**PROJECT CAPABILITIES**

**NOₓ EMISSIONS REDUCTION**

**NOₓ Generation Mechanisms**

<table>
<thead>
<tr>
<th>Fuel N</th>
<th>Volatile N</th>
<th>Char N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COS</td>
<td>NO</td>
</tr>
<tr>
<td></td>
<td>NH₃</td>
<td>N₂</td>
</tr>
<tr>
<td></td>
<td>C₂H₄</td>
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<table>
<thead>
<tr>
<th>B. “Prompt” NOₓ</th>
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<tbody>
<tr>
<td>CH + N₂ ↔ HCN + N</td>
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<tr>
<td>CN + H₂ ↔ HCN + H</td>
</tr>
<tr>
<td>CN + O₂ ↔ OCN + O</td>
</tr>
<tr>
<td>OCN + O ↔ CO + NO</td>
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</tbody>
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<table>
<thead>
<tr>
<th>C. Thermal NOₓ</th>
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<tbody>
<tr>
<td>N₂ + O ↔ NO + N</td>
</tr>
<tr>
<td>N + O₂ ↔ O + NO</td>
</tr>
<tr>
<td>N + OH ↔ NO + H</td>
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</tbody>
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**Background**

Many plants are facing stricter NOₓ emission limitations from boiler stack gases in the near future. Often, NOₓ emissions must be reduced by more than 50% from current levels.

**Jansen’s Approach to Solving NOₓ Issues**

1. Understanding the customer’s goals
2. Understanding the local environmental permitting constraints.
3. Evaluating the current boiler operation to:
   a. Determine current NOₓ creation mechanism
   b. Analyze the physical arrangement of the combustion system; size of furnace, location of existing burners and air supply
   c. Determine operating strategy/control, fuel splits, load variability
   d. Establish fuel properties
4. Perform Computational Fluid Dynamics (CFD) modeling to predict effectiveness of types of solutions.
5. Evaluating types or combination of NOₓ reduction solutions for most viable and cost effective solutions. Determine capital cost and operating costs as well as “side effects” of proposed solutions.
6. Providing operating recommendations and hardware alterations that best meet the customers’ goals. Where appropriate, possible solutions may include:
   - Staged combustion/overfire air
   - Low excess air
   - Fuel rich secondary combustion (reburning)
   - Urea/ammonia injection (SNCR)
   - Flue gas recirculation (FGR)
   - Low NOₓ burners
   - Automatic combustion controls
7. Design and supply specific NOₓ reduction technology and equipment.

**Selected References (see next page)**
Selected References
NOx Emissions Reduction

Boise - International Falls, MN
Boise - Wallula, WA
Clearwater Paper - Lewiston, ID
Dominion Virginia Power - Altavista, VA
Dominion Virginia Power - Hopewell, VA
Dominion Virginia Power - Southampton, VA
Domtar, Inc. - Ashdown, AR
Georgia-Pacific Corporation - Camas, WA
Georgia-Pacific Corporation - Crossett, AR
International Paper Company - Roanoke Rapids, NC
International Paper Company - Texarkana, TX
International Paper Company - Ticonderoga, NY
Kapstone Papers - Longview, WA
MeadWestvaco Corporation - Covington, VA
MeadWestvaco Corporation - Phenix City, AL
PurEnergy LLC - Rabun Gap, GA
Rayonier, Inc. - Jesup, GA
Simpson Tacoma Kraft - Tacoma, WA
Smurfit-Stone Container Corporation - Hodge, LA
Smurfit-Stone Container Corporation - Missoula, MT
Smurfit-Stone Container Corporation - Stevenson, AL
Stora Enso North America - Wisconsin Rapids, WI
Veolia Waste-to-Energy - Burnaby, BC
Weyerhaeuser Company - Valliant, OK
Wheelabrator Technologies, Inc. - Baltimore, MD
Wheelabrator Technologies, Inc. - Hudson Falls, NY