



Coal Startup Optimization

Commander STARTIM™

Automated Start-up Technology

Dr. Ray Boucher, Real Time Power

STARTIM: what is it?

- Technology that allows unit operators to obtain best-practice start-ups, consistently.
- *“Like having your best operator always doing the start-up.”*

Where can it be used?

- Originally developed for large coal-fired units.
- Equally applicable to combined cycle and cogen facilities.



Reference Sites

Ironbridge, UK, coal-fired

- 2 x 500 MW wall-fired units
- Automation of Hot Starts
- C&I Contact: Dave Rowlands



West Burton, UK, coal-fired

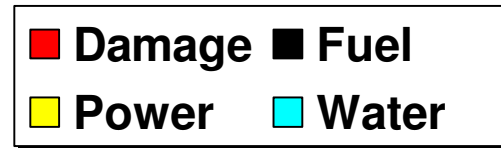
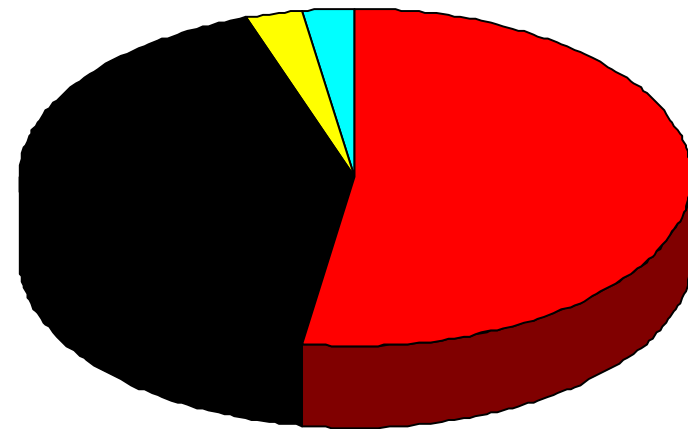
- 4 x 500 MW tangentially-fired units
- Automation of Hot Starts
- C&I Contact: Dick Wright



Business Case

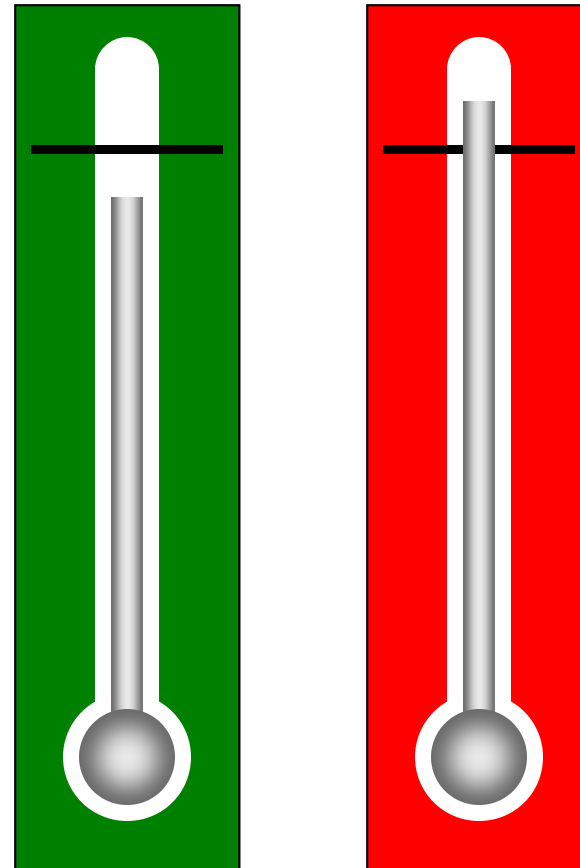
- Minimization of start-up costs
- Most significant start-up cost is plant damage (reduced lifetime)
- Therefore greatest benefits are obtained by minimizing plant damage during start-ups

