TURBOTROL® and EGATURN® Control Systems for Steam and Gas Turbines
ABB turbine control

- Retrofit concepts
- Hydraulic solutions
- Turbine control solutions
- Project management

ABB provides well proven solutions for all makes and models of steam, gas and hydro turbines for new and retrofit business.
ABB Turbine Control Overview
ABB turbine control
Customer benefits - Why ABB turbine control?

- Experience
  - More than 45 years in power plant business guarantees well proven and cost effective solutions

- Know-how
  - State of the art technology and highest quality of various turbine types / suppliers

- Modular design
  - Custom tailored solutions
  - All sizes of applications
  - Uniform solutions for all turbine brands
  - One for one replacement of installed equipment for cost effective solutions for the customers
ABB turbine control
Customer benefits - Why ABB turbine control?

- Top of the class systems
  - Reliability
  - Safety
  - Scalability
  - Flexibility
  - Integration
  - Openness
- Large product portfolio
  - Smooth integration into overall plant DCS
  - Optimized and cost effective interface within ABB scope
- Numerous successful installations worldwide
- Around 30 well educated engineers dedicated to turbine control
ABB solutions around the turbine

- Technical consulting and studies
- Service and maintenance
- Training simulators
- Model-based, coordinated unit control
- Condensate and extraction shut-off
- Model-based, predictive start-up optimization
- Electro-hydraulic solutions
- Generator protection excitation synchronization
- Turbine control and protection
- Turbine aux. control and automation
- Supervision and monitoring
- HP and LP bypass systems
Retrofit
A cycle of improvement

Better Operation
- Improved low load limit setting
- Enhanced auto-dispatch response
- Superior load following
- Automated valve transfers
- Automated valve calibration
- On-line serviceability

Lower Maintenance
- Less wear and tear
- Fewer connections
- Reduced inventory of parts
- Reduced O&M expense
- Reduced overall expenditures

Better Performance
- Heat rate improvement
- Automated valve management
- Greater reliability
- Improved unit availability
Turbine control
Functions

Control and protection
- Turbine protection
- Overspeed protection
- Turbine closed loop control
- Thermal stress
- Turbine supervision

Auxiliary control and automation
- HSI, PIMS
- Turbine aux. control
- Synchro-nization
- Bypass control
- Electrical systems

Unit control
- PMO
- Unit control

PMO
- Unit control
- HSI, PIMS
- Turbine aux. control
- Synchro-nization
- Bypass control
- Electrical systems

2 out of 3 trip block
- Control valve
- Control oil
- Stop valve
- Speed sensors
Turbine control
Requirements

- Extremely small cycle times for fast process
- High availability and security requires
  - Redundant controllers
  - Multi-channel protection systems
- Special interfaces required for special modules (e.g. speed, valve contr., vibration)
- Deep process know-how and big experience for complex processes
- Long-term experience prevents failures and damage for process equipment
Turbine control

Highlights

- Sophisticated upgrade-concepts
  - Long-term experience with time critical projects (retrofit and upgrade)
  - Very short outage times with minimum risk possible
- Extensive quality assurance
  - 100% workshop test including FAT
- Best availability with highest safety
  - Redundant closed loop control
  - 3-channel turbine protection system (not just I/O-level)
TURBOTROL®
Closed loop control for ST

Features

- Base control level:
  - For safe manual operation

- Automatic control level:
  - For automatic run-up and loading
  - For coordination with the unit DCS (UCTE)

- Stress calculator:
  - For calculation of the thermal stress
  - Gradients for run-up and loading
  - Limits for alarms and trips
TURBOTROL®
Base controller

Features
- Speed control
- Load adjustment
- Main steam pressure gradient limiter
- Acceleration limiter
- Manual start-up
- Manual load operation
-Selectable dead band for frequency (small, wide)

* acc. to No. of CV’s
P_m = main steam pressure
n = speed

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TURBOTROL®
Automatic controller

TURBINE MASTER SYNCHRONIZER
UNIT MASTER CONTROLLER

Thermal stress evaluator

Protection

Automatic control level

Target speed
Target load
Run up program
Load program

Control mode

Option
M. St. Pr. contr.*
MW controller

Limiters HP
Limiters IP

Speed
Load
Valve coord.

