Siemens Power Plant Automation
Take the lead with our state-of-the-art solutions

Our competence: power plant, automation and IT know how

Management
- Fleet Management
- Generation Management

Operation
- Plant Operation
  - Automation
  - Field
  - Process Optimization
  - Electrical

Maintenance
- Service
- Diagnostic

Life Time Extension
Planning
Optimization
Modernization
Construction
Service

- Waste Incineration Plants
- Wind Power Plants
- Nuclear Power Plants
- Industrial Power Plants
- Biomass Power Plants
- Fossil fired Power Plants
- Combined Cycle Power Plants
- Desalination Plants
- Coal Gasification Plants
- District Heat Power Plants

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Solutions for Turbine Modernization

Can I ...

... improve the reliability of my old turbines with new I&C?

Yes, you can!
Advanced solutions for all turbines
All types and makes from 1 to 1600 MW

For Siemens turbines
- Siemens
- Westinghouse
- Allis Chalmers
- Parsons
- AEG
- Fiat Avio
- Alstom/BBC/ABB Industrial Turbines

For other manufacturer's turbines
- GE
- ANSALDO
- MHI
- Alstom/BBC/ABB utility turbines
- Hitachi
- Toshiba
- Franco Tosi
- .... and many others
**SPPA-R3000 Turbine Controls**  
*Our portfolio*

### Turbine control master program

<table>
<thead>
<tr>
<th>Closed loop</th>
<th>Protection</th>
<th>Open loop</th>
<th>Monitoring</th>
<th>Electrical</th>
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</table>
| - Turbine governor  
- LP bypass control  
- Gland steam controller  
- Boiler feed pump turbine controls  
- Coordination with boiler  
- Extraction control  
- Start-up optimization  
- Frequency control acc. to NERC | - Overspeed  
- Vibration  
- Expansion  
- Axial shaft pos.  
- Electronic Turbine protection  
- Manual trip | - Turbine oil supply  
- Turbine drains  
- Vacuum  
- Turning gear  
- Extraction Header  
- Valve test  
- Generator controls  
- etc | - TSI Turbine supervisory instrumentation  
- Diagn. Monitor Vibration  
- Expans./ Position Operation param.  
- Analysis | - Generator / unit / grid protection  
- Excitation systems  
- Synchronization  
- Voltage regulators AVR  
- Electrical metering  
- MV & LV Switchgear  
- Uninterruptible Power Supply |

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**High Pressure Servo Actuators, hydraulic / mechanical components**
Your benefit with SPPA-R3000
Increased reliability and reduced costs*

*) During all main operating modes:
- Startup
- Load operation
- Load ramping
- Load rejection
- Shutdown

SPPA-R3000 Turbine Controls

- Increased availability
- Increased flexibility
- Reduced maintenance
Your benefits
Improved flexibility

Task
To react on grid demands and offer new possibilities in today's energy markets.

Solution
- Replacement of old hydraulic **governor** with new redundant electronic control system
- Single valve control
- Advanced control algorithms
- Thermal stress control and supervision
- New HP hydraulic power unit
- New Synchronization equipment

Benefits
- Improved load flexibility, with improved dynamics and island mode capability
- Follow NERC requirements
- Expanded range of economic operation, with improved control accuracy
- Improved start-up sequence for hot stand-by operation and reduced start-up time
Increased revenues due to improved flexibility

References for flexibility

KU Brown - e.on USA
Westinghouse-Steam turbine; 200 MW
Modernization of hydraulic/mechanic interface with single valve control
- Improved load range
- Improved coordinated boiler control

Wilmersdorf, Germany
Gas turbine plant; Alsthom/GE Frame 9; 3x 90 MW
Replacement of GE Speedtronic MARK II
Reduced start-up time from 21 min to 7.5 min

Benefit for a standard unit

- 200 MW hard coal fired unit
- Change from base load plant to peaking plant selling load on competitive markets
- $4 /MWh difference

Revenue: $2,880,000 year

production time per year 300d x 12h
Your benefits
Increased availability

Task
To avoid unnecessary and forced outages of the unit and to increase lifetime of the turbine.