Start-up Costs



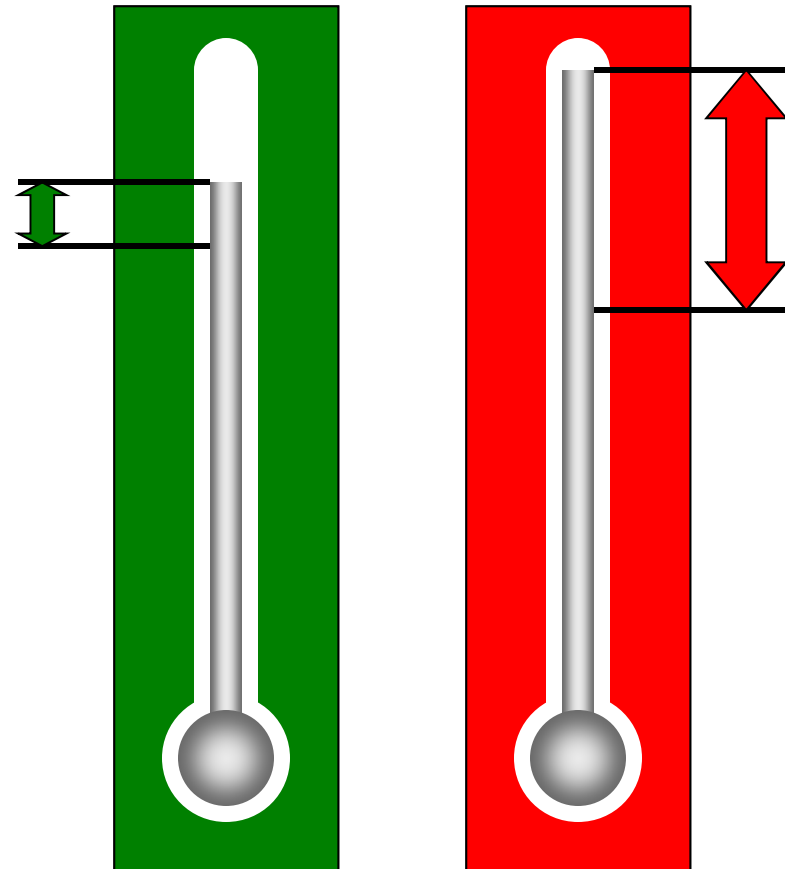
Minimising Plant Damage

- Prevent excessively high temperatures.



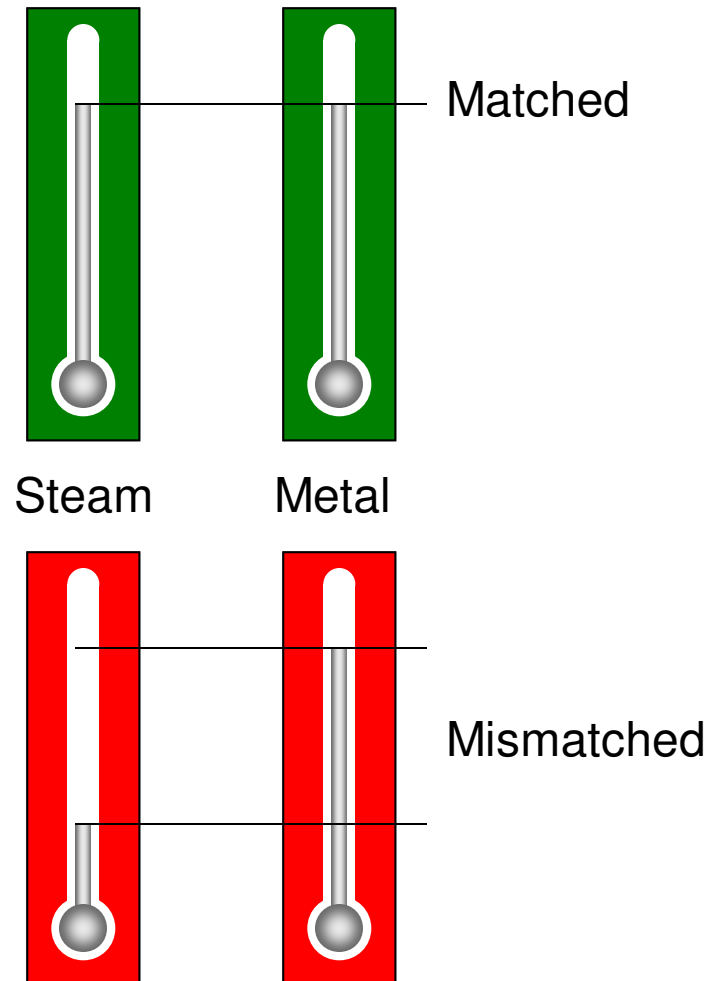
Minimising Plant Damage

- Prevent excessively high temperatures.
- Prevent excessively high rates of change of temperature.



