True North Consulting, LLC

The Next Level for Thermal Performance

150 Merchant Drive
Montrose, Colorado 81401
970-252-1832
970-252-1837 (fax)
tnorthconsulting.com

Thermal Performance
TRUE NORTH CONSULTING
Company Profile
Thermal Performance

True North Consulting is dedicated to providing the highest level of support to the power industry regarding Thermal Performance Services. Our focus is on providing service which is technically sound and meets the needs of the power plant. True North Consulting brings significant engineering and plant experience to provide a complete suite of services and complementing products to analyze a power plant’s total ability to produce electricity reliably and efficiently. Our products are integrated with our service commitment ensuring the client’s needs are met. True North’s experience level includes all aspects associated with plant efficiency from Engineering, Design, Maintenance and Operations.

Presented in this booklet is an overview of services and products offered by True North Consulting along with a comprehensive experience profile listing clients and services performed on their behalf. Also included is information concerning our managerial staff and Engineering resources as well as general information concerning our office locations and contact information.

We sincerely hope this provides a clear representation of how True North Consulting could benefit Thermal Performance and engineering needs at your Station. We look forward to hearing from you and the opportunity to propose our services.
Why Thermal Performance?

Thermal Performance is the overall evaluation of a power plant’s electrical production with respect to its fuel consumption expressed in heat rate (BTU/KWH). In the case of a Nuclear Power plant, an improved heat rate will result in more electricity being provided to the grid and can result in increased revenue to the plant. If the yearly average price for electricity is $25. per MWhr, a 1 MWe improvement will result in a yearly revenue increase of approximately $200,000. In the case of a Fossil Fire plant, the savings will be in fuel costs and will vary based on whether the plant is peak or base loaded and the particular fuel arrangements. These savings could be as high as $100,000 per year for every 0.1% improvement in plant heat rate. Many plants will have recoverable losses up to 5MWe which will result in fuel saving of $500,000 per year or in the case of nuclear power plants $1,000,000 per year of increased revenue. These returns will vary based on a particular Power Plant’s contracts and agreements with transmission and distribution grids. With the increasing cost of non-renewable fuel sources, the possible savings will only increase. The goal of True North’s Thermal Performance group is to take advantage of existing investments while increasing efficiency which results in providing more power or using less fuel.

With all the new legislation coming down the pike, a utility’s ability to improve efficiency may have significantly more benefits than those described above.
Thermal Performance

Table of Contents

Services / Capabilities ................................................................. 6

Company Experience Profiles ....................................................... 33

Core Staff & Resources ................................................................. 47
Services / Capabilities

Thermal Performance Program Assessment .............................................. 7

Engineering Analysis and Support .......................................................... 10

Testing ........................................................................................................ 13

Training ....................................................................................................... 15
  Thermal Performance Training ................................................................. 15
  Performance Software Applications Training ....................................... 15
  Advanced Courses .................................................................................. 16

Customized Software Solutions ............................................................... 17
  TP-Plus Thermal System Monitor ............................................................. 17
  TP-Plus Cycle Isolation Monitor .............................................................. 25
Thermal Performance Program Assessment

The Key to our success at True North Consulting is the integration of our products and services to bring an all encompassing, well structured solution to improving plant Thermal Performance. The flow chart below indicates our approach to providing a results oriented solution to your Thermal Performance needs. It all starts with an assessment which integrates our experience and tools to identify specific performance improvements as well as foundational programmatic solutions.
True North Consulting performs full scope program assessments. We leverage our experiences at similar plants to quickly validate existing scope and then focus in-depth on plant areas or situations unique to that particular station.

The full scope assessment executes reviews of design data such as thermal kits and plant drawings aimed at validating the scope of the program under review. It is typically structured to ensure all required systems and components are included within the program. It can also be designed to perform a negative logic review to verify required program systems or components have not been excluded. Included in the full scope review is a management overview, designed to provide a review of program implementation and maintenance aimed at providing a responsible manager, confident that his program is being correctly implemented and maintained.

The areas covered in the full scope review include:

- **Department interfaces:**
  - Operations: Insure operational issues identified by the Thermal Performance program are adequately addressed based on the severity of the issue.
  - Work Control: Insure proper scheduling of work to minimize the loss to plant electrical generation (i.e. not working on circulators in the summer months). This evaluation will also include prioritization of work that can affect plant output especially work that may not be easily recognized as a Thermal Performance issue. This would include Planned Maintenance and Corrective Maintenance.
  - Maintenance Interface: Evaluate the connection between the work being performed and the expected result.
  - Design Engineering: This is a two way evaluation to insure all the latest design information is taken into account by the Thermal Performance program and any Thermal Performance issues that may affect design calculations are taken into account.
  - Programs Engineering: Are the proper interfaces established between the various Programs that have an effect on the Thermal Performance program or the Thermal Performance program’s effect on other Programs. Examples may be: Erosion Corrosion Program; Steam Generator Replacement Program; MOV/AVV Programs; System Engineering.

- **Thermal Performance Model:** Review the current secondary heat balance model comparing it to the plant design. This review will include not only the turbine vendor thermal kit, but also all plant drawings related to the heat balance. It is
often the case that the turbine vendor thermal kit does not accurately reflect either the plant design or the current plant operation. True North has extensive modeling experience and can greatly improve the accuracy of the heat balance model.

- Plant and/or Component Evaluations: Perform a step wise review of each plant component and its effect on overall plant performance. All Secondary cycle heat exchanges, pumps, turbines, and drain tanks will be evaluated based on the plant data.

- Cycle Isolation Walk Down: After a review of secondary cycle plant drawings, a walk down of all paths that could result in energy bypassing the cycle to the condenser will be performed. This will yield a list of valves that should be further evaluated for leakage. Depending on the access to the various locations, temperatures will be measured either at the valve bonnets or at a downstream location.

- Plant Reconciliation: A report classifying all identified losses will be provided. This report will reconcile the actual generation of the plant with the target generation based on the vendor thermal kit corrected to actual plant design.

- MWe Improvement Recommendations: Based on the plant and component evaluations and reconciliation process, a list of recommended repairs or operational changes will be produced. This list will be prioritized by the overall cost effectiveness of each recommendation.