Base control level

Target load
Load gradient

Min

Features
- Automatic run-up
- Automatic loading, unloading
- Automatic HP/IP coordination
- Load (MW) control
- Main steam pressure control
- Coordination with unit control
- Limiting of:
  - Thermal stress (HP/IP)
  - HP exhaust temp (HP/IP) $T_{ex}$
  - Main steam pressure (HP) $P_m$
  - Hot reheat pressure (IP) $P_{hr}$

* main steam pressure controller

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EGATURN®
Closed loop control for GT

Features

- Speed control
- Start-up control
- Speed control
- Frequency control
- Load control
- Temperature limiter
- Fuel selection
- Automatic load shedding
- Fast loading

Optional supplements:

- Setpoint for gas turbine outlet temperature control
- Selection of loading and load shedding rates
- Fixed blade adjustment (if applicable)
ABB Turbine Control Protection
TURBOTROL®
Steam turbine protection

PROTECTION CONDITIONS (examples):
- LP OUTLET PRESSURE (3)
- LUBE OIL PRESSURE (3)
- SAFETY SYSTEM PRESSURE (3)
- SHAFT POSITION (3)
- THERMAL STRESS (3)
- LEVEL LUBE OIL TANK (3)
- BEARING TEMPERATURE (3)
- VIBRATION
- BOILER PROTECTION
- GEN. PROTECTION

- Three channel, fail safe principle:
  Trip, if more than 1 channel is deenergized!
- Equal trip logic in each channel
- Independent electronic overspeed trip testable during turbine operation
- Trip memory and resetting device
- Online testing of all trip channels via test program
EGATURN®
Gas turbine protection

- Three channel, fail safe principle:
  Trip, if more than 1 channel is deenergized!
- Equal trip logic in each channel
- Independent electronic overspeed trip testable during turbine operation
- Trip memory and resetting device
- Online testing of all trip channels via test program

PROTECTION CONDITIONS (examples):
- INLET TEMPERATURE (2)
- LUBE OIL PRESSURE (2)
- FUEL PRESSURE
- FIRE PROTECTION
- GUIDE VANE POSITION
- BEARING TEMPERATURE (2)
- BEARING VIBRATION
- EXHAUST TEMPERATURE (2)
- EXHAUST PRESSURE
- GEN. PROTECTION (2)
ABB Turbine Control
Open Loop Control
TURBOTROL®
Open loop control

- Evacuation system
- Turning gear
- Turbine drains
- Lube oil supply
- Gland steam system
- Control oil system
- Generator cooling
- Automatic test programs
- Turbine master program
EGATURN®
Open loop control

- Turning gear
- Lube oil supply
- Hydraulic system
- Fuel supply
- Turbine washing / cleaning
- Electrical auxiliaries
- Turbine master program
Operation

- Concept
- Local / remote HSI
  - Identical operation for local and remote
  - Hierarchical set of process displays
  - Windows concept
  - Mouse and keyboard operation
Operation

- Displays
  - Alarm line
  - Navigation buttons
  - Animated objects
  - Alarm list
  - Diagnostic displays
  - Object displays
  - Trend curves
ABB Turbine Control
Turbine Supervision
Turbine Supervision

- Optimized solutions for supervision and monitoring of all turbines:
  - ABB MCM800
  - ABB symphony harmony
  - 3rd party
    - EPRO
    - Jaquet
    - BRAUN
    - Vibrometer
    - Bently Nevada
ABB MCM800

Features

- Independent monitoring device
  - Standalone basis
  - No controller required
  - Mounted locally or remotely
- Cost effective configurations
  - Universal module – 4 channels, all TSI measurements
- All protection and diagnostic data
- Open architecture
  - Profibus or Modbus
  - MCM OPC server software
ABB Turbine Control
Turbine Hydraulic
Turbine hydraulic Solutions and products