Minimising Plant Damage

- Prevent excessively high temperatures.
- Prevent excessively high rates of change of temperature.
- Prevent excessively high temperature differences between steam and metal when re-establishing steam flows.

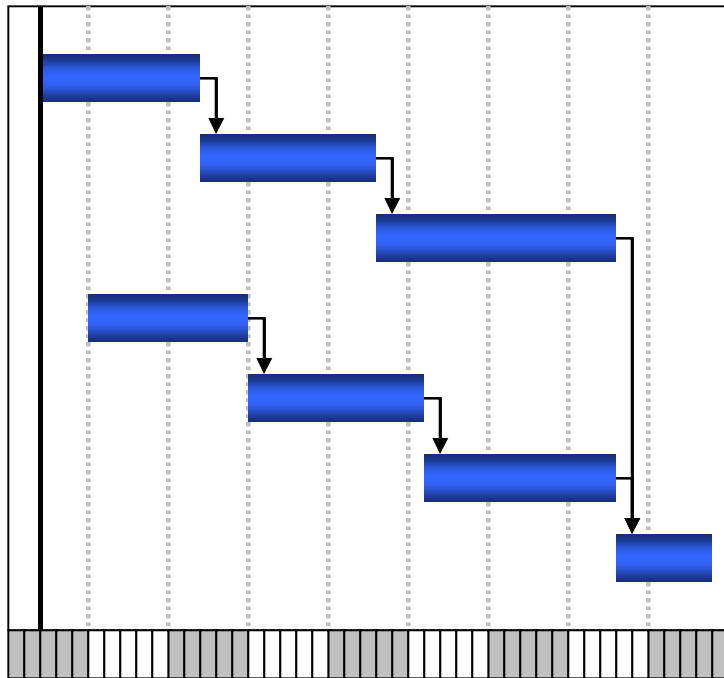


Good planning is needed

- The minimization of plant damage requires that unit start-ups are well planned.
- Enough time must be allowed for purging and establishing initial firing.
- Enough time must be allowed for achieving temperature matches.