- Monitoring Practices: The current plant monitoring practices will be evaluated to determine their effectiveness in identifying plant losses. This evaluation will include which parameters are monitored and at what frequency, the calculations used to assess performance, and the communication of the monitoring results. This evaluation will include not only plant parameters, but also cycle isolation and plant walk downs.

- Instrument Modifications: A detailed evaluation of key instruments used in performance monitoring will be performed to determine if any cost effective changes are necessary to adequately monitor plant performance. This evaluation will include the location of the instrument, calibration practices, and the type of instrument used. One possible result of this evaluation may be using other already installed instrumentation in conjunction with the instrumentation currently being monitored.
Engineering Analysis and Support

True North’s Thermal Performance group has significant experience in various aspects of engineering analysis in support of major plant modifications. We hold a license for THERMODYNAMIC MODELING, the industry standard for power plant thermodynamic analysis, and have experience in the use of various other engineering analysis tools. We also can perform uncertainty analysis for complex systems as well as individual components. Our engineering staff has broad experience and can meet many of your engineering needs.

- **Procedural Support/Development**: True North has significant experience in procedural development for engineering programs coupled with expertise in efficiency monitoring. This combination will provide program procedures which covers every aspect of the Thermal Performance program.

- **PTC-6 Testing Support**: True North can provide support for turbine guarantee testing including independent assessment of results, test procedure development, instrumentation specifications, and turbine vendor negotiation support.

- **Heat Balance Analysis**: True North has over 25 years of modeling experience using THERMODYNAMIC MODELING, the industry standard for heat balance software. Even if the utility does not own a copy of the software, heat balance evaluations can be performed for design or diagnostic purposes. The heat balance model determines the thermodynamic conditions (pressures, temperatures, flows etc…) at various locations in the secondary plant. This information can be used for either design analysis or for understanding the affects of abnormal plant conditions. Listed below are some of the heat balance evaluation services True North has experience in providing.

  - **Power Uprate Turbine Cycle Evaluation**: Many plants are opting to increase their power output by increasing the thermal generating capability of the plant. True North can provide detailed analysis of the secondary cycle to find the “pinch points” which may be limiting for the proposed power uprate.

  - **Steam Generator Replacement Evaluations**: Most steam generator replacement projects require interface with the secondary cycle heat balance. True North has experience working with Steam Generator replacement projects to insure the two sides of the plant are adequately matched up to obtain the expected results.
- Model Development & Improvements: Heat balance models can either be
developed from scratch or improved to more accurately reflect plant
conditions. Model improvement can also be made to aid in day to day
performance evaluation of plant efficiency.
- Run a “what if” operating scenario (heater out of service, etc.)
- Plant Condition Evaluation: If a plant is experiencing a thermal efficiency or
even a reliability problem, the secondary heat balance model can be used to
evaluate the condition.
- Plant Modification Studies: When a modification is proposed for a plant, a
heat balance evaluation can determine the effect of the modification on the
entire turbine cycle thus preventing a good idea from turning into a bad
application.
- Environmental Heat Rejection Studies: Both Federal and State agencies
require permits and have requirements for heat rejection to the environment.
True North has experience performing engineering evaluations of the power
plant’s heat rejection for permit renewal and design modifications.
- Megawatt Loss Evaluations: The heat balance software can be leveraged to
provide identification of efficiency losses and to evaluate the magnitude of a
plant efficiency problem.
- Vendor Claim Evaluation: Evaluations can be performed on vendor’s
(Turbine, Feed water Heater, and Moisture Separator Re-heater) proposals to
independently assess the impact or MWe increase of a proposed modification.

- Thermal Component Analysis: True North can provide services from plant data
evaluation to complete testing to troubleshooting thermal efficiency problems with
secondary plant components including:
  - Feedwater Heaters
  - Turbines
  - Cooling Towers
  - Pumps
  - Moisture Separators
  - Re-heaters
  - Condensers
  - Secondary Valve Leakage

- Power Calculation Evaluation: In nuclear power plants, operating within the
licensed thermal limits is of the utmost importance; in Fossil plants, knowing your
thermal power input can have significant economic implications. True North has
experience in evaluating the power calculation from the thermal cycle point of
view. Our experience includes flow, pressure and temperature measurement
expertise, and can provide significant improvements to the power calculation
uncertainty. True North’s services include:
- Review all inputs to the plant calculation of power.
- Evaluate overall power calculation uncertainty.
- Evaluate power calculation instrumentation.
- Identify plant parameters which can be used as an independent means of monitoring core power in order to prevent any error in the power calculation to go unnoticed and result in an over power condition or lost generation due to operating with an overly conservative power calculation.

- **Uncertainty Analysis**: Related to the power calculation or safety systems, uncertainty analysis plays an important role in maintaining safety margins or understanding the true quality of a turbine test. True North has significant experience in the performance of formal uncertainty analysis.

- **Thermal Performance Monitoring**: True North can provide assistance in every aspect of thermal performance monitoring either from the ground up or through enhancement of an existing monitoring program. True North has experience working with Online Monitoring software providers to insure any package will meet the needs of the power plant. With extensive knowledge of performance calculations and instrumentation, True North will insure that any performance monitoring program will be effective. The following services can be provided by True North:
  - Develop or enhance existing online monitoring capability.
  - Provide software to evaluate plant performance.
  - Provide remote monitoring of plant performance.
  - Provide Thermal Performance Reporting
    - Heatrate
    - Management
    - Component Efficiency
    - MWe Accounting

- **Major Modification Engineering**: True North has extensive experience in developing and implementing major plant modifications, both from the project management and the engineering side of the process. This includes various types of power plant uprates (EPU/MUR) and component change outs.
Testing

Results from Thermal Performance Tests assist plants in quantifying equipment performance, identifying and quantifying losses, minimizing or preventing future losses, and optimizing unit operation. Additionally, testing can be used to meet environmental or grid controller requirements.

Thermal Performance testing results can be used to:

- Schedule maintenance outages
- Evaluate equipment modifications
- Evaluate changes in operating procedures
- Detect location of performance changes
- Establish baseline performance for major equipment
- Meet environmental commitments (316.b)
- Diagnose performance degradation
- Independently evaluate turbine retrofits (3rd party evaluations)
- Assist load dispatching to reduce overall utility fuel usage
- Evaluate energy credits or carbon usage

True North Consulting's Capabilities

True North Consulting is highly qualified to perform routine thermal performance and equipment acceptance testing. Our engineers have extensive experience in various types of power plant testing in accordance with the applicable industry standard test codes (ASME, ATC, ASHRA, etc.)

