool down the ash temperature after grinder below 100°C**
- **Conveyor is operated at low speed around 0.03~0.15m/sec (1.8~9m/min)**
### 3. Type of Bottom Ash Handling System

<table>
<thead>
<tr>
<th>Pros</th>
<th>Wet Type</th>
<th>Dry Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Repair and maintenance can be done in between operation from periodic operation and large storage capacity. (Boiler needs to be built high: about 10m above floor level)</td>
<td>Hydraulic (Water Impounded) Type</td>
<td>Submerged Drag Chain Conveyor</td>
</tr>
<tr>
<td>- With many references, reliability of the system is proven.</td>
<td>- Boiler Structure can be lower by 3 ~ 5m compared to Hydraulic type (Boiler bottom opening: about 5m above floor level)</td>
<td>- Boiler Structure can be lower by 2 ~ 3m compared with Hydraulic type. (Boiler bottom opening: about 7m above floor level)</td>
</tr>
<tr>
<td>- Less power consumption and water consumption than Hydraulic type</td>
<td>- Needs smaller Ash Pond than Hydraulic type.</td>
<td>- Bottom ash can be recycled.</td>
</tr>
<tr>
<td>Cons</td>
<td>- Power consumption and water consumption is large.</td>
<td>- Slag from boiler can damage the conveyor</td>
</tr>
<tr>
<td>- Seawater needs to be supplied continuously.</td>
<td>- Transportation path has less flexibility than the Hydraulic type</td>
<td>- Needs separate Pyrite handling system or manual process is required.</td>
</tr>
<tr>
<td>- Bottom ash cannot be recycled.</td>
<td>- Smaller Ash storage capacity than Hydraulic type</td>
<td>- Initial operation and maintenance activities can be difficult since Operators are not familiar with Dry Type.</td>
</tr>
<tr>
<td>- Needs big Ash Pond.</td>
<td>- For maintenance, Conveyor needs to be removed from Boiler bottom.</td>
<td>- For maintenance, Conveyor needs to be removed from Boiler bottom.</td>
</tr>
<tr>
<td>- High Boiler structure, Foundation cost is high</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Ref | - Hadong1~6, Taeahn 1~6, Dangjin 1~4 | - Youngheung 1,2, Dangjin 5~8 | - Hadong 7,8, Boryeong 7,8, Taeahn 7,8, Youngheung 3,4 |
3. Type of Bottom Ash Handling System

3.2 Bottom Ash Hopper System (Water impounded type) utilizing Hydro-ejectors

- A bottom ash sluice system with a bottom ash hopper and a hydraulic jet pump has been applied, where the bottom ash is quenched and collected in a water impounded bottom ash hopper to be periodically removed by a jet pump through a clinker crusher and sluiced to ash pond.

- The major advantage of a jet pump is the simplicity and ease of maintenance, since there are no routing parts nor moving sections.
3. Type of Bottom Ash Handling System

3.3 SDCC (Submerged Drag Chain Conveyor) System

- The SDCC system for a large scale power plant can be the combination of a SDCC and standard belt conveyors, where the routing of the belt conveyor is available both inside and outside of the boiler house up to a bottom ash bin.

- The SDCC is normally equipped with a closed loop water recirculation system to remove heat absorbed in the SDCC’s water from the ash and furnace radiation. The water overflows from the SDCC trough into an overflow pump, then it is supplied again to the SDCC.
3. Type of Bottom Ash Handling System

Submerged Drag Chain Conveyor (SDCC)
3. Type of Bottom Ash Handling System

Submerged Drag Chain Conveyor (SDCC)

Project: Dangjin Thermal Power Plant Unit No. 5 & 6 (500MW x 2), Korea

- Normal Capacity: 10 ton/h
- Maximum Capacity: 25 ton/h
Submerged Drag Chain Conveyor (SDCC)

Project: Gheco Thermal Power Plant Unit No. 1 (700MW x 1), Thailand

Submerged Drag Chain Conveyor
- Normal Capacity: 8.9 ton/h
- Maximum Capacity: 40 ton/h
Bottom Ash Conveyor (BAC) & Bottom Ash Silo

