Powerhouse and Energy Management Capabilities Overview

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JMP Profile

The JMP Difference

We are a culture of assume nothing
Where do our ideas and solutions come from? We are a culture of assume nothing. Our inquisitive mindset requires us to challenge current assumptions and be open-minded to possibilities that no-one has considered before and, through that, develop solutions that will create value for our clients.

We are people producing results
In serving our clients locally and leveraging our global expertise, we have gained our experience by doing and our knowledge from learning. Our people have an uncompromising commitment to producing results and providing exceptional customer service.

We are a promise of performance
Our people bring their intelligence and their hearts to the work they do, in service to our clients’ needs. At its core, our commitment to our clients is one of guaranteed performance, that what we promise is what we will deliver.

We are a product of out think, out do
At JMP, we think in an inside-out way. We are an engineering company who constantly evolves the engineering of our own process to deliver results time after time for new and returning clients. At JMP, we are tireless at finding answers and creating solutions that are a product of this thinking.
A History of Innovation – From Day One

JMP was founded in 1987 in London, Ontario, Canada. From day one, we have pursued leadership positioning in every market we serve. Leadership based on our ability to creatively leverage current technology to enhance manufacturing performance.

We achieved leadership first in the field of Industrial Control Systems, widely recognized and rewarded for our ability to always deliver what we said we would deliver. As we continued to grow in size and influence, we expanded the range of services we offered, adding Data Collection and Information in 1995, and complete Automation Solutions in 1999.

To better serve existing relationships and build new ones, JMP has expanded geographically over the years. Our branch offices are the heart of our project capabilities, with 120+ engineers staffing our offices in:

- Burlington, Ontario (1997)
- Cambridge, Ontario (1997)
- Toronto, Ontario (2003)
- San Antonio, Texas (2006)
- Information Group, Toronto, Ontario (2006)
  - Merger of JMP with Automation Applications Inc., LLC (AAI)
- Dallas, Texas (2011)
- Calgary, Alberta (2012)
- Houston, Texas (2014)
- Montreal, Quebec (2015)
- Lexington, Kentucky (2016)

Our Values – The JMP Way

Our values and beliefs are at the heart and soul of everything we do, what we stand for and, most importantly, where we are going – they are the bedrock upon which we build our future. The values you see below are a set of principles, which capture the spirit, philosophy, and day-to-day business practices of our company – they represent the JMP way. They are not new values, but rather a reinforcement of long-held company principles that underscore our relationships with clients, employees, and business partners.

![Values Graphic]

INTEGRITY
RELATIONSHIPS
EXCELLENCE
LEADERSHIP
RESPECT
COLLABORATION
Our Solutions

JMP is committed to providing manufacturers with the solutions, processes, and technology needed to optimize their production capabilities. In support of this, JMP has developed a series of branded production-ready solutions to help businesses solve their most persistent challenges. We deliver our solutions through our focused branch capabilities, supported by the lines of business.

We Listen and We Deliver! Having delivered over 15,000 projects since 1987, JMP has earned a reputation for delivering world class engineering solutions in core areas.

Our differentiation is founded on delivering engineering services and turnkey solutions that are backed by our Promise of:
1. Guaranteed Performance
2. Exceptional Communications
3. Radical Commitment

For us, it’s simple.

SayDo Ratio: What we say, we do. Every time. All the time!
JMP Engineering

JMP – Philadelphia (Our Process Center of Excellence)
We are an independent full service turnkey solutions provider that specifies, designs, implements, and supports industrial process control and information systems. We represent the Process Control Center of Excellence for JMP, and support JMP branches across North America with boiler and powerhouse control solutions.

JMP - Philadelphia provides innovative automation solutions to industry leading corporations in the chemical, consumer goods, petrochemical, pharmaceutical, pulp and paper, and refining industries, and is unique in its ability to support clients across all of the commonly used process automation system platforms including Distributed Control Systems, Hybrid Control Systems, Programmable Logic Controllers, Redundant Processing Systems, SCADA Systems and PC’s. JMP is able to provide valuable and objective assistance not only in systems implementation, but also in planning project specific and/or long-term process control strategies.

The JMP - Philadelphia technical team specializes in the control, electrical, and software engineering disciplines, and has successfully completed over 500 automation projects. They maintain extensive process and control engineering resources, a full suite of development tools, in-house development systems of commonly used control platforms, and standards and practices to ensure quality and timely delivery.