- Heat Rate testing
- Capacity testing
- Steam Turbine testing (nuclear, fossil, combined cycle)
- Gas Turbine testing
- Feedwater Heater testing
- Cooling Tower testing
- Boiler testing
- Pump testing
- Condenser testing
- Accurate flow testing
- Diagnostics
- Troubleshooting
- Overall plant monitoring
- Heat Exchanger testing
- Moisture Separator Reheater testing
True North Consulting can also provide custom Thermal Performance Testing services to fit individual plant requirements.

**Methodology**

- Participate in an on-site kick off meeting
- Perform on-site plant walk down
- Prepare information request
- Review plant schematics, P&IDs, heat balances and other plant data
- Prepare detailed test procedure in accordance with applicable test codes
- Provide sufficient manpower to properly install and validate test instrumentation
- Perform pretest analysis with thermodynamic modeling software
- Prepare test calculation spreadsheet using TP-PLUS TSM Thermal System Monitoring Software
- Prepare cycle isolation analysis using TP-PLUS CIM Valve Leakage Analysis Software
- Provide on-site test supervision, coordination and support
- Perform detailed data reduction, test data analysis
- Deliver a peer-reviewed, comprehensive final report with incorporation of customer comments

**Instrumentation**

True North Consulting uses state-of-the-art, high accuracy instrumentation, data acquisition systems and software. An additional benefit to using True North Consulting is the ability to accurately measure critical system flows with advanced cross-correlation flow measurement techniques.

**Support and Additional Services**

As a feature of our “total plant solution” approach, we are able to integrate thermodynamic modeling, analysis and other unique plant optimization concepts for consideration as an extension to our testing services or as an adjunct to a client’s testing program.
Training

Monitoring a power plant’s Thermal Performance requires talents from various disciplines combined with practical ability and a good understanding of thermodynamic principles. True North Training Courses bring these attributes together by combining excellent theoretical knowledge with significant plant experience. True North brings over 25 years of applying thermodynamic theory and procedures to increase plant generation and recover lost generation.

Thermal Performance Training

The Thermal Performance Course lays a foundation in theory, provides practical methods for thermal performance program development, and explains how to detect and recover lost generation due to component or systemic problems. The course includes various workshops where the student uses tools to analyze plant problems. Interfaces with various departments are discussed along with how to integrate plant data into decision making process. This is typically a four-day course.

We have specific courses focused on your type of power plant whether it is Fossil (Coal or Oil), Combined Cycle, or Nuclear. We even have a course on electrical aspects of a power plant for thermal performance personnel.

Performance Software Applications Training

The Performance Software Applications Training provides specific applications of the THERMODYNAMIC MODELING performance software to actual practical plant scenarios to assist plant personnel in quickly finding and recovering lost generation due to component or systemic problems. True North brings these scenarios together by combing excellent theoretical and software application knowledge with significant plant experience. This is typically a four-day course.
Advanced Courses

Performance Monitoring Software Use
Detailed explanation and workshops on how to use Thermal Performance software to:

- Find plant lost generation.
- Perform design analysis.
- Generate reports.
- Evaluate plant changes.

Power Plant Thermodynamic Applications
In depth study of thermodynamics as it relates to analysis of power plant components and cycles. This course will take you through the theory and application using many hands on examples. All components of the power plant will be covered in detail.

Power Plant Testing
This is a complete course on Power Plant Testing. This course will enable an engineer to design and implement a full scale ASME PTC-6 test along with other component tests such as feed water heaters, condensers, and cooling towers.

Component Specification Development
The aging fleet is looking at the new vendor turbine designs as a way of improving and extending the life of existing investments. This course will provide the necessary information to ensure that the generation purchased will be the generation delivered. It also provides an understanding of how to specify all power plant components from the Generator to the heat exchangers.

Electrical Aspects for Thermal Performance Personnel
There are many points of contact between those responsible for the mechanical/thermodynamic side of the power plant and the Electrical elements. This course gives those not familiar with the electrical aspects a good theoretical foundation and practical understanding of transmission / distribution, metering power, generators, and other major electrical components in the power plant. This course also clearly draws out the important connection between the Thermal Performance monitoring of a power plant and the electrical aspects.
Customized Software Solutions

Thermal Performance – Plus

There are many software products on the market promoting performance evaluation tools and features. TP Plus helps solve day to day performance problems rapidly and in a cost effective manner. The true value of the True North TP-Plus solution lies in the associated services provided by our plant performance experts – expertise that will be passed on to the plant engineer.

TP – Plus is a Thermal Performance engineering tool kit consisting of several powerful and unique calculation modules for use in the electric power industry to simplify and provide time-saving convenient methods of tracking Thermal Performance in nuclear, fossil and combined cycle plant applications.

TP – Plus includes a user interface into this family of calculation modules. Modules can be purchased as needed and added to the TP – PLUS package at any time.

The TP - Plus family consists of many power thermal performance modules.

Implementation Services

To complement the software, True North Consulting includes services by experienced staff to install, configure and provide training at the plant site for use and application of TP-Plus.

The True North guarantee is that when we leave your site you will know how to use the tools to improve your plant Thermal Performance! Additionally we will be there to help resolve any problems encountered.

Thermal Performance Plus TSM - Thermal System Monitor

TP - Plus TSM is designed by utility engineers as a tool to perform all standard Thermal Performance analysis and reporting functions, while also providing a familiar platform to do further analysis if desired. TSM is designed to display a top down evaluation of a plant’s Thermal Performance.

TP - Plus TSM provides an overall summary to quickly grasps the status of the unit while providing the ability to easily obtain detailed reporting of significant Thermal Performance behavior to account for lost generation and heat rate in fossil, nuclear and combined cycle generating plants.
With TP - Plus TSM, plant personnel can quickly detect and quantify losses in a plant cycle. True North will configure customized TP – Plus TSM reports that match your needs and reporting structure.

Interface forms are available in a web-like convenient format for easy access to reports and performance information. Alerts are provided for quick identification of performance deviation.

TP - Plus TSM includes powerful trends to view performance information. Each report compares current plant operation to both baseline and historical targets in tabular and graphical formats.