Project: Dangjin Thermal Power Plant Unit No. 5 & 6, Korea

Bottom Ash Silo and Unloading Chute
- Volume: 180 m³
- Diameter x Height: 7m x 8.24m

Bottom Ash Conveyor
- Normal Capacity: 10 ton/h
- Maximum Capacity: 25 ton/h
- Slope Angle: 52°
3.4 Dry Ash Extraction System

- The Dry Ash Extraction System allows the discharge and transportation of the combustion chamber ash of boilers with dry bituminous and brown coal firing systems without the use of cooling water.
- Cooling of the ash takes place through cold air, which is to a small amount on the discharge of the conveyor, but predominant pulled in by the combustion chamber under-pressure via variable air inlets between upper and sub-strand of the apron-belt in the horizontal part.
- This cooling air requirement amounts to approximately 2% of the entire combustion air and reduces beyond that the part of unburned in the combustion chamber ash.
- Fine-grained grinding provided, the possibility often exist to sell this bottom ash together with the flight ash, e.g. as an additive, to the local building and cement industry.
3. Type of Bottom Ash Handling System

Dry Ash Extraction Conveyor (DAC)
Dry Ash Extraction Conveyor (DAC)

Project: Boryeong Thermal Power Plant Unit No. 7 & 8 (500MW x 2), Korea

Dry Ash Extraction Conveyor
- Normal Capacity: 3.74 ton/h
- Maximum Capacity: 12 ton/h
Dry Ash Extraction Conveyor (DAC)

Project: Boryeong Thermal Power Plant Unit No. 7 & 8 (500MW x 2), Korea

Dry Ash Extraction Conveyor
- Normal Capacity: 3.74 ton/h
- Maximum Capacity: 12 ton/h
Secondary Cooling Conveyor

Project: Boryeong Thermal Power Plant Unit No. 7 & 8 (500MW x 2), Korea

- Normal Capacity: 3.74 ton/h
- Maximum Capacity: 12 ton/h
- Slope Angle: 35°
Crushers

Project: Boryeong Thermal Power Plant Unit No. 7 & 8 (500MW x 2), Korea

Primary Crusher
- Maximum Capacity: 12 ton/h
- Single Roll Type

Secondary Crusher
- Maximum Capacity: 9 ton/h x 2 sets
- Vibrating Tube Mill Type
4. Type of Fly Ash Handling System

- Dilute Phase
- Dense Phase
- Vacuum
- Hydraulic
## 4.1 Pneumatic Conveying Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Conditions</th>
<th>Transfer Pressure</th>
<th>Transfer Velocity</th>
<th>Pros / Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dilute(Lean) Phase</td>
<td></td>
<td>1 ~ 1.3 kg/cm(^2) or less</td>
<td>15m/s ~ 30m/s</td>
<td>Can be designed together with Hydraulic type. Branch lines can be merged to one line. Larger bore pipe is required and Higher abrasion is expected.</td>
</tr>
<tr>
<td>Medium Phase</td>
<td></td>
<td>2.5 kg/cm(^2) or less</td>
<td>10m/s ~ 20m/s</td>
<td>Good for grain transportation. Not used for Ash Handling Application nowadays.</td>
</tr>
<tr>
<td>Dense Phase</td>
<td></td>
<td>2 ~5 kg/cm(^2)</td>
<td>2m/s ~ 10m/s</td>
<td>Smaller pipe with high intensity transportation is possible. Smaller Vent Filter is required due to reduced air consumption. Cannot be designed together with Hydraulic type.</td>
</tr>
<tr>
<td>Vacuum</td>
<td></td>
<td>-0.2 ~ -0.7 kg/cm(^2)</td>
<td>10m/s ~ 20m/s</td>
<td>Simple system with low CAPEX compared with positive pressure types. System capacity has limited transportation distance and capacity.</td>
</tr>
</tbody>
</table>
4.1 Pneumatic Conveying (空壓 輸送式)의 분류

PNEUMATIC CONVEYING SYSTEMS
LEAN, MEDIUM AND DENSE PHASE CONVEYING
4. Type of Fly Ash Handling System

