A power plant’s competitiveness is measured not only by performance, but also by overall plant operating economics. This includes having the ability to start up and shut down the plant quickly and effectively. Through extensive analysis, Siemens is able to provide fast cooling* of steam turbines which could result in maintenance beginning significantly sooner than with traditional cooling methods and thus has the potential to get your power plant back online faster. Cool down gradients are determined using the finite element method, to help protect against excessive thermal distortion and differential expansion. Existing temperature measuring points are used to monitor the cool down gradients. This helps to maintain the recommended temperature limits during a fast cool down.

Our solution
During fast cooling, the existing or the retrofitted condenser air removal system is used to draw air from the turbine hall through the blade path of the turbines, and into the condenser, where it is ultimately exhausted from the system. This air flow allows for a greater amount of heat to be removed from the components and for the steam turbine to cool down more quickly than with natural cooling. Subsequent work on the unit can therefore be started much earlier, allowing for an increase in availability and improvement of the overall plant operating economics.

Implementation
Fast cooling is a reliable way of saving up to 5 days of cool down time compared to natural cooling. Detailed analyses are performed for the cool down process taking into account material strength limits, plant specific operating variables and usage factors. The fast cooling process combines a modified software package, filters and mechanical analyses. Siemens has developed this process into a patented product, which can be used to potentially speed up inspections and reduce plant downtime. Permanent installation of additional hardware or modification of existing hardware is not generally required. Only the installation of a nozzle and filter is necessary at each turbine admission control valve. This nozzle is mounted on the existing flanges for the dehumidifiers. The process itself is monitored using the temperature sensors installed as standard in the turbine.

* Fast cooling is the improvement of the successful forced cooling procedure and part of Flex-Power Services™.
Procedure
For scheduled shutdowns the fast cooling process is divided into the following steps:

- **Operational cool down of turbine**
  Prior to the plant shutdown, main steam/reheat steam temperatures are reduced to the minimum allowable value in accordance with allowable limits and protection criteria for the plant. Reducing the temperature during operation shortens the overall cool down time due to the lower starting temperature of the fast cooling process.

- **Natural cooling**
  Once steady-state temperature conditions have been achieved with reduced steam temperatures, the steam turbine is shut down. While on the turning gear, the turbine enters a natural cooling phase to permit the temperature differentials within the steam turbine to reach an equilibrium state.

- **Fast cooling with ambient air**
  At the end of the natural cooling phase for the steam turbine, the nozzles provided for connecting dehumidifiers at the admission control valves are opened and the vacuum pumps are switched on. This draws in ambient air via the control valves, which passes through the turbine blade path. The air flow is regulated using the control valves. Air is drawn in until a target temperature is reached.

After completion of these steps and sufficient reduction of temperature, the turning gear can be switched off and working access to the steam turbine can be commenced.

Cooling down after an unexpected steam turbine trip, i.e. without operational cool down of the turbine, results in a prolonged fast cooling process.

**Potential improvements of fast cooling**
For turbines already equipped with the forced cooling system, different optimizations are possible. These provide further shortening downtimes as well as simplified handling:

- **Automation**
  The degree of automation can be increased at a suitable steam turbine instrumentation and control system. The positioning of the control valves for the adjustment of the air flow rate is achieved by a control circuit.

- **Process optimization**
  A system-specific check of the existing procedure is carried out with the aim to optimize the process. This may lead to higher permitted cool down transients.

- **Hardware modification**
  Measures may be proposed for the improvement of the condenser vacuum during the air intake phase.

The potential of the improvements depends on the respective turbine and condenser configuration as well as the instrumentation and control system.

**Your benefits**
Our fast cooling solution offers the following potential advantages:

- **Power plant specific optimization**
- **Reduction of overall outage times for inspection**
- **Increased availability through shorter cool down times at no risk to the turbine**

**References**
More than 150 plants have already been equipped with forced cooling, which is the technology base for fast cooling.