Energy Solutions and Services are a JMP - Philadelphia core application expertise. The Energy Solutions team is comprised of individuals with hands-on background in boiler controls and process design, start-up and operation, and has collective experience that exceeds 180 years, with an average experience level greater than 15 years. This highly proficient solutions team has successfully completed over 200 Energy and Power automation projects, and has the background and experience to know what is required in automating and upgrading our clients’ powerhouse systems.

JMP Engineering is a certified member of the Control Systems Integrators Association (CSIA) and an active member of the Council of Industrial Boiler Owners (CIBO - www.cibo.org ). JMP is also proud to have reached Solution Partner status with Rockwell Automation, along with Rockwell’s “Control”, “Process”, “Power and Quality Energy Management”, and “Information and Enterprise Manufacturing Intelligence (EMI)” designations. These achievements, coupled with our Robotic Industries Association (RIA) certification, sets JMP apart as being the only company in the world with these three unique and complementary classifications. Add that to our ongoing partnerships with Rockwell Automation, Honeywell, and FANUC, and our capacity to deliver low-risk projects and solutions for our customers is unmatched.
Powerhouse and Energy Management Capabilities Overview

The **powerhouse operating challenges** of meeting the facilities steam and electrical demands at lowest possible cost while operating smoothly, reliably, consistently, safely, and within managed emissions levels can be difficult to accomplish. This can be especially challenging in an atmosphere of unpredictable purchased fuel and electricity costs, electricity deregulation, continual operating and maintenance cost reductions, and increasing environmental regulations.

**JMP Energy Solutions and Services help to meet these challenges.** Through our experienced staff and process knowledge base, we help our clients focus on meeting these demands at lowest possible cost, subject to operating and emissions constraints imposed on the units. Our controls are focused on meeting the Powerhouse Key Performance Indicators. These include:

- Maximize steam supplied per unit of fuel
- Maintain stable header pressures
- Reduce purchased lime
- Provide smoother and more reliable Powerhouse operations

**Our solutions** include:

- **Boiler Regulatory Control Upgrades**
  - Combustion Controls
  - Water-side Controls
  - Balance of Plant

- **Burner Management Systems**
  - Design and Implementation
  - BMS - CCS Integration

**Our approach** begins with a focus on the implementation of the regulatory level controls for each unit. Typical services provided include:

- Control System (DCS/PLC) definition and design
- Regulatory level controls configuration
- Display definition and build
- System staging and test
- Factory Acceptance Test (FAT)
- Installation support
- On-site system load and verification (loop checkout)
- On-site Customer Acceptance Test (CAT)
- Start-up and tuning
- Operator training

Our standard methodology in control system implementation is to collaborate with the owner, the OEM and primary contractors to deliver a control system focused on meeting the defined project objectives.
Our implementation is based upon the design P&I drawings, Sequence of Operations, Instrumentation and I/O lists, and control system standards. Our experience includes most of the major DCS and PLC manufacturers.

**Our Control and SCADA platform experience** includes the following:

- **Distributed (DCS) and Hybrid Control Systems**
  - Rockwell Automation: PlantPAx™
  - Honeywell: TDC3000/Experion®, PKS/LT, PlantScape®/Experion® HS
  - ABB/Bailey: INFI 90
  - Emerson: Fisher PROVOS™, DeltaV™
  - Schneider: Foxboro I/A
  - Siemens: Moore® Products APAC, SIMATIC PCS 7

- **Programmable Logic Controllers**
  - Rockwell Automation: ControlLogix®, CompactLogix™/MicroLogix™, PLC-5®, SLC™ 500
  - Honeywell: IPC 620
  - Schneider/Modicon®: 584, 984, Quantum™
  - Siemens: S7 series
  - General Electric: 90/30, 90/70
  - Triconex TMR

- **Historian Packages**
  - Rockwell Automation: FactoryTalk® Historian
  - General Electric: Historian
  - OSIsoft®: PI System™
  - Honeywell: PHD
  - Microsoft: SQL

- **SCADA and HMI Packages**
  - Rockwell Automation: PanelView™/RSView®/FactoryTalk® View, VantagePoint
  - Honeywell: WebHMI
  - Wonderware®: InTouch
  - Inductive Automation: Ignition® Platform
  - General Electric: Cimplicity, iFix
  - Siemens: WinCC

Our most recent projects in Power and Energy include control system implementations for two separate BFB Power Boiler projects, one for a client in Georgia, and a second project for a BFB and package boiler at a client in Alabama. A third represented engineering and implementation of a multi-phased/multi-year control room consolidation and legacy controller upgrade project for Recovery and Power Boilers for a client in Maine.