Solution
- New redundant digital control. Replacement of mechanical governor and overspeed protection.
- Electronic turbine protection with 3 channel overspeed device.
- New hydraulic interface with redundant or 2oo3 failsafe hydraulic trip block.
- New field instrumentation
- Turbine supervisory instrumentation (TSI equipment)
- Standardized and proven I&C-systems.

Benefits
- Minimization of forced outages
- Reduction of lifetime consumption (no more testing above sync speed)
- Lifetime extension of the plant
Reduced costs by increased availability

References for availability

Laredo Generating Station Texas, USA
Westinghouse steam turbine
110 MW
MHC to EHC upgrade

Reid Gardner Unit 1 - 3
Nevada, USA
GE steam turbines
130 MW
Minimization of forced outages

Benefit for a standard unit

- 200 MW hard coal fired unit
- ONE unforced outage – FOUR hours back to grid
- Average price for peak load ¹):
  $60 MWh (estimated)

$48,000 /avoided outage

Plus:
Additional lifetime extension of plant

¹) Source: Estimated average value
Your benefits
Reduced maintenance costs

Task
Reduce costly efforts for maintaining and troubleshooting old controls.

Solution
- New redundant digital control.
  Replacement of mechanical governor and overspeed protection.
- Electronic turbine protection with 3 channel overspeed device.
- New hydraulic interface with redundant or 2oo3 failsafe hydraulic trip block
- New field instrumentation
- Turbine supervisory instrumentation (TSI equipment)
- Standardized and proven I&C-systems.

Benefit
- Advanced I&C diagnostics
- Advanced operational supervision
- Reduced maintenance for mechanical components
- Automatic tests during operation
Reduced maintenance costs

Benefit for a standard unit

- Less components
  - less spare part stock costs ➔ $20,000 /yr
- Less labor …
  - …due to less planned maintenance efforts
  - less plant labor ➔ $100,000 /yr
  - less purchased labor ➔ $50,000 /yr
- Less labor …
  - …due to increased field instrumentation resulting in better diagnostics
  - less plant labor ➔ $100,000 /yr

$270,000 /year

References for maintenance costs

Reid Gardner Unit 4
Nevada, USA
Westinghouse
Steam turbine 270 MW
Replacement of mechanical trip system. Standardize trip systems across all units

DC Cook Unit 2
Michigan, USA
ABB Nuclear
Steam turbine 1100 MW
Comprehensive solution for nuclear power plant
Basic Concept Modernization
Let’s do it electronically

- Electronic turbine governor (optionally redundant - master/slave)
- 2003 electronic protection with 2003 tripping device
- Independent 3-channel electronic over speed trip according to SIL3
Governor upgrade philosophy
Get rid of the complex hydraulic control system
Modular control structure for enhanced transparency

Speed control
- Speed set point
- Auto/manual ramp-up rates
- Acceleration synchronizing
- Island mode

Load control
- Load set point
- Auto/manual load rates
- Load limiters
- Frequency regulation
- Auto load rejection and island mode

Pressure control
- Main Steam-Pressure Control
Benefits of governor upgrade
Increased availability and flexible turbine operation

Modern I&C-Systems of SPPA-R3000

- Optimized run-up and loading procedures
  - Improved HP and IP valve positioning
- Higher availability
  - Redundant HW and SW structures
  - Individual valve control
- Improved control performance
  - Flexible adoption of valve opening sequences
  - Linearization of valve characteristics
  - Simple optimization of control loops
  - Fulfill NERC requirements (primary frequency control)
- Less mechanical components
  - Minimized maintenance costs
  - Reduction of mechanical spare parts
Turbine protection upgrade philosophy
Get rid of the complex hydraulic protection system