- Electro-hydraulic converters (EHC)
- Hydraulic actuators
- Trip solenoid valves
- Hydraulic trip blocks
- Hydraulic power units, filter and supplies
- Optimization of existing hydraulic control and protection systems
ABB trip block
SIL3 certified

- First SIL3 certified 2003 trip block on the market
- TÜV - certified
- ABB exclusive design
- Extended failure supervision and diagnosis
- Single fault detection
ABB trip block
SIL3 certificate
Optimization of a hydraulic system (I)

Example
Optimization of a hydraulic system (II)

Example

original Rateau Schneider design:

New ABB design:
- New ABB – hydraulic actuators for each valve
- removal of old mech. levers
Optimization of a hydraulic system (III)

Example

Detail:

- Individual EHC for each HP-CV
- New common EHC for IP-CV
- Removal of old system of levers
- Mechanical components largely replaced by modern electronics

- Accuracy (<0.5%)
- Adjustable stroke time (0.35 - 1 sec) for closing
- Fail safe
Scholven C – hydraulic upgrade
Before upgrade
Scholven C - hydraulic upgrade
After upgrade

E-Stop
Tripblock
Oilfilter
Interface electronic / hydraulic

**ABB UTAC universal turbine actuator card**
- Designed to drive electrical actuators, electro-hydraulic converters & proportional distributors
- Provides LVDT and/or oil pressure feedback

**ABB VP800**
- Profibus DP interface
- Integrated valve curve
- Integrated valve testing
- Automatic calibration
Turbine hydraulic
Possible benefits

- Optimized solutions for high- and low pressure hydraulic systems:
  - Less mechanical loose
  - Less mechanical parts - minimised wear
  - Less maintenance and overhaul works
  - Improved dynamic properties
  - Less opening / closing times
ABB Turbine Control
Electrical Equipment
Electrical equipment
Products
Electrical equipment
Products

- Excitation systems
- Voltage regulators (AVR)
- Synchronisation systems
- Generator protection
- Circuit breakers (generator, grid)
- Electrical generator by metering and measuring
- Starting frequency converter for gas turbines
ABB Turbine Control Services
Services
Project execution

You know the targets – we know the way

- Basic engineering
- Detail engineering
- Plant design
- Installation
- Commissioning
- Documentation
- Optimization
Services – training
Custom tailored courses

ABB training services
- Needs assessment
- Process and product theory
- Power plant simulator
- Hands-on training
- Classroom and on-site courses

Highly trained operation staff
- Reduces and prevents human errors
- Optimizes plant performance
- Secures plant availability
- Protects your investment

Locations
- ABB University
- At your place
Quality management
Example of Q-certificates
After sales service

Local support services
- Local engineers supported by service centre specialists

Telephone support
- 24-hour hotline service

Remote diagnosis
- Instant access also for long-term process optimisation

Service contracts
- Customised and cost effective

The ABB service concept covers all phases of a typical plant's life-cycle, starting with its commissioning and warranty period, through routine service inspections, subsequent repairs and major retrofits.
Spare parts and logistics
Urgent is our pleasure!

- Repair and return services
- Fast parts replacement
- Emergency service parts
- On-line information for spare
- Efficient logistics network
- Spare parts contracts

Wherever your plant is located, you receive fast and reliable access to product, application and process specialists 24 hours a day, 365 days a year.
ABB Turbine Control Summary
EGATURN® and TURBOTROL®
Cost benefits

- Smooth control for improved turbine lifetime
- Optimized and safe startup
- Simulator tested solutions
  - Extremely short commissioning time
  - Less outage times
- Comprehensive diagnostic features
  - Reduced maintenance costs
  - Reduced shutdown times
- ABB migration strategy for secured investments
EGATURN® and TURBOTROL®
Operation benefits