For Energy Management and Targeting (EM&T), we have recently implemented both small and large system applications over the past five years. These include a large system for an auto assembly plant in Ontario, Canada, and several systems for food manufacturing clients. All of these systems were implemented with the Rockwell VantagePoint platform.
EM&T Solution Overview

The JMP EM&T Solution further meets the operating challenges defined above by optimizing the powerhouse operations to meet rapidly changing steam and electricity demands of the facility at lowest possible cost, subject to operating and emissions constraints imposed on the generating equipment. This is accomplished by:

- Allocating the entire steam demand among boilers based on minimum costs, while adhering to operational and environmental constraints.
- Maximizing steam supplied by the lowest cost fuels and, as necessary, the lowest emissions fuels.
- Distributing steam economically among turbines and PRV’s to maximize total power generated and minimize the use of PRV’s, while meeting downstream header demands.
- Maintaining stable individual header pressures for operating units and electrical generating requirements.
- Managing the facilities bill for purchased electricity and fuel.

The JMP EM&T Solution is enabling companies to achieve:

- Smoother and more reliable powerhouse and demand-side operations
- Significant reductions in total purchased energy (fuel and electricity)
- Managed emissions
- Accelerated project ROI’s

The JMP EM&T Solution consists of a suite of modules that are tailored to the client’s powerhouse. The EM&T Suite includes:

- **Energy Management and Targeting (EM&T)** - Provides a unified energy dashboard with real-time actual usage/demand reporting. Includes data from all energy use systems, e.g. water, heat, powerhouse, air, HVAC, process and manufacturing areas. Desk-top visualization of where peak costs are impacting each department, including real-time performance of assets, to set consistent priorities and reduce energy consumption on non-performing assets. Also provides basis for determination of which assets should be replaced and when.

- **Advanced Boiler and Fuels Allocation** - This module allocates the total steam among multiple boilers and/or fuels based on minimum costs while controlling header pressure and adhering to boiler constraints (e.g. furnace draft, drum level, emissions). Load decisions are made in direct response to header pressure fluctuations. Incremental cost for the next unit of steam is continuously calculated for each boiler. Boilers and fuels with lower incremental steam costs and emissions are favored more than boilers and fuels that are more costly.

- **Advanced Turbine Load Allocation** - This module allocates steam economically among multiple turbines and pressure reducing valves while adhering to constraints (e.g. header pressure, electrical power generation, electrical power purchased, extraction flows) to minimize the cost of producing electricity and venting steam, and maximize total electrical power generated.
• **Advanced Coordinated Header Pressure (CHP™)** - This module maintains stable header pressures for all combinations of boilers, fuels and equipment conditions. It minimizes header pressure disturbances and can handle several pressure upsets on different headers concurrently in a coordinated fashion with minimum upset to the overall steam system. This module also provides multiple prioritized control strategies depending on the severity of the upset.

• **Advanced Tie-Line Control** - This module manages the facilities electric power purchases to minimize the total cost of purchased energy (electricity and fuels). The advanced control strategy is built around the client’s contract with the power company serving the facility, whether it is based on established rates or real-time pricing schedules. This module has several control modes:
  - The **Real-Time Pricing (RTP) Control Mode** downloads the power company’s purchase and sell prices, compares these current prices against incremental generation costs, determines optimal equipment (condensing, extracting, and gas turbines, steam condensers and venting) loading based on cost comparisons, and advises how much should be bought or sold.
  - In the **Fixed Purchase or Sell Mw Control Mode**, total plant generation is controlled to maintain instantaneous Mw purchase or sales target while respecting multiple constraints without regard to purchase demand intervals.
  - In the **Interval Demand Mw Control Mode**, total plant generation is controlled to maintain an average Mw purchase target over 15 or 30-minute intervals.

• **Advanced Economic Load Shedding** - This module utilizes an inferential rule-based risk assessment strategy to make load shedding decisions to reduce purchased electrical costs. In the manual mode, the system advises operators that electrical or steam loads should be shed. Loads may also be tripped automatically.
EM&T Solution Technology Overview

The JMP EM&T Solution is based on proven technology, and is comprised of a combination of regulatory controls and a rule-based, closed-loop supervisory control system utilizing multivariable priority constraint control strategies. Powerhouse equipment and operational constraints, as well as environmental constraints, define a safe operating envelope. The EM&T drives to the optimum operating conditions within the envelope. Advanced energy management control strategies are implemented using a prioritized grouping of configurable tunnel controllers that incorporate rules and constraints to form the safe operating envelope and optimize the Powerhouse.

The EM&T includes a library of advanced control functions, standard operating, engineering and maintenance displays and reports, and on-line tools for configuration, tuning and system modification. Operating displays have an intuitive look and feel. Graphical interfaces allow adjustment of costs, constraints and rules without programming. Tuning the system is achieved graphically. Rules are easily added as additional constraints and requirements are discovered. Increased flexibility insures long term maintainability.