Hydraulic Components

Modern I&C-Systems of SPPA-R3000

Overspeed protection

Turbine trip block
SPPA-R3000 Electronic turbine protection
The safe solution

- Three channel, fail safe principle from sensor to hydraulics
- Equal trip logic in each channel
- Additional CPU redundancy (Master/Slave)
- Triple instrumentation for all important protection measurements
- Independent SIL 3 electronic overspeed protection (testable during turbine operation)
- 3-channel SIL 3 fail safe trip system
- 2oo3 hydraulic voting of 3 electronic trip channels offers online test capability from sensor to hydraulics
SIL3 electronic overspeed protection
The lifetime extension for your turbine

- Fast sample time (< 5 msec)
- Alarm and status relays
- 2 out of 3, voting logic
- Fail safe operation
- Manages all fault conditions
- Automatic onboard test routine with integrated diagnostics

- Overspeed bolts no longer required
- No “real” overspeed tests necessary
- Repeatable and reliable over speed detection
- Avoids unnecessary stress to your turbine

Total protection - without compromise
Benefits of protection upgrade:
Higher safety and availability, reduced maintenance

Modern I&C-Systems of SPPA-R3000

Increased safety
with 2 out of 3 protection logics
- Optimization of old mechanical protection loops
- Continuous monitoring of sensors (absence, no coincidence)

Increased availability
- Automatic test routines for overspeed protection loop
- Sequential test of all channels 2 out of 3 trip blocks
- No limitation of protection status through test routines

Reduced maintenance due to fewer mechanical components
- Minimized maintenance costs
- Reduction of mechanical spare parts

Benefits of protection upgrade:
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Modern I&C-Systems of SPPA-R3000

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Modernization of hydraulics
The high performance solutions

<table>
<thead>
<tr>
<th>Electro-hydraulic modules for Governing</th>
<th>Electro-hydraulic modules for Protection</th>
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<tbody>
<tr>
<td>Conversion to <strong>individual valve control</strong> for maximum operating flexibility</td>
<td>Installation of new <strong>hydraulic lines, filters and hydraulic power supply stations</strong> to reduce maintenance</td>
</tr>
<tr>
<td><strong>New actuators and valves</strong> increase control flexibility, accuracy and speed</td>
<td><strong>New 2-out-of-3 turbine trip block</strong> to increase operating reliability</td>
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<tr>
<td>Installation of new <strong>electro-hydraulic converters (EHC)</strong> for maximum control accuracy</td>
<td><strong>New speed transmitters &amp; overspeed protection</strong> for maximum control accuracy and reliability</td>
</tr>
</tbody>
</table>

New actuator and valves increase control flexibility, accuracy and speed.
Turbine hydraulics upgrade philosophy
Increased flexibility and availability

BEFORE Modernization

Removal of obsolete mechanical devices, which need a huge efforts for maintenance, through modern state of the art electronic solution lead to:

Increased flexibility
- Electro-hydraulic-control EHC
- Speed governor
- Mech. extraction control
- Mechanical / hydraulic limiters

Increased availability
- Overspeed protection
- Vacuum
- Shaft position
- Extraction protection
- Mech./hydraulically manual trip
- Test of control and safety devices

Optimized maintenance costs
- Less mechanical components

AFTER Modernization
The SPPA-R3000 Turbine control master program
The easy way to operate

The turbine control master program ensures 
**fully automatic turbine operation**  
for all operating modes  
by one push button operation:

- Coordination of **automatic start-up** from  
  stand still up to full load operation
- Direct influence of **thermal stress** on  
  different operating conditions (gradients,  
  cold, warm, hot **start-up** and **load changes**,  
  protection, critical speed ranges)
- Automatic **load shedding** and **island operation** in case of **disconnected grid**
- Automatic shut-down from full load to turning gear operation

---

**Safe and reliable turbine operation based on**  
150 years experience in turbine design and manufacturing
SPPA-D3000 Machinery protection and diagnostic Turbine Monitoring - Your early warning system

- Automatic learning for up to 64 operating conditions
- Extremely sensitive detection of abnormalities
- Outstanding early fault identification
- Complete diagnostic tool kit

Benefits:
- Increase availability
- Predict and avoid future trouble
- Reduce maintenance costs
SPPA-E3000 Electrical Solutions