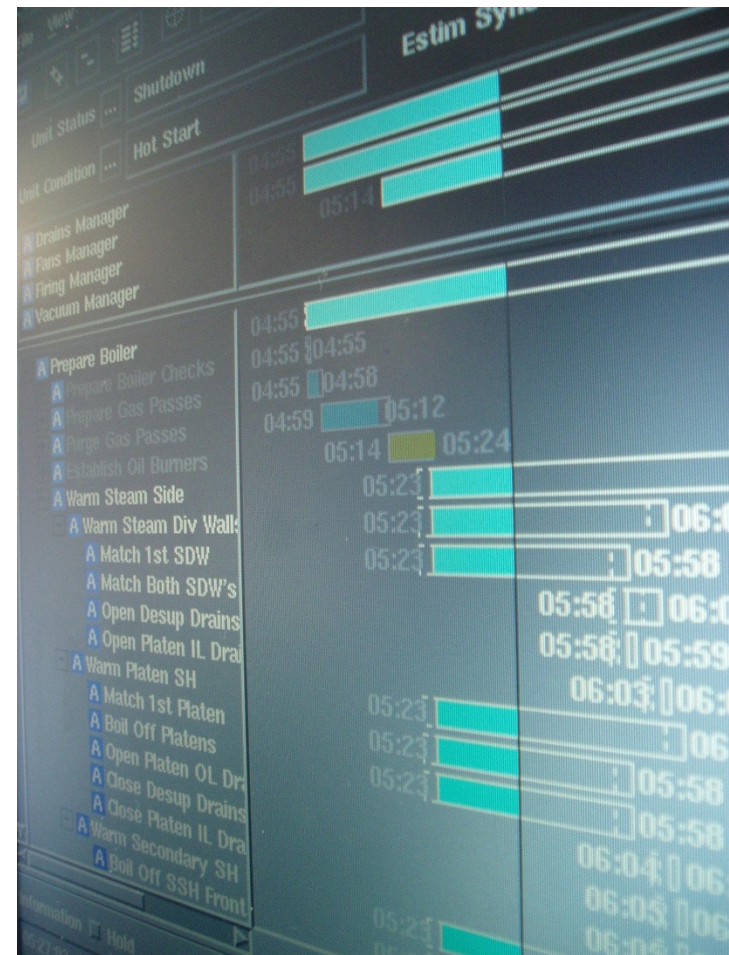
Good execution is needed



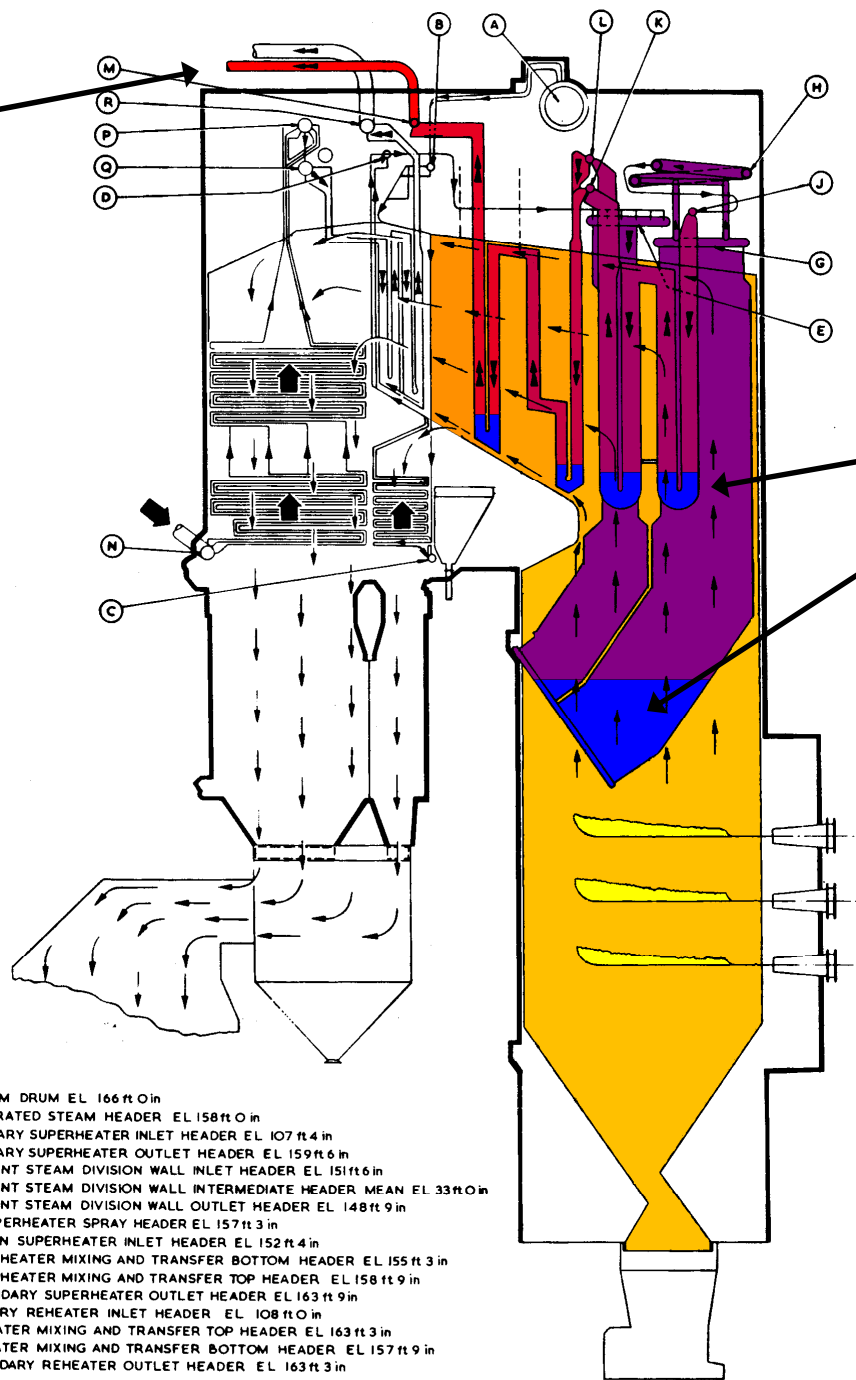
- The minimization of plant damage requires that unit start-ups are well executed.
- Actions must be performed at the correct time in order for boiler and turbine to be ready at synchronisation.
- Parallel activities must be precisely coordinated.

Good Planning & Execution

- With STARTIM we define the start-up procedure as a project plan (Gantt chart).
- We go further than MS Project by adding actions and checks to each task.
- Plan is then automatically updated and executed in real-time at start-up.