- Easy and fully automatic operation prevents from operator mistakes
- Optimized operation through very fast information access
- Consistent operation for machine and plant control
- Very high system availability through consistent system redundancy
- Options and scope can be adapted to any customer needs (e.g. grid code req., fuel adaptations)
EGATURN® and TURBOTROL®
Reliability benefits

- Multi-channel protection system provides highest reliability
- Automatic system self tests ensure reliable and secure operation
- Validated software prevents from unexpected system failures
EGATURN® and TURBOTROL®

Summary

- ABB is an experienced and reliable partner for turbine control
- ABB delivers well proven solutions and techniques, that are subject to continuous improvements
- Large Product Portfolio allows ABB to deliver everything “Around the Turbine” with minimized interfaces

You know the targets – we know the way!
ABB Turbine Control - References
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## References (extract) II

More than 500 EGATURN® references

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Customer need
- Retrofit of 2x GE gas turbines

ABB’s response
- 2 x EGATURN
  - Closed loop control
  - Protection (incl. overspeed)
  - Open loop control for auxiliaries
- Instrumentation
- Turbine monitoring
- Synchronization
- Switch gear
- Excitation
- Generator protection

Customer benefits
- Common, integrated control system for low life cycle costs
- Electronic protection system
Qassim PP3
9x 50 MW, Saudi Arabia

Customer need
- Retrofit of 9x Westinghouse WH-501D4 solo gas turbines
- Remote operation of 5x ABB GT9

ABB’s response
- 9 x EGATURN
  - Closed loop control
  - Protection (incl. overspeed)
  - Open loop control for auxiliaries
- Turbine monitoring
- Synchronizing equipment
- New fuel control valve
- Remote connection (40km) for operation of 5x ABB GT9 in Qassim PP2

Customer benefits
- Common, integrated control system for low life cycle costs
- Replacement of maintenance-intensive pneumatic turbine control by electric system with higher accuracy and low maintenance cost
HKW Barmen
2x 33 MW, Germany

Customer need
- Retrofit of 2 GE MS6001B, Build in 1980

ABB’s Response
- 2x EGATURN
  - Closed loop control
  - Protection (incl. overspeed)
  - Open loop control for auxiliaries
- New field cabling
- New measurement transmitters for pressure, differential pressure and temperature (exc. T/Cs)
- Exchange of all binary switches to analoge transmitters
- All pressure transmitters for turbine protection extended to 2oo3 redundancy
Gersteinwerk
1x 55 MW, Germany

Customer need
- Retrofit von 1 KWU (Siemens) V93 Gasturbine

ABB’s Response
- 2x EGATURN
  - Closed loop control
  - Protection (incl. overspeed)
  - Open loop control for auxiliaries
- New field cabling
- New measurement transmitters for pressure, differential pressure and temperature (exc. T/Cs)
- Exchange of all binary switches to analoge transmitters
- All pressure transmitters for turbine protection extended to 2oo3 redundancy
- New Excitation System
- New Start-up Frequency Converter
- Hydraulic retrofit with SIL3-Trip Block
## References of the last years (extract)

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### TURBOTROL®

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More than 100 TURBOTROL®

since 2003

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Fynsvaerket 7
1x 400 MW, Denmark

- Business Case
  - Retrofit of 1x Siemens steam turbine

- ABB Solution
  - Plant DCS with HMI
  - Turbine closed loop and protection
  - Replacement of turbine supervision system
  - Full implementation of existing CVA’s

Fynsvaerket
Denmark
1 Unit, 400 MW
Customer: Vattenfall
Year of commissioning: 2007
Scholven
3x 384 MW, Germany

- **Business Case**
  - Retrofit of 3x SIEMENS steam turbines

- **Reasons for retrofit**
  - Obsolete mechanical control
  - Protection purely mechanic/hydraulic
  - Undesired turbine trips
  - High maintenance costs