- Generator protection
- Unit and grid protection
- Excitation systems
- Synchronization
- Voltage regulators AVR
- Electrical metering
- MV & LV Switchgear
- UPS

One common I&C system for the entire plant by SPPA-T3000 according to IEC61850

- Benefits in planning, design, communication and execution
SPPA-R3000 Automation system
Highlights
SPPA-R3000 Turbine controls
One platform fits all

Hardwired technology
One of the most stable systems world wide

ISKAMATIC
1970

S5 based solution
Well proved

TELEPERM ME,
TELEPERM XP
Based on
SIMADYN D, S5 & S5-95F
HW Technology
1985

SPPA-R3000
Full integrated

SPPA-T2000, SPPA-
T3000, SIMATIC PCS7
Based on
S7 Hardware Technology
2006
SPPA-R3000 Turbine controls
The compact high performance automation system

Reliable
- Meets even the most stringent requirements for turbine control and protection systems

Scalable
- From single-channel to 100% redundancy for turbine governor (CPU, I/O modules and communication modules)
- Integrated fail-safe application. Certified to IEC for protection trip

Fast-response
- Control circuit for valve positioning integrated in CPU.
  Typical cycle time: 6ms
- Meets the requirements of UCTE for frequency support ancillary services

Universal
- Only one type of module is used for speed acquisition, digital data processing and analog data processing
S7-400 F/H Turbine Governor and Protection

CPU SIMATIC S7-400H
- Redundant CPU
- Integrated PROFIBUS DP-Master-Interface
- Interface to Plant Network

AddFEM (Optimized process interface for turbine control applications)
- Speed
- Analog I/Os
- Digital I/Os

Protection
Governor

ESV/CV Valve

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System Highlights

- Leading-edge performance for closed-loop control and arithmetic operations
- 100% redundancy for CPU, I/O modules, communication modules and bus system
- 1-out-of-2 logic for controls (hot standby concept)
- Switchover in < 1 ms on I/O module fault
- Extremely high availability
- Supports online reconfiguration
- Direct link to plant bus
- Add T 3000 Highlights
SPPA-R3000 Highlights
Interface for turbine controls AddFEM

Optimized process interface

- 12 analog inputs (6 can be used as current inputs and 6 optionally as current or voltage inputs)
- 8 analog outputs
- 12 digital inputs DI / 3 counting pulse inputs for speed detection
- 16 digital outputs DO (can also be used as DI)
- In addition to the measuring ranges of 0...20 mA, 4...20 mA and 20 mA common for current inputs and outputs a range of 50 mA is also available
- Analog and digital outputs are resistant to sustained short circuits. All outputs are monitored and can be connected in parallel with other outputs.
- Connection to host with time optimized Profibus DP performance for closed loop control and arithmetic operations
- Redundant configuration possible
SPPA-R3000 Turbine Controls can be used in any plant and operates with any type of I&C equipment.

**Turbine Controls with third-party DCS**

- HMI & Engineering
- Unit I&C
  - Third-party system
- SPPA-R3000

**Turbine Controls with Siemens DCS**

- HMI & Engineering
- Unit I&C
  - SIMATIC PCS7 PS
  - SPPA-T2000
  - SPPA-T3000
  - SPPA-R3000

**Plus:** Electrical systems, field, diagnostic, process optimization, service, management solutions
Consistent engineering and uniform HMI for unit BoP and turbine control!

SPPA-T3000 architecture

User interfaces

Power servers

Process interfaces

SPPA-R3000 fully embedded in SPPA-T3000

A shared platform:

Embedded Component Services™

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SPPA-R3000 Turbine Controls
Project Execution
Close cooperation during project execution is a key to success