4.2 Dilute Phase System
Dilute Phase System

Project: Dangjin Thermal Power Plant Unit No. 5 & 6 (500MW x 2), Korea

Air Lock Feeder & Fly Ash Transporting Pipe
Dilute Phase System

Project: Dangjin Thermal Power Plant Unit No. 5 & 6 (500MW x 2), Korea

Fly Ash Silo and Unloading Chute
- Volume: 2,880 m³
- Diameter x Height: 15m x 19.13m

Fly Ash Transport Blower & EP Hopper Fluidizing Blower Room
- T.A Blower: 5,040 m³/h, 1.1 kg/cm²
- Fluidizing Blower: 900 m³/h, 0.6 kg/cm²
Dilute Phase System

Project: Gheco Thermal Power Plant Unit No. 1 (700MW x 1), Thailand

Fly Ash Transport Blower & EP Hopper Fluidizing Blower Room
- T.A Blower: 4,800 m³/h, 0.9 kg/cm²
- Fluidizing Blower: 900 m³/h, 0.6 kg/cm²

Fly Ash Silo and Unloading Chute
- Volume: 2,760 m³
- Diameter x Height: 14m x 28.8m
4. Type of Fly Ash Handling System

4.3 Dense Phase System
Dense Phase System

Project: Jeddah South Oil Thermal Power Plant (600MW x 4 Units), Saudi Arabia
Dense Phase System

Project: Jeddah South Oil Thermal Power Plant (600MW x 4 Units), Saudi Arabia
Dense Phase System

Project: Tufanbeyli Limestone Handling System (350MW x 3), Turkey
4. Type of Fly Ash Handling System

4.4 Vacuum System

- Ash Silo
- Vent Filter
- Unloading Equipment
- Bag Filter
- Double Damper
- Vacuum Pump
- Ash Intake Valve
- Air Intake Valve
- Heater
- Fan
Vacuum System

Project: Jeju Thermal Power Plant Unit No. 2 (40MW x 1), Korea

Ash Intake Valve & Transporting Pipe
4. Type of Fly Ash Handling System

4.5 Hydraulic System

Project: Dangjin Thermal Power Plant Unit No. 5 & 6 (500MW x 2), Korea

Hydro-Ejector for Sump
4. Type of Fly Ash Handling System

4.5 Hydraulic System

Hydro-Ejector for Pyrites Ash

Project: Dangjin Thermal Power Plant
Unit No. 5 & 6 (500MW x 2), Korea

Gheco Thermal Power Plant Unit
No. 1 (700MW x 1), Thailand
4. Type of Fly Ash Handling System

Project: Dangjin Thermal Power Plant Unit No. 5 & 6 (500MW x 2), Korea

- **Agitating Nozzle**
- **Sump Pump**

**Fly Ash Area Sump Pump**
- Volume: 120 m$^3$
- Pressure: 2.2 kg/cm$^2$
- Pit Size: 2.1m x 2.1m x 2.7m
4. Type of Fly Ash Handling System

HCSD System (High Concentration Slurry Disposal)
5. KC Global Network

Lodge Cottrell Ltd. (UK)
KC Envirotech E&C (Fushun) Co., Ltd.
KC Cottrell China Co., Ltd.
KC Cottrell Inc. (USA)
Nol-Tec System Inc. (USA)
Nol-Tec Europe Srl. (Italy)
Lodge Cottrell India Pvt. Ltd.
KC Catalyst services Co., Ltd.
Beijing Office
Clestra Ltd. KK
Clestra Hauserman Architectural Products Ltd.
KC Cottrell Taiwan Co., Ltd.
Clestra Ltd. Hong Kong
Clestra Australia Pty Ltd.
Nol-Tec Systems (Asia) Pte Ltd.
KC Cottrell Vietnam Co., Ltd.
KC Green Holdings Co., Ltd., KC Cottrell Co., Ltd.,
Jord KC Co., Ltd., Clestra Hauserman Co., Ltd., NWL Pacific Co., Ltd.
## 6. Reference List for Power Plant

