

# Emerson's SmartProcess™ Improves Ramp Rate and AGC Performance at Datang's Tuoketuo Resulting in Higher Monthly Revenue

## RESULTS

- 1.0% per minute average ramp rate improvement (from 1.5-2.0% to 2.5-3.0%)
- 85% improvement in Automatic Generation Control (AGC) performance (1.4 to 2.6)
- 73% increase in average monthly compensation (¥547,000 RMB or \$82,000 USD of additional revenue per month)
- 30-40% improvement in steam pressure overshoot



## APPLICATION

600-megawatt, sub-critical (operating main steam pressure of 17.6Mpa or 2,552 PSI), coal-fired unit with a Dongfang boiler and a Dongfang steam turbine generator

## CUSTOMER

China Datang Corporation, Datang International Power Generation Company (Datang), Tuoketuo Power Plant Unit 7, located in Hohhot, Inner Mongolia, China

## CHALLENGE

The 8-Unit Tuoketuo Power Plant is the largest coal-fired facility in China and the second largest in the world. The power generated by Tuoketuo is sold to the North China Electric Power Group Company through a long-term purchase agreement to supply the generation demands of Beijing. Each month, all power plants connected to the China North power grid must contribute funds to a common pool, which is distributed back to the utilities based on AGC performance. Plants with better AGC performance are compensated from the joint account, while those with poor performance are penalized. All Tuoketuo units must be able to quickly ramp up or down to meet the grid regulator's request for power. Less than optimal performance by Unit 7 had Datang searching for an economical solution that would improve the unit's maneuverability and increase monthly revenue.

***“Emerson's SmartProcess Unit Response Optimization technology has greatly improved performance of Tuoketuo Unit 7. Our ability to more accurately control the boiler and operate in a more stable manner has allowed us to quickly meet the demands set by the China North power grid. This has resulted in better AGC performance and increased monthly revenue.”***

**Duan Wenwei**

Vice Manager  
China Datang Corporation  
Datang International Power Company  
Tuoketuo Power Plant



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**SOLUTION**

Datang selected Emerson’s SmartProcess™ Unit Response Optimization (URO) technology that uses advanced unit analysis and modeling techniques to provide optimal load trajectory and control for improved unit ramping, startup, turndown, and overall performance.

By modeling process response and unit characteristics, the URO solution calculates a variable derivative ramp rate to optimize plant maneuverability and AGC capabilities; eliminates overshoots; and provides a high level of unit control precision.

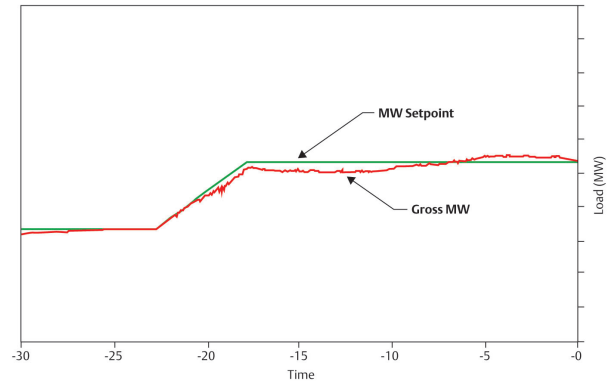
The URO solution combines feed-forward control with dynamic setpoint control for turbine valve position, main steam pressure, and fuel variables to track expected responses and correct the feed-forward reactions. Convection and radiant energy effects are also used as variables in the feed-forward models.

The overall goal is to optimize final output of the boiler by providing predictive control of changes in the boiler due to load, fuel BTU quality, radiant energy absorption, and spray valve performance. By considering current plant operating constraints and varying economic factors, the model provides optimal results over a full range of process characteristics.

The SmartProcess URO reacts to unit dynamic load demands by calculating the proper amount of fuel required to ramp the unit and the corresponding pressure response. Dynamic steam pressure and unit load models allow the optimization solution to forecast key manipulated variables such as boiler fuel flow and the turbine control valve movement in a coordinated mode, allowing for quicker and more stable unit reaction to load changes.

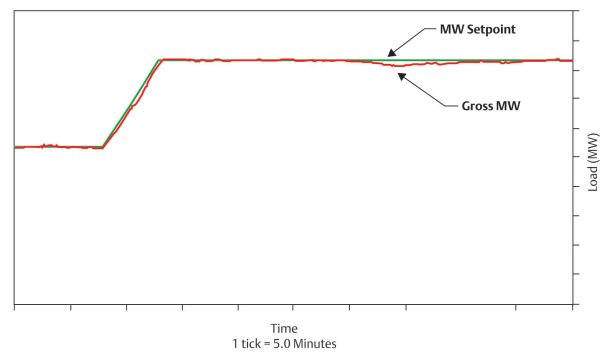
After implementation of the SmartProcess URO solution, Unit 7 now has the quickest ramp rate and best AGC performance out of all eight Tuoketuo units. The average ramp rate went from 1.5-2.0% per minute to 2.5-3.0% per minute, resulting in an 85% improvement in the unit’s AGC Kp Performance Index (1.4 to 2.6). The ramp rate and AGC performance improvements have contributed to a 73% increase (¥547,000 RMB or \$82,000 USD) in average monthly compensation. Prior to the installation, the average monthly compensation was ¥212,000 RMB or \$30,000 USD. Operating Unit 7 with the URO technology yielded an average monthly compensation of ¥795,000 RMB or \$112,000 USD - an increase of ¥547,000 RMB or \$82,000 USD. Additionally, steam pressure overshoot was improved by 30%-40% which has increased boiler efficiency.

Tuoketuo Unit 7 Load Changes Before URO Installation



Trend results while operating in coordinated boiler-follow mode (CBF) before URO installation showed instability when the load was increased by 60 MWs at a 12 MW per minute ramp rate (2% per minute).

Tuoketuo Unit 7 Load Changes After URO Installation



After URO implementation, Unit 7 was able to increase load by 90 MWs at a ramp rate of 18 MWs per minute (3% per minute).

|            | Test Mode | Ramp Rate     | Transition | Pressure Deviation   |
|------------|-----------|---------------|------------|----------------------|
| Before URO | CBF       | 2% per minute | 60 MW      | 0.88 MPa (127.6 PSI) |
| After URO  | With URO  | 3% per minute | 90 MW      | 0.6 MPa (87 PSI)     |
|            | With URO  | 4% per minute | 50 MW      | 0.5 MPa (72.5 PSI)   |

During testing with the URO, Unit 7 was able to exceed the project goal of a 2.5% per minute ramp rate with a pressure deviation of 0.8 MPA (116 PSI).



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