EM&T Solution Technology provides the following benefits:

- Superior level of dynamic/robust control
- Easy for operations personnel to understand and use
- Requires little technical system know-how
- Easy to maintain, modify. System functions are configured – no programming.
Energy Solutions and Services

Delivery of a JMP Energy Solution includes services ranging from solution definition with associated projected benefits through design, implementation, installation, start-up and on-going support. All Energy Management Solution Services are implemented under the direction of a JMP Project Manager who assures all work is completed under a standard systems development methodology to ensure the highest level of quality, a consistent development approach, and the timely completion of all tasks.

The JMP Energy Solutions Team brings extensive Powerhouse experience, knowledge of both legacy and current control systems, and a proven project execution methodology. The Energy Solutions Team can provide the following project services:

- **Solution Definition**
  - Solution scope definition with projected benefits
  - Functional specifications

- **Solution Design**
  - Application engineering
  - Control system hardware, software, and subsystem integration design
  - Drafting services – AutoCAD

- **Instrumentation Design**
  - Field instrumentation design
  - Instrumentation database package – instrument data sheets

- **Implementation**
  - Regulatory and Advanced Control and operator interface configuration
  - Hardware selection, specification and procurement

- **Solution Testing/Simulation**
  - Solution testing to meet functional criteria
  - Support of operator “what if” scenarios
  - New constraint testing and tuning before on-line commissioning

- **Installation and On-Site Integration**
  - Field instrument, rack room, and control room installation design
  - Site management/supervision
  - Field I/O, subsystems

- **Start-Up and Commissioning Assistance**
  - System Load and check-out
  - I/O Loop checkout support
  - Tuning
• **Documentation with all documents updated to “as built”**
  - Functional, system design, and subsystem interface specifications
  - Logic and SAMA loop drawings
  - Operator, engineer, and data base configuration manuals

• **System Maintenance and Continuing Support**
  - Operator and Maintenance training
  - Ongoing phone support
  - Follow-on tuning
  - Enhancement and support agreement.
EM&T Solution Example Installations

Location: Alberta, Canada

Powerhouse Equipment: power boilers, recovery boilers, turbines, steam headers

Project Scope: JMP installed a complete Energy Management System that controls all aspects of steam and electrical generation and electrical purchasing. The system is designed to meet the mill’s requirements: reduce and minimize purchased gas, maximize steam from waste fuel, maximize power boiler stability, reduce steam venting and excessive steam condensing, generate electrical power in the most cost effective manner, and increase electrical power generation when import power costs are high. Major components of the system are:

- Boiler Load Allocation
- Turbine Load Allocation
- Coordinated Header Pressure Control
- Demand and RTP Tie-Line Control

Control System Platform: PC, Honeywell DCS

Results:

- Reduction in natural gas purchase of 14%
- Reduction in total purchased energy (gas and electricity) of 13%
- Greater Powerhouse operating stability
- Accelerated Return on Investment
  - Actual ROI was less than six months vs. original estimate of one year.

Location: Alabama

Powerhouse Equipment: power boilers, recovery boilers, turbines, steam headers

Project Scope: The mill entered into a contract to purchase power from its utility, Alabama Power. The contract includes a Real Time Pricing (RTP) provision for mill power pricing on an hour-to-hour basis. The Tie-Line Control System coordinates and optimizes the mill’s utility connection to provide the lowest total energy cost possible and operates with the following objectives:

- Ensure compliance with operating regulations and constraints
- Reliably provide steam and power with minimal variation
- Minimize costs of steam and power

The PC-based Tie-Line Control System automatically makes BUY vs. MAKE power decisions, based on real-time cost of purchased power and other cost and constraint parameters.

Control System Platform: PC, Rockwell-AB PLC, GE Mark V

Results:

- Reduction in Mill’s overall purchased power costs
- Project ROI in less than six months
Experience List - Boiler Control Implementation

Industrial and Utility Boiler Owners have seen significant improvement in operating efficiency and combustion stability through application of JMP control strategies, with payback on some projects within a few months. This is accomplished by applying proven control techniques on individual processes, then moving to an overall coordination scheme, and finally by designing systems which are accepted by operation and remain in automatic nearly 100% of the time.

The following is a representative list of installed boiler controls designed and implemented by the JMP Boiler Combustion Control Team. To date, JMP has installed combustions controls and advanced optimization solutions on 50 plus Recovery and Industrial/Utility Power Boilers in North America. Examples of those installations are as follows:

(Note: Please pardon any errors in this list. While this list is updated frequently and every attempt is made to maintain the accuracy of this information, given the ongoing rationalization of mills and industrial boilers, this list may contain errors.)