Results from TP- Plus TSM reports provide information to the busy plant engineer prioritizing plant Thermal Performance. The reports are developed to the plant specifications. Additionally, manager reports are included with summarized results of Thermal Performance alerts and prioritized action items.

**Features of TP-Plus TSM**

- Top level summaries of plant performance
- Detailed Megawatt/Heatrate accounting
- Customized Thermal Performance status to describe losses
- Detailed performance information for all major components
  - Boiler/Reactor/HRSG
  - Turbines
  - Air Heaters
  - Feed water Heaters
  - Re-Heaters
  - Moisture Separators
  - Re-Heaters
  - Major Pumps
  - Condenser
  - Cooling Tower
- Thermal Power Monitor to track the health of Reactor Power or Boiler Power Calculation.
- Pre defined customized trend menus (resident in memory)
- Easy graphing of all data from input to final calculated values
- Data Validation
- Ongoing service and support from True North’s experienced Thermal Performance staff
• Tailored Reporting for specific studies

Benefits of TP - Plus TSM

• Identify new areas where plant efficiency can be increased.
• Establish a Thermal Performance Monitoring Program.
• Recover Lost Megawatts.
• Reduce elapsed time between the start of a problem and the correction of the problem
• Report thermal performance information easily and simply to plant management.

Sample Summary Report
Sample TP-Plus TSM Summary Graphs

Sample TP-Plus TSM MW Accounting Report
## Unit 3 Thermal Power Health Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Tag Name</th>
<th>Units</th>
<th>Today</th>
<th>Licensed</th>
<th>Historical Average</th>
<th>Predicted</th>
<th>Uncertainty</th>
<th>Power Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Power</td>
<td>TNC PWR</td>
<td>MWth</td>
<td>3987.8</td>
<td>3980.0</td>
<td>3981.7</td>
<td>3970.4</td>
<td>0.35%</td>
<td>-0.21%</td>
</tr>
</tbody>
</table>

### Power Calculation Independent

<table>
<thead>
<tr>
<th>Description</th>
<th>Tag Name</th>
<th>Units</th>
<th>Today</th>
<th>Benchmark Date (Manual Input)</th>
<th>Predicted CTP</th>
<th>Systematic Uncertainty</th>
<th>Random Uncertainty</th>
<th>Total Uncertainty</th>
<th>Power Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP TURB 1ST STG PRESS</td>
<td>ppsa1</td>
<td>psa</td>
<td>736.5</td>
<td>737.0</td>
<td>3967.1</td>
<td>0.56%</td>
<td>0.194%</td>
<td>0.635%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP TURBINE EXHAUST PRESS</td>
<td>ppsa2</td>
<td>psa</td>
<td>273.5</td>
<td>272.0</td>
<td>3807.3</td>
<td>2.08%</td>
<td>0.228%</td>
<td>2.316%</td>
<td>3800.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa3</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa4</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa5</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa6</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa7</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa8</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa9</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa10</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa11</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa12</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa13</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa14</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa15</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa16</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa17</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa18</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa19</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
<tr>
<td>HP 8 SHELL PRESS</td>
<td>ppsa20</td>
<td>psa</td>
<td>291.5</td>
<td>290.0</td>
<td>3968.9</td>
<td>3.96%</td>
<td>0.220%</td>
<td>4.186%</td>
<td>3960.0</td>
</tr>
</tbody>
</table>

---

**Sample Report Screen – Thermal Power Health Summary**
Sample Report Screen – TP-Plus TSM Condenser Performance Summary

<table>
<thead>
<tr>
<th>Performance - All Condensers</th>
<th>Today</th>
<th>Baseline</th>
<th>Delta</th>
<th>Historical</th>
<th>Delta</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcooling (deg f)</td>
<td>1.5</td>
<td>0.0</td>
<td>1.5</td>
<td>1.7</td>
<td>0.1</td>
<td>Okay</td>
</tr>
<tr>
<td>Average Condenser Back Pressure (in hga)</td>
<td>3.6</td>
<td>3.6</td>
<td>0.0</td>
<td>3.5</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Performance - Condenser A</td>
<td>Today</td>
<td>Baseline</td>
<td>Delta</td>
<td>Historical</td>
<td>Delta</td>
<td>Status</td>
</tr>
<tr>
<td>Cleanliness Factor (%)</td>
<td>74.3</td>
<td>75.0</td>
<td>-0.7</td>
<td>75.3</td>
<td>-1.0</td>
<td>Okay</td>
</tr>
<tr>
<td>TTD (deg f)</td>
<td>12.4</td>
<td>12.7</td>
<td>-0.3</td>
<td>12.3</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Condenser Back Pressure (in hga)</td>
<td>2.62</td>
<td>2.50</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance - Condenser B</td>
<td>Today</td>
<td>Baseline</td>
<td>Delta</td>
<td>Historical</td>
<td>Delta</td>
<td>Status</td>
</tr>
<tr>
<td>Cleanliness Factor (%)</td>
<td>83.9</td>
<td>75.0</td>
<td>8.9</td>
<td>83.4</td>
<td>0.5</td>
<td>Alert</td>
</tr>
<tr>
<td>TTD (deg f)</td>
<td>8.4</td>
<td>9.6</td>
<td>-1.2</td>
<td>8.4</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Condenser Back Pressure (in hga)</td>
<td>3.18</td>
<td>3.0</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance - Condenser C</td>
<td>Today</td>
<td>Baseline</td>
<td>Delta</td>
<td>Historical</td>
<td>Delta</td>
<td>Status</td>
</tr>
<tr>
<td>Cleanliness Factor (%)</td>
<td>89.5</td>
<td>75.0</td>
<td>14.5</td>
<td>88.8</td>
<td>0.7</td>
<td>Alert</td>
</tr>
<tr>
<td>TTD (deg f)</td>
<td>6.3</td>
<td>7.8</td>
<td>-1.5</td>
<td>6.3</td>
<td>-0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Condenser Back Pressure (in hga)</td>
<td>4.02</td>
<td>3.8</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Supporting Data