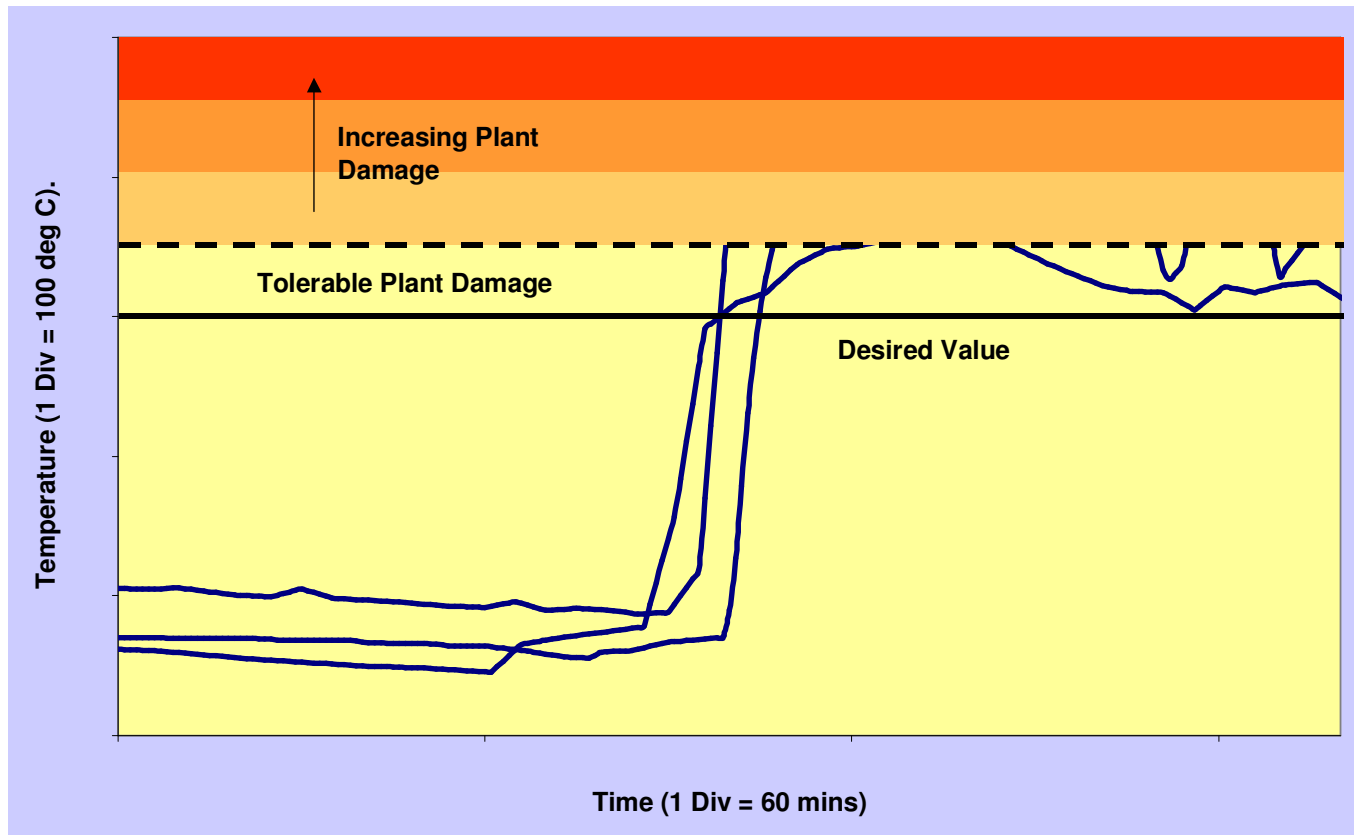
Minimize thermal shocks at final superheater outlet