- **ABB Solution**
  - Plant DCS based on 800xA and AC870P
  - Turbine control and protection based on AC870P (TURBOTROL 10)
  - Hydraulic upgrade with SIL3-certified 2oo3-trip block
  - Engineering, installation & commissioning for the whole scope
Tutuka
6x 600 MW, South Africa

Customer need
- Modernization of 6 x 609 MW coal fired power plant with higher efficiency and lower emissions
- Redesign for turbine control and protection

ABB’s response
- Complete DCS and instrumentation
- Boiler protection, turbine hydraulics and control
- Model-based MODAN unit control system

Customer benefits
- Common, integrated control system for low life cycle costs, covering DCS, boiler protection and turbine control
- Leading automation and optimization technology
  - Improving the efficiency and start-up processes
  - Increased frequency accuracy and grid stability
- Replacement of maintenance-intensive mech.-hydr. turbine control by EHC system with higher accuracy and low maintenance cost

Tutuka
South Africa
6 Units, 3.600 MW
Customer: ESKOM
Year of commissioning: 2004 - 2007
Blénod
3x 265 MW, France

- **Business Case**
  - 3x Rateau Schneider steam turbine, built in 1968

- **Reasons for retrofit**
  - Bumping actuators damaging the mechanical construction.
  - Bad energy efficiency
  - The plant was running on base load.
  - Opportunity to get a higher price if the turbine could handle peak load demands.
  - Trips and standstills from obsolete parts

- **ABB Solution**
  - Turbine closed loop and protection
  - Upgrade of hydraulic system
  - Unit control MODAN

Blénod
France
3 Units, 795 MW
Customer: EDF
Year of commissioning: 2003 - 2007
Asnaes 5
1x 700 MW, Denmark

Business Case
- BBC steam turbine, built in 1973, 700 MW
- BBC feedwaterpump turbine, built in 1973, 17.5 MW

ABB Solution
- Closed loop control and protection for main turbine and feed water pump turbine
- Closed loop control and protection for low pressure bypass
- Profibus-interface to ABB main-DCS
- Engineering, workshop test, erection, commissioning

Asnaes
Denmark
1 Units, 700 MW
Customer: Energi E2
Year of commissioning: 2004
Kharg
2x 7 MW, Iran

Business Case
- 2x Mitsubishi steam turbines 7MW

Reasons for Retrofit
- Turbine start-up only locally possible
- Damaged mechanical speed control
- Inaccurate actuation of steam inlet valves
- Bad energy efficiency of the plant.
- Obsolete parts caused trips and standstills.

ABB Solution
- Turbine control and protection
- Operator station
- Upgrade of hydraulic system
- Excitation, generator protection & synchronization

Kharg
Iran
2 Units, 14 MW
Customer: Kharg Petrochemical Company
Year of commissioning: 2004
Redhawk
2x 200MW, USA

Business Case
- 2x Alstom steam turbines

New Plant

ABB Solution
- Closed loop control
- Protection (incl. overspeed)
- OLC for auxiliaries
- Turbine monitoring
- Operation via existing conductor NT
- DC starters

Redhawk
USA
2 Units, 400 MW
Customer: Pinnacle West Energy
Year of commissioning: 2002
Banias  
2x 170 MW, Syria

Business Case
- 2x Ansaldo steam turbine

ABB Solution
- Upgrade of Plant DCS
- Upgrade of Turbine Control & Protection
- Upgrade of Turbine Monitoring
- Engineering, Installation & Commissioning for the whole scope

Banias  
Syria
2 Units, 340 MW
Customer: PEEGT
Year of commissioning: 2006
Jeddah 4
5x 127 MW, Saudi Arabia

Business Case
- 5x Franco Tosi Steam turbine

ABB Solution
- Upgrade of Plant DCS
- Upgrade of Turbine Control & Protection
- Upgrade of Turbine Monitoring with CMM11
- Engineering, Installation & Commissioning for the whole Scope

Jeddah
Saudi Arabia
5 Units, 635 MW

Customer: SWCC

Year of commissioning: 2004 - 2006
Power and productivity for a better world™