<table>
<thead>
<tr>
<th>Calculation</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Circulating Water Flow (gpm)</td>
<td>552860</td>
<td>552860</td>
<td>552860</td>
</tr>
<tr>
<td>Circulating Water Flow (Manl) (gpm)</td>
<td>554500</td>
<td>554500</td>
<td>554500</td>
</tr>
<tr>
<td>Circulating Water Inlet Temperature (deg f)</td>
<td>88.8</td>
<td>97.9</td>
<td>108.7</td>
</tr>
<tr>
<td>Circulating Water Out Temperature (deg f)</td>
<td>97.9</td>
<td>108.7</td>
<td>119.3</td>
</tr>
<tr>
<td>Circulating Water Temperature Rise (deg f)</td>
<td>11.1</td>
<td>10.7</td>
<td>10.7</td>
</tr>
<tr>
<td>Hotwell Temperature (deg f)</td>
<td>127.1</td>
<td>127.1</td>
<td>127.2</td>
</tr>
<tr>
<td>LMTD (deg f)</td>
<td>17.3</td>
<td>13.1</td>
<td>10.7</td>
</tr>
<tr>
<td>Total Effective Tube Surface Area (ft^2)</td>
<td>336880</td>
<td>374311</td>
<td>411742</td>
</tr>
<tr>
<td>Actual HTC (Btu/lb-ft^2-deg f)</td>
<td>525.0</td>
<td>606.8</td>
<td>663.7</td>
</tr>
<tr>
<td>Ideal HTC (Btu/lb-ft^2-deg f)</td>
<td>706.5</td>
<td>723.7</td>
<td>741.5</td>
</tr>
</tbody>
</table>
Sample TP-Plus TSM Report Screen – Cooling Tower Performance Summary

### Cooling Tower Daily Report - Unit 3

<table>
<thead>
<tr>
<th>Cooling Tower Performance</th>
<th>Today</th>
<th>Baseline</th>
<th>Delta</th>
<th>Historical</th>
<th>Delta</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capability (%)</td>
<td>78.41</td>
<td>100.00</td>
<td>-21.59</td>
<td>76.77</td>
<td>23.23</td>
<td>Adjust</td>
</tr>
<tr>
<td>Predicted Circ Water Temp (deg f)</td>
<td>81.97</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Supporting Data

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Circulating Water Flow (gpm)</td>
<td>552860</td>
</tr>
<tr>
<td>Circulating Water Flow (Main) (gpm)</td>
<td>554500</td>
</tr>
<tr>
<td>Cold Water Temperature (deg f)</td>
<td>88.84</td>
</tr>
<tr>
<td>Hot Water Temperature (deg f)</td>
<td>119.92</td>
</tr>
<tr>
<td>Range (deg f)</td>
<td>32.45</td>
</tr>
<tr>
<td>Wet Bulb Temperature (deg f)</td>
<td>67.85</td>
</tr>
<tr>
<td>Approach (deg f)</td>
<td>19.19</td>
</tr>
<tr>
<td>Fan Power (HP)</td>
<td>427.89</td>
</tr>
</tbody>
</table>

Sample TP-Plus TSM Report Screen – Cooling Tower Performance Summary

### Feed Pump Daily Report - Unit 3

<table>
<thead>
<tr>
<th>Feed Pump Report - Unit 3</th>
<th>7/27/2010</th>
<th>MW Accounting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pump A</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure Rise (psi)</td>
<td>794.0</td>
<td></td>
</tr>
<tr>
<td>Flow (gpm)</td>
<td>25319.4</td>
<td></td>
</tr>
<tr>
<td>Head (ft)</td>
<td>2051.6</td>
<td></td>
</tr>
<tr>
<td><strong>Pump B</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure Rise (psi)</td>
<td>793.2</td>
<td></td>
</tr>
<tr>
<td>Flow (gpm)</td>
<td>27200.9</td>
<td></td>
</tr>
<tr>
<td>Head (ft)</td>
<td>2051.1</td>
<td></td>
</tr>
</tbody>
</table>

Sample TP-Plus TSM Pump Summary
Thermal Performance Plus CIM – Cycle Isolation Monitor

TP – Plus CIM is a unique software product designed and developed for advanced cycle isolation and secondary cycle leakage predictions. This is a valuable tool for any Thermal Performance program to quantify flow loss and the associated generation or heat rate loss.

Benefits of TP – Plus CIM

- Identify faulty valves.
- Establish a cycle isolation performance monitoring program.
- Recover lost Megawatts and Heat Rate degradation.
- Reduce elapsed time between the start of a valve leakage and the correction of the problem.

TP – Plus CIM can identify power loses due to leakages through steam and water valves that are either faulty or not seated correctly. Often these losses are significant and have been difficult to quantify.

The following diagram shows a typical valve loss scenario:

Valve Leakage to Condenser Diagram
Data for each valve are entered into TP-Plus CIM which then produces results from advanced cycle isolation loss calculations which can be graphed and reported to monitor valve degradation over time.

TP – Plus CIM is unique in offering up to five different methods to predict valve leakage providing the user with confidence in the results. This information is then used to prioritize maintenance and repair of valves.

The user simply measures the downstream conditions using installed sensors or a hand held instrument and enters these readings and valve related information into convenient input forms for each valve available for easy access to add or edit valve information.
Sample TP-PLUS CIM Activity and Action Item Form

Reports are easily generated using pull down menus to present results in both graphical and tabular formats.
Sample TP-Plus CIM Reports List

Sample TP-Plus CIM Graphing Interface Menu
TP-Plus CIM provides detailed reports of valves and groups of valves as seen in the following sample of a turbine bypass valve. **Alarm colors identify critical deviation issues**
TP-Plus CIM provides detailed multi-page reports action items for each valve as seen in the following sample of a feed pump recirculating control valve.

Sample TP-Plus CIM Action Recommended Report
Sample TP-Plus CIM Graphing interface Menu

Convenient forms provide the user with tools to compose graphs using information that best fits the requirements of the user’s data reporting needs.
The graphing tools in TP-Plus CIM are very helpful in showing and quantifying thermal performance losses due to valve leakages as seen in the following actual example of a cycle isolation issue with a faulty valve having an approximate .25 MWe loss to the plant cycle.

![Sample TP-Plus CIM Graph of Power Loss from a Faulty Valve](image-url)
Company Experience Profiles

Client List .......................................................................................................................... 34

Recent Experience & References .................................................................................. 35

Experience Profile/Work History .................................................................................. 42
Client List

Listed below are companies for which we have performed Thermal Performance Services. Work scope information and client references are listed following this listing.