<table>
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<th>Discussion of situation</th>
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<th>Implemen -tation</th>
<th>Optimized operation</th>
<th>Compre -hensive service concepts</th>
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<td>■ Proposal: Scope of modernization, different variants</td>
<td>■ Engineering based on comprehensive power plant know-how</td>
<td>■ Availability</td>
<td>■ Corrective maintenance</td>
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<tr>
<td>■ Targets</td>
<td>■ Benefits</td>
<td>■ Installation</td>
<td>■ Flexibility</td>
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<tr>
<td>■ Options for optimization</td>
<td>■ Profitability (return on investment)</td>
<td>■ Commissioning / fine-tuning</td>
<td>■ Reduced maintenance</td>
<td>■ Performance enhancement</td>
</tr>
<tr>
<td>■ Result: Which solutions are feasible for this unit?</td>
<td>■ Engineering</td>
<td>■ Training</td>
<td>■ Training &amp; Consulting</td>
<td></td>
</tr>
</tbody>
</table>

Contract

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The future proof execution

Modular and scalable I&C Packages

- Start today with a basic package and extend easily according your future needs
- Proven and standardized hardware and software modules
- Embedded solution in plant DCS

Latest innovations of turbine technology and controls from one of the biggest turbine manufacturer

- Participate on newest technology based on more than 2000 installed turbine control systems
- According latest VGB, DVG, IEC etc. standards
- Latest advanced control algorithm for smoothest operation of your turbine

Siemens: Your future – proof technology partner
Siemens Power Plant Automation

Combination of strengths to boost your profitability

**Excellence in Process know-how**
600 GW installed, 10 GW operated by Siemens

The only DCS supplier with power plant-OEM process know-how

**Excellence in Automation**
2000 systems installed, based on proven and trendsetting SIMATIC technology

SPPA-T3000: The benchmark in controls

**Excellence in Power-IT**
Role based information supply with power plant know-how

**Excellence in Project Management**

Benchmark in project management

Shortest outage times

Shortest execution times

Global leader in power generation management

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Modernization highlights worldwide

- Ilsan, Korea
  - Westinghouse GT 6x 110 MW, W 501D5

- Huntly, New Zealand
  - Parsons ST 2x 350 MW

- Shedgum, Farras KSA
  - 16x GE Frame 7
  - 5x Westinghouse 501D4

- Barking Power, UK
  - GEC/Alstom ST 1x 215 MW, 1x 145 MW

- Duisburg, Germany
  - Siemens ST 1x 130 MW

- Altbach, Germany
  - Siemens ST 1x 430 MW

- Salamanca, Mexico
  - Franco Tosi ST 1x 300 MW

- Uruguaiiana, Brazil
  - Westinghouse GT 2x WH 501 FC

- Kriel, RSA
  - BBC ST 6x 500 MW

- Bexbach, Germany
  - BBC/Alstom ST 1x 750 MW

- Moscow, Russia
  - LMZ ST 1x 230 MW

- KU Brown, USA
  - Westinghouse ST 1x 200 MW

- Kriel, RSA
  - BBC ST 6x 500 MW

- Bexbach, Germany
  - Siemens ST 1x 130 MW

- Moscow, Russia
  - LMZ ST 1x 230 MW

- Barking Power, UK
  - GEC/Alstom ST 1x 215 MW, 1x 145 MW

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- Uruguaiiana, Brazil
  - Westinghouse GT 2x WH 501 FC

- Kriel, RSA
  - BBC ST 6x 500 MW

- Bexbach, Germany
  - Siemens ST 1x 130 MW

- Moscow, Russia
  - LMZ ST 1x 230 MW
Modernization highlights in the US

- KU Brown, Westinghouse ST 1x 200 MW
- Hines, Westinghouse 2X 1 CCPP W501FC
- Rocky Road, GE LM5000 CT
- Reid Gardner, GE ST 3X 130 MW, Westinghouse ST 1X 270 MW
- Laredo, Westinghouse ST 1x 110 MW
- DC Cook, ABB Nuclear ST 1x 1100 MW
- Bergen, Siemens CT 4X V84.2
- Venice, GE LM2500 CT
- GE LM2500 CT
- GE ST 3X 130 MW
- Westinghouse ST 1X 270 MW
- Westinghouse ST 1x 110 MW
More than 2000 power plants in operation worldwide with electrical systems, I&C systems and IT technology supplied by Siemens
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