<table>
<thead>
<tr>
<th>No.</th>
<th>Customer</th>
<th>Project Name</th>
<th>Application</th>
<th>Boiler Type</th>
<th>Handling Type</th>
<th>Start-Up Date</th>
<th>Removal Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Korea Electric Power Corp.</td>
<td>Yeosu Thermal Power Plant ESP Unit No. 1 &amp; 2</td>
<td>ESP for 200MW x 1 300MW x 1</td>
<td>B-C Oil Fired Boiler</td>
<td>Vacuum</td>
<td>1990</td>
<td>1,000 kg/hr 1,560 kg/hr</td>
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<td>2</td>
<td>Taiwan Power Company</td>
<td>Talin Steam Power Station Unit No. 3 &amp; 4</td>
<td>ESP for 200MW x 2</td>
<td>B-C Oil Fired Boiler w/NH3</td>
<td>Vacuum</td>
<td>1992</td>
<td>650 kg/hr x 2</td>
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<tr>
<td>3</td>
<td>Taiwan Power Company</td>
<td>Shen-Ao Steam Power Station Unit No. 1, 2 &amp; 3</td>
<td>ESP for 75MW x 1 125MW x1 200MW x 1</td>
<td>Coal Fired Boiler</td>
<td>Dense Phase</td>
<td>1993</td>
<td>12 ton/hr 20 ton/hr 28 ton/hr</td>
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<tr>
<td>4</td>
<td>Korea Electric Power Corp.</td>
<td>Boryeong Thermal Power Plant Unit No. 1 &amp; 2</td>
<td>Air preheater for 500MW x 2</td>
<td>Coal Fired Boiler</td>
<td>Sluicing(Wet)</td>
<td>1994</td>
<td>18 ton/hr x 2</td>
</tr>
<tr>
<td>5</td>
<td>Korea Electric Power Corp.</td>
<td>Youngnam Thermal Power Plant Unit No. 2</td>
<td>ESP for 200MW x 1</td>
<td>B-C Oil Fired Boiler</td>
<td>Vacuum</td>
<td>1996</td>
<td>500 kg/hr</td>
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<tr>
<td>6</td>
<td>Korea Electric Power Corp.</td>
<td>Ulsan Thermal Power Plant Unit No. 4, 5 &amp; 6</td>
<td>ESP for 400MW x 3</td>
<td>B-C Oil Fired Boiler</td>
<td>Vacuum</td>
<td>1997</td>
<td>1,200 kg/hr x 3</td>
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<tr>
<td>7</td>
<td>Korea Electric Power Corp.</td>
<td>Samcheonpo Thermal Power Plant Unit No. 1 &amp; 2</td>
<td>ESP for 560MW x 2</td>
<td>Coal Fired Boiler</td>
<td>Dilute Phase</td>
<td>1999</td>
<td>43 ton/hr x 2</td>
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<tr>
<td>No.</td>
<td>Customer</td>
<td>Project Name</td>
<td>Application</td>
<td>Boiler Type</td>
<td>Handling Type</td>
<td>Start-Up Date</td>
<td>Removal Capacity</td>
</tr>
<tr>
<td>-----</td>
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</tr>
<tr>
<td>8</td>
<td>Korea Southern Power Co., Ltd.</td>
<td>Youngnam Thermal Power Plant Unit No. 1 &amp; 2</td>
<td>ESP for 200MW x 2</td>
<td>Orimulsion Fired Boiler</td>
<td>Vacuum w/ Granulating(Pelletizer)</td>
<td>2002</td>
<td>1.5 ton/hr x 2</td>
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<tr>
<td>9</td>
<td>Korea Southern Power Co., Ltd.</td>
<td>Samchunpo Thermal Power Plant Unit No. 1 &amp; 2</td>
<td>ESP for 560MW x 2</td>
<td>Coal Fired Boiler</td>
<td>Fly Ash Classifier System</td>
<td>2002</td>
<td>90 ton/hr</td>
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<tr>
<td>10</td>
<td>Korea Midland Power Co., Ltd.</td>
<td>Jeju Thermal Power Plant</td>
<td>ESP for 40MW x 1</td>
<td>Diesel Generator</td>
<td>Vacuum</td>
<td>2005</td>
<td>1.656 ton/hr</td>
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<tr>
<td>12</td>
<td>Korea Midland Power Co., Ltd.</td>
<td>Boryeong Thermal Power Plant Unit No. 7 &amp; 8</td>