- Arizona Public Service
- Cernavoda Nuclear Generating Station
- Columbia Generation Station
- Constellation Energy Corporation
- Dominion
- DTE
- Duke Energy
- Electric Power Research Institute
- Excel Energy
- First Energy
- Nebraska Public Power District
- Nevada Power Company
- NextEra Energy
- North American Energy Services
- NRG
- Nuclear Management Company
- Omaha Public Power District

- Pacific Corp
- Progress Energy
- Public Service Company of New Mexico
- Public Service Electric & Gas
- Reliant
- Salt River Project
- Santee Cooper
- Sask Power
- Southern California Edison
- Toshiba Nuclear
- Westinghouse Owners Group Crossflow Task Force
- Vattenfall- Ringhals Power Station, Sweden
- CNAT- Almaraz Power Station, Spain
Recent Experience & References

Listed below are Utilities for which we have recently performed Thermal Performance Services along with a brief description of the services provided. References and contact information are also listed.

**Arizona Public Service Company – Palo Verde Nuclear Generating Station**
- Thermal Performance Assessment (2009)
- TP-Plus TSM

Contact: Robert Lee (623) 393-5962

Contact: Mark Radspinner (623) 393-5867

**Centrales Nucleares Almaraz-Trillo – Almaraz Unit 1**
- Feed water Flow Assessment (2009)
- Uncertainty Calculation (2009)

Contact: David Ramirez

**Cernavoda Nuclear Generating Station**
- MSR Design Upgrade - Unit 1 (2007-2008)
- Thermal Performance Analysis - Unit 1 & 2 (2012)

Contact: Marcel Dreptate

**Constellation Energy Corporation – Calvert Cliffs**
- Evaluation of Thermal Performance Including
  - Turbine Test
  - Tracer Test (2005)
  - Ultrasonic Flow Measurement (Crossflow)
- Secondary Modeling Support (2009)
- -TP-Plus CIM (2011)

Contact: Tom Baummer (410) 495-4535

**Constellation Energy Corporation – Nine Mile Point**
- Thermal Performance Assessment (2009)
- Turbine Testing Support (2011)
- EPU Modeling (2011)

Contact: Allen Deyo (315) 349-1919

**Dominion – Kewaunee Plant**

Contact: Brandon Glasser (920) 388-8155

**Dominion – North Anna Plant**
- TP – Plus TSM Thermal Performance Monitoring Software Installation and Support

Contact: Ed Thomas (540) 894-2784

**DTE - FERMI**
- TP Plus – TSM Thermal Performance Monitoring System
- Thermal Performance Training Site Specific Course (2008)
- Secondary Leakage Software Installation TP-Plus CIM (2011)

Contact: Eric Sorg (734) 586-4294
Duke Energy
- Thermal Performance Training
Contact: Tony File (828) 478-7745

Duke Energy – Gibson Station
- Feed water Flow Measurement
Contact: Ed Kramer (812) 386-4212

Electric Research Power Institute (EPRI)
- Thermal Performance Training (2011)
- Cycle Isolation Study Nuclear Plants (2012)
- Cycle Isolation Study Fossil Plants (2011)
Contact: Fossil: Sam Korellis (704) 595-2703
          Nuclear: Andrew Mantey (484)-467-5864

Excel Energy – Prairie Island
Contact: Ryan Cox (651) 388-1121 ext 4232

Excel Energy – Monticello
- Ultrasonic Flow Monitoring Support (2009)
- EPU Support (2010)
- Core Thermal Power Uncertainty Calculation (2011)
- Thermal System Monitor TP-Plus TSM (2011)
- Feed Flow Measurement Uncertainty Calculation and Calibration (2011)
Contact: Russ Van Dell (763) 295-1326  Stephanie Bruesehoff (763) 271-5859
First Energy – Perry
- Thermal Performance Training Site Specific Course (2008)
Contact: Allen Deyo (315) 349-1919

Nebraska Public Power District – Gerald Gentlemen Station

Nebraska Public Power District – Cooper Generating Station
- TP-Plus TSM
- MSR Cost Benefit Analysis (2011)
Contact: Kyle Hilgenfeld: (402) 825-5170

Nevada Power Company - Reid Gardner Station
- Turbine Testing (2011)
Contact: Don Hopper (702) 402-1306

NextEra Energy – Point Beach Nuclear Power Plant
- Extended Power Uprate Support – (2011)
- Turbine Performance Testing third party review – (2011)
Contact: Kevin McCann: (920) 755-7937
North American Energy Services

- Combined Cycle Thermal Performance Training
  - July 2008
  - November 2008
  - November 2009
  - December 2009
  - August 2011

Contact: Bill Lovejoy (207) 449-3584

NRG – Indian River Fossil Power Plant

- Thermal Performance Assessment

Contact: Joe Blades (302) 934-3600

Nuclear Management Company – Palisades Plant

- Palisades Feed water Flow Measurement Assessment (2006)

Contact: Tom Wiggins (269) 764-2497

Omaha Public Power District – Nebraska City Plant

- Feed water Heater Assessment (2009)

Contact: Bruce Stanley (402) 514-8113

Omaha Public Power District – Fort Calhoun Plant

- TP Plus Cycle Isolation Module Package (2011)

Contact: Nicole Breytey (402) 533-7260

Pacificorp – Huntington Station


Contact: Ron Hall (435) 687-4303
Progress Energy (now Duke)– Brunswick Power Station
- MSR Evaluation (2011)
Contact: Chris Mills (910) 457-2567

Progress Energy (now Duke) – Harris Power Station
- Moisture Separator Reheater Upgrade evaluation (2010)
- Develop New Plant Heat Balances for Turbine and MSR upgrade (2011)
Contact: Barry Schneidman: (919) 362-2014

Progress Energy – (now Duke) Robinson Station
- Turbine Test Support (2011)
Contact: Tim Surma (843) 857-1086

Public Service Company of New Mexico – San Juan Station
- Turbine Test Review (2011)
Contact: Hank Adair (505) 598-7625

Public Service Electric & Gas Company – Hope Creek Nuclear Plant
- Uncertainty Analysis(2008)
- Provide Turbine Test Support (2008, 2009)
- Thermal Performance Support (2011)
Contact: Larry Curran (856) 339-5271
Salt River Project – Coronado Plant
- Train and Support Site Personnel in Thermal Performance Techniques
Contact: Doug Sturm (928) 337-5519