<table>
<thead>
<tr>
<th>Experience List - Boiler Control Implementation</th>
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<tbody>
<tr>
<td><strong>Abitibi Bowater</strong></td>
<td><strong>CANFOR Pulp, Intercon</strong></td>
<td><strong>Norske Skog Canada</strong></td>
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<tr>
<td>Thunder Bay, ON</td>
<td>Prince George, BC</td>
<td>Campbell River, BC</td>
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<tr>
<td>1 Power Boiler</td>
<td>1 Recovery Boiler</td>
<td>2 Recovery Boilers</td>
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<tr>
<td>Fuels: Wood, NG, Mill Waste</td>
<td>w/JMP PRC™</td>
<td>w/JMP PRC™</td>
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<tr>
<td>Foxboro DCS</td>
<td>Foxboro DCS</td>
<td>Honeywell DCS</td>
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<tr>
<td><strong>Catalyst Paper (formerly Verso)</strong></td>
<td><strong>CANFOR Northwood</strong></td>
<td><strong>Georgia-Pacific Corporation</strong></td>
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<td>Rumford, ME</td>
<td>Prince George, BC</td>
<td>Brunswick, GA</td>
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<tr>
<td>1 Recovery Boiler</td>
<td>2 Power Boilers</td>
<td>2 Recovery Boilers</td>
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<tr>
<td>w/JMP PRC™</td>
<td>Fuels: Bark, NG,</td>
<td>w/JMP PRC™</td>
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<tr>
<td>2 CFB Power Boilers</td>
<td>Energy Management Solution</td>
<td>1 Power Boiler</td>
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<tr>
<td>Fuels: Wood, Coal, Mill Waste</td>
<td>1 Recovery Boiler</td>
<td>Fuels: Bark, NG, Oil</td>
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<tr>
<td>Honeywell DCS</td>
<td>w/JMP PRC™</td>
<td>Honeywell DCS</td>
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<td>Emerson DCS</td>
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<td><strong>Resolute Forest Products</strong></td>
<td><strong>Daishowa-Marubeni Int’l. Ltd.</strong></td>
<td><strong>Georgia-Pacific Corporation</strong></td>
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<tr>
<td>Catawba, SC</td>
<td>Peace River, AB</td>
<td>Cedar Springs, GA</td>
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<tr>
<td>2 Recovery Boilers</td>
<td>1 Recovery Boiler</td>
<td>3 Recovery Boilers</td>
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<td>w/JMP PRC™</td>
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<td>Honeywell DCS</td>
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<td></td>
<td>Fuels: Bark, NG, Oil</td>
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<td>Energy Management Solution</td>
<td>Honeywell DCS</td>
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<td>Company</td>
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<td>Boilers/Units</td>
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<td>St. John, NB</td>
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<td>Resolute Forest Products</td>
<td>St Felecian, PQ</td>
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<td>SAPPI</td>
<td>Cloquette, MN</td>
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<td>Graphic Packaging</td>
<td>West Monroe, LA</td>
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<td>Fuels: Bark, NG, Oil</td>
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<td>Av Nackawic</td>
<td>Nackawic, NB</td>
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<td>w/JMP PRC™</td>
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<td>Northern Pulp (formerly K-C)</td>
<td>Abercrombie Point</td>
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<td>w/JMP PRC™</td>
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<td>1 Power Boiler</td>
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<td>Fuels: Bark, Oil</td>
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<td>Smurfit-Stone Corporation</td>
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<td>International Paper</td>
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<td>International Paper</td>
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<td>International Paper</td>
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<td>Kaukauna, WI</td>
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<td>Company</td>
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<td>Boilers/Boiler Details</td>
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<td><strong>Renew Paper (formerly Tembec)</strong></td>
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<td>1 Recovery Boiler w/JMP PRC™ ABB/Bailey DCS</td>
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<td><strong>Domtar</strong></td>
<td>Kamloops, BC</td>
<td>2 Power Boilers Fuels: Bark, Gas, Oil Emerson DCS</td>
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<td><strong>EnGeneration</strong></td>
<td>Lumberton, NC</td>
<td>4 Stoker Power Boilers Fuels: Coal Honeywell DCS</td>
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<td><strong>Eli Lilly and Company (ImClone)</strong></td>
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<td><strong>WestRock</strong></td>
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<td>1 Gas fired PKG Boiler 1 BFB Boiler Honeywell DCS</td>
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