<td>Bottom Ash for 500MW x 2</td>
<td>Coal Fired Boiler</td>
<td>Dry Ash Extraction System</td>
<td>2007~2008</td>
<td>11.21 ton/hr x 2</td>
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<tr>
<td>13</td>
<td>Taiwan Power Company</td>
<td></td>
<td>500MW x 2</td>
<td>Coal Fired Boiler</td>
<td>Dilute</td>
<td>2011</td>
<td>93.12 ton/hr x 2</td>
</tr>
<tr>
<td>14</td>
<td>Doosan Heavy Industries &amp; Construction Co., Ltd.</td>
<td>&lt;br&gt; Tailand Gheco Thermal Power Plant Unit No.1</td>
<td>Bottom, Fly Ash 700MW x 1</td>
<td>Coal Fired Boiler</td>
<td>Bottom Ash - SDCC System, Eco. Ash - Dilute, A.P.H Ash - Dilute, Fly Ash - Dilute</td>
<td>2013</td>
<td>Bottom 30 ton/hr Fly 33 ton/hr</td>
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<tr>
<td>No.</td>
<td>Customer</td>
<td>Application</td>
<td>Boiler Type</td>
<td>Handling Type</td>
<td>Start-Up Date</td>
<td>Removal Capacity</td>
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<td>15</td>
<td>Doosan Heavy Industries &amp; Construction Co., Ltd.</td>
<td>Fly Ash 700 MW x 4</td>
<td>Oil Fired Boiler</td>
<td>Pressure Type (Dense)</td>
<td>2014</td>
<td>3 TPH x 4</td>
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<tr>
<td></td>
<td>Saudi Arabia Rabigh 6 Power Plant Unit No.1~4</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>16</td>
<td>SK Engineering &amp; Construction Co., Ltd.</td>
<td>Limestone handling 350MW x 3</td>
<td>Coal Fired Boiler</td>
<td>Pressure Type (Dense)</td>
<td>2015</td>
<td>114 TPH x 3</td>
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<td></td>
<td>Turkey Tufanbeyli Thermal Power Plant Unit No.1~3</td>
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<td>17</td>
<td>Samsung Engineering Co., Ltd.</td>
<td>Fly Ash 30 MW x 4</td>
<td>Oil Fired Boiler</td>
<td>Vaccum Type</td>
<td>2014</td>
<td>17.3kg/h x 4</td>
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<td></td>
<td>Saudi Arabia Ma’aden Alumina Refinery Steam Plant Unit No.1~3</td>
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<td>18</td>
<td>Hyundai Heavy Industry</td>
<td>Fly Ash 600 MW x 4</td>
<td>Oil Fired Boiler</td>
<td>Pressure Type (Dense)</td>
<td>2015</td>
<td>3 TPH x 4</td>
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</tr>
<tr>
<td></td>
<td>Saudi Arabia Jeddah South Steam Plant Unit No.1~4</td>
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<td></td>
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<tr>
<td>19</td>
<td>Korea Southern Power Co., Ltd.</td>
<td>Bottom, Fly Ash 1,000 MW x 2</td>
<td>Coal Fired Boiler (CFB)</td>
<td>Pressure Type (Dense, Dilute)</td>
<td>2016</td>
<td>31.6 TPH x 2/50.67 TPH x 2</td>
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<tr>
<td></td>
<td>Samcheok Green Power Plant Unit No. 1&amp;2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. World Largest CFBC Boiler Application

2. No Ash Pond, No Discharge, No Open Coal Yard

3. No Waste Water, No Discharge

4. Ash Handling System
   - Bottom(Bed) Ash : Dense Phase (31.6 t/h x 2 Line/Unit)
   - Fly Ash : Dilute Phase (50.56 t/h x 2 Line/Unit)
   - Conveying Distance : Approx. 1,000m
   - Storage Silo : 23,300m³(Fly ash silo x 2 units)
     8,200m³(Bed ash silo x 1 unit)
A Global Leader in Air Pollution Control

Thank you for attention

KC Cottrell