Salt River Project – Corporate
- TP Steam Software and User Manual (2011)
Contact: Eric Robinson (602) 236-3861

Santee Cooper – Cross Station
Contact: Leif Svensen (843) 761-8000 ext. 4823

Sask Power – Boundary Dam Stations 4 & 5
- Thermal Performance Cycle Isolation Monitoring Software Package (2011)
Contact: Alyssa Beisel (306) 566-3171

Southern California Edison Company
- RASO/Turbine Upgrade Support (2012)

Toshiba Nuclear – Yokohama Facilities
- Presented PWR Technology Seminar including Balance of Plant systems, Reactor and Steam Generator operation and controls
Contact: Tetsuya Noda

Westar Energy/Jeffrey Energy Center (sub contract to MD&A)
Contact: Dustin T. Ringer (785) 458-6261

Westinghouse Owners Group Crossflow Task Force
- Drafted industry response to NRC RIS – (2008)
- Drafted revision to user guidelines – (2008)
Experience Profile / Work History

The following represents a comprehensive listing of clients and associated work scopes for which we have performed Thermal Performance related services.

**Arizona Public Service**
Palo Verde Nuclear Generating Station
- Spray Pond Flow Measurements

**CNAT**
Almaraz
- Uncertainty Analysis
- Feed Flow Review
- Plant Analysis

**Cernavoda Generating Station**
- Flow Measurement Support/Secondary Plant Analysis
- MSR Design Upgrade Support
- Thermal Performance Analysis

**Columbia Generation Station**
- Thermal Performance Assessment
- Feed Flow Analysis

**Constellation Energy Corporation**
Calvert Cliffs
- Thermal Performance Evaluation
- Secondary Modeling Support
- TP-Plus CIM

Nine Mile Point
- Thermal Performance Assessment
- Turbine Testing Support
- EPU Modeling

**Dominion**
Kewaunee Plant
- Feed water Flow Measurement
- Uncertainty Analysis
North Anna Plant
  - TP Plus Software Installation and Support

DTE
Fermi
  - TSM Monitoring System
  - Thermal Performance Program Evaluation
  - Thermal Performance Course
  - Cycle Isolation Gold Contract
  - Secondary Leakage Software Installation TP Plus CIM

Duke Energy
  - Thermal Performance Course

Excel Energy
Prairie Island
  - Secondary Plant Modeling Support
  - Thermal Performance Evaluation

Monticello
  - Ultrasonic Flow Monitoring Support
  - EPU Support
  - Uncertainty Calculation
  - TP-Plus TSM
  - Uncertainty Calculation and Calibration

First Energy
Perry
  - TP Plus CIM Software Installation
  - Thermal Performance Course
  - Turbine Upgrade Testing Support

Nebraska Public Power District
Gerald Gentlemen Station
  - Feed water and Spray Flow Measurement
  - Cooper Generating Station
- Heat Balance Evaluations
- TSM
- MSR Analysis

**North American Energy Services**
- Combined Cycle Course

**NRG**
Indian River Fossil Power Plant
- Thermal Performance Assessment

**Nuclear Management Company**
Palisades Plant
- Feed water Flow Assessment

**Omaha Public Power District**
Nebraska City Plant
- Feed water Heater Assessment
Fort Calhoun Plant
- TP Plus Module Package

**Pacific Corp**
Huntington Station
- Feed water and Spray Flow Measurement
- Uncertainty Calculation

**Progress Energy**
Brunswick Power Station
- Thermal Performance Modeling Support
Harris Power Station
- Turbine Testing Support
- Moisture Separator Reheater Replacement Support

Robinson Station
- Turbine Testing Support
Public Service Company of New Mexico
San Juan Station
- Turbine Testing Support

Public Service Electric & Gas
Hope Creek Nuclear Plant
- Feed water Flow Measurement
- Uncertainty Analysis
- Extended Power Uprate Secondary System Modeling
- Turbine Test Support
- Thermal Performance Support

Salem 2 Plant
- Modeling of Steam Generator and Turbine
- Turbine Upgrade; New Steam Generator
- Steam Generator Replacement Test
- Turbine Test Support
- Moisture Separator Reheater Assessment
- Environmental Evaluation

Reliant
South Texas Project
- Thermal Performance Assessment

Salt River Project
Coronado Plant
- Turbine Cycle Testing
- Thermal Performance Site Personnel Training
- Corporate
- TP Steam Software

Santee Cooper
Cross Station
- TP Plus CIM Software Installation

Sask Power
Boundary Dam Stations 4 & 5
- CIM Software Package

**Southern California Edison**
- RASO/Turbine Upgrade

**Toshiba Nuclear**
Yokohama Facilities
- PWR Technology Seminar

**Vattenfall**
Ringhals Power Station
- Feed water Flow Uncertainty Analysis

**Westinghouse Owner Group Crossflow Task Force**
- Drafted Industry Response to NRC RIS
- Drafted Revision to User Guidelines
Core Staff & Resources

Core Staff ................................................................................................................. 48

Contact Information .............................................................................................. 55
Core Staff

True North Consulting is comprised of four primary Divisions with a staff of over forty engineers and technical personnel. Our organization and processes are structured to optimize support between divisions with heavy emphasis on cross training.

A primary tenet of the True North business model is the ability to quickly assemble necessary expertise as a project team, manage that team with our core staff and standardized practices, and then return to normal responsibilities upon completion. Additionally, our relationship and access to a wide range of industry expertise, typically with former utility, regulatory, or industry type backgrounds, provides an excellent resource pool in support of our consulting services approach.

Biographical information for key True North Management and Thermal Performance staff are provided below. Additional organizational information, complete resumes of those listed below, or our other forty plus staff are available upon request.

Please contact our corporate office at 970-252-1489 or by email at info@tnorthconsulting.com should additional information be desired.
Donald R. Horn, P.E
President / Owner

As Founder, President, and Owner of True North Consulting Don's primary responsibilities regard ensuring adherence to the True North Consulting Vision.

This vision consists of providing Engineering Programs support of the highest quality, technical merit, and usefulness while standardizing engineering program related positions across the industry. It is his goal and the goal of True North Consulting to provide a strong contribution towards success of the nuclear power industry through application of effective, efficient, Programs related support.

Inherent in this responsibility are managing day to day operations for the company, client relations, strategic planning, business development, and support for project management / staffing requirements.

Don applies his twenty–five years of energy industry related experience, both domestic and abroad, encompassing a wide spectrum of managerial and engineering responsibilities, towards accomplishment of this True North Vision.

Managerial experience for Don has been steadily progressive; initiated with Engineering Lead responsibilities in fossil and nuclear power generation, expanding to multidiscipline project management, on to complete P&L responsibility for a company division, and currently as president and owner of True North Consulting.

Don's primary engineering expertise resides in the electric power discipline with extensive knowledge in the areas of power generation, electrical distribution, and power plant systems. He has a strong background in the nuclear power industry with experience in construction, start-up, power ascension testing, and commercial operation. Strong technical skills with a diverse engineering background provide a solid; common sense based foundation for accomplishing company objectives.

Don holds a Bachelor of Science in Electrical Engineering, BSEE, from Colorado State University, and is a registered Professional Engineer.
Frank D. Todd  
Manager, Thermal Performance

As Senior Manager for True North Consulting Thermal Performance Division, Frank has focused on advancing the power industry through increasing the awareness of the necessity of Thermal Performance. He possesses over 30 years of diverse technical experience in fossil and nuclear power plants. This background encompasses significant expertise in areas of engineering, construction, planning and scheduling, power ascension testing, startup testing, turbine testing, secondary leakage testing, flow measurement testing, heat balance analysis, plant walk downs, procedure writing, and software development both in fossil and nuclear power stations.

Frank is highly skilled in the use of analytical tools designed to evaluate Thermal Performance and improve plant efficiency and reliability. These tools include a variety of approaches using computer based plant modeling with strong emphasis on problem analysis and resolution. Frank has also developed a wide spectrum of test specification, procedure, and testing configurations in support of Thermal Performance improvements.

Frank has been instrumental in the development of various software products to aid the power industry.

Additionally Frank has conducted numerous Thermal Performance Training courses. These courses are designed to help the plant engineer to evaluate and monitor the power plant in which he works. Engineers return to their plant equipped with the necessary knowledge to implement plant improvements which will increase their plant’s production.
Ken F. Porter
Senior Engineer, Thermal Performance

Ken has an extensive Thermal Performance background garnered from 25 years of service in the electric utility industry as a System/Thermal Performance Engineer. The utility/client perspective gained through these years provides an excellent foundation for Ken in his consulting role for the industry. He is highly proficient in all aspects of thermal performance including technical writing, procedure development, component analysis, overall system analysis and is skilled in analyzing the performance of operating power plants using both off-line and on-line thermodynamic modeling systems. Additionally, Ken has been very active regarding application of advanced pattern recognition modeling in the area of thermal performance. His significant involvement in this area has maintained him on the cutting edge of both application of the technology and recent applications within the electric power industry.

Ken’s extensive experience and training in GE Large Steam Turbine technical support, director for large steam turbine overhauls and system engineering for steam turbines, condensate and feedwater systems brings significant depth to the True North Thermal Performance team. Ken’s capabilities interfacing with various organizations such as NERC, WANO, NRC and Utility owners gives him a sound basis for understanding the needs of the utility engineer.

Ken has a BSME from the University of Arizona and an MBA from Keller Graduate School of Management.
Richard C. Duggan  
Senior Engineer, Thermal Performance

Rich serves as Senior Engineer for True North and is the project manager for Cycle Isolation and Flow Measurement. Rich has extensive background in Engineering design, statistical process control and uncertainty analysis with over 18 years of experience using statistical tools to evaluate and improve processes and engineering products.

Additionally, Rich has been involved in plant testing for both Fossil and Nuclear applications.

Rich has certifications in the following areas:

- Quality Engineer (CQE) - Certified by ASQ December 2001
- Master Statistical Engineer - Certified by General Motors, March 2001
- Six Sigma Black Belt – Certified by Villanova August 2007
R. Brian Dodd  
Senior Engineer, Thermal Performance

Brian has 30 years experience in power plant operations; maintenance, project design/management and thermal performance related to fossil and combined cycle generating plants.

Brian previously worked at Tri-State Generation & Transmission as a project/performance engineer and at General Physics as a senior performance engineer. He received a B.S. degree in Mechanical Engineering from Oklahoma State University.

Brian serves as a senior consulting engineer in the Thermal Performance Division with primary responsibility for the area of plant thermal performance. He is currently involved in providing performance assessments, evaluating plant uprates, repowering projects, performing heat rate tests and performance software tool applications.
W. Cary Campbell  
Senior Engineer, Thermal Performance

Cary served as Principal Engineer over nuclear and gas turbine performance for the Southern Company. Cary has performed or directed most of the performance evaluations of Southern Company gas turbine, combined cycle and nuclear units for the past 32 years. His responsibilities included thermal performance testing, monitoring and modeling of the Southern Company’s units. Cary provided consulting and testing services to numerous external electric generating utilities, both domestic and international.

Cary has extensive experience with ASME performance test codes, test instrumentation, flow and power metering, heat balances, performance monitoring, and power plant design. Cary’s expertise in performance testing and monitoring of nuclear, gas turbine, and combined cycle units is known industry wide.
Contact Information

True North Consulting is headquartered in Montrose, Colorado and in addition to our Thermal Performance Division represented in this brochure is comprised of Engineering Programs, Power Services, and Software Services Divisions. Please contact us should information be desired for one of our other Company Divisions or if additional detail is needed regarding our Thermal Performance Division.

Office and primary contact information for our Colorado headquarters and each of our Company Divisions are:

**Corporate Office**
Primary Contact--Donald R. Horn  
150 Merchant Drive  
Montrose, Colorado 81401  
970-252-1832 (telephone)  
970-252-1837 (fax)  
drh@tnorthconsulting.com

**Engineering Programs**
Primary Contact--Ronald C. Lippy  
402-493-9562 (telephone)  
rcl@tnorthconsulting.com

**Software Services**
Primary Contact--Jeffrey A. Neyhard  
315-430-7218 (telephone)  
jan@tnorthconsulting.com

**Thermal Performance**
Primary Contact--Frank D. Todd  
150 Merchant Drive  
Montrose, Colorado 81401  
970-964-2753 (telephone)  
970-252-1837 (fax)  
fdt@tnorthconsulting.com

**Power Services**
Primary Contact--Ray Moore Sr.  
302-740-5205 (telephone)  
rtm@tnorthconsulting.com