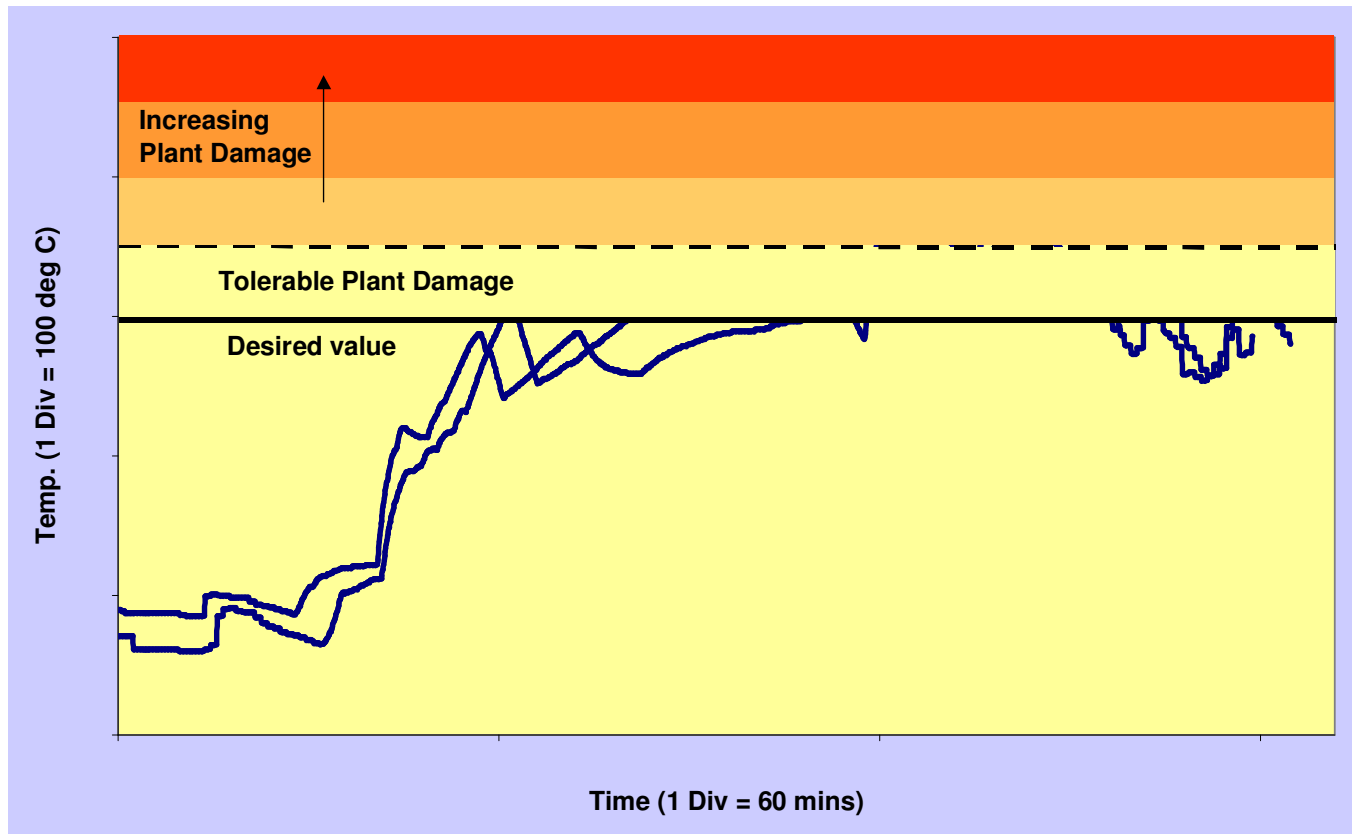
Avoid tube leaks in initial superheater sections

- A STEAM DRUM EL 166 ft 0 in
- B SATURATED STEAM HEADER EL 158 ft 0 in
- C PRIMARY SUPERHEATER INLET HEADER EL 107 ft 4 in
- D PRIMARY SUPERHEATER OUTLET HEADER EL 159 ft 6 in
- E RADIANT STEAM DIVISION WALL INLET HEADER EL 151 ft 6 in
- F RADIANT STEAM DIVISION WALL INTERMEDIATE HEADER MEAN EL 33 ft 0 in
- G RADIANT STEAM DIVISION WALL OUTLET HEADER EL 148 ft 9 in
- H DESUPERHEATER SPRAY HEADER EL 157 ft 3 in
- J PLATEN SUPERHEATER INLET HEADER EL 152 ft 4 in
- K SUPERHEATER MIXING AND TRANSFER BOTTOM HEADER EL 155 ft 3 in
- L SUPERHEATER MIXING AND TRANSFER TOP HEADER EL 158 ft 9 in
- M SECONDARY SUPERHEATER OUTLET HEADER EL 163 ft 9 in
- N PRIMARY REHEATER INLET HEADER EL 108 ft 0 in
- P REHEATER MIXING AND TRANSFER TOP HEADER EL 163 ft 3 in
- Q REHEATER MIXING AND TRANSFER BOTTOM HEADER EL 157 ft 9 in
- R SECONDARY REHEATER OUTLET HEADER EL 163 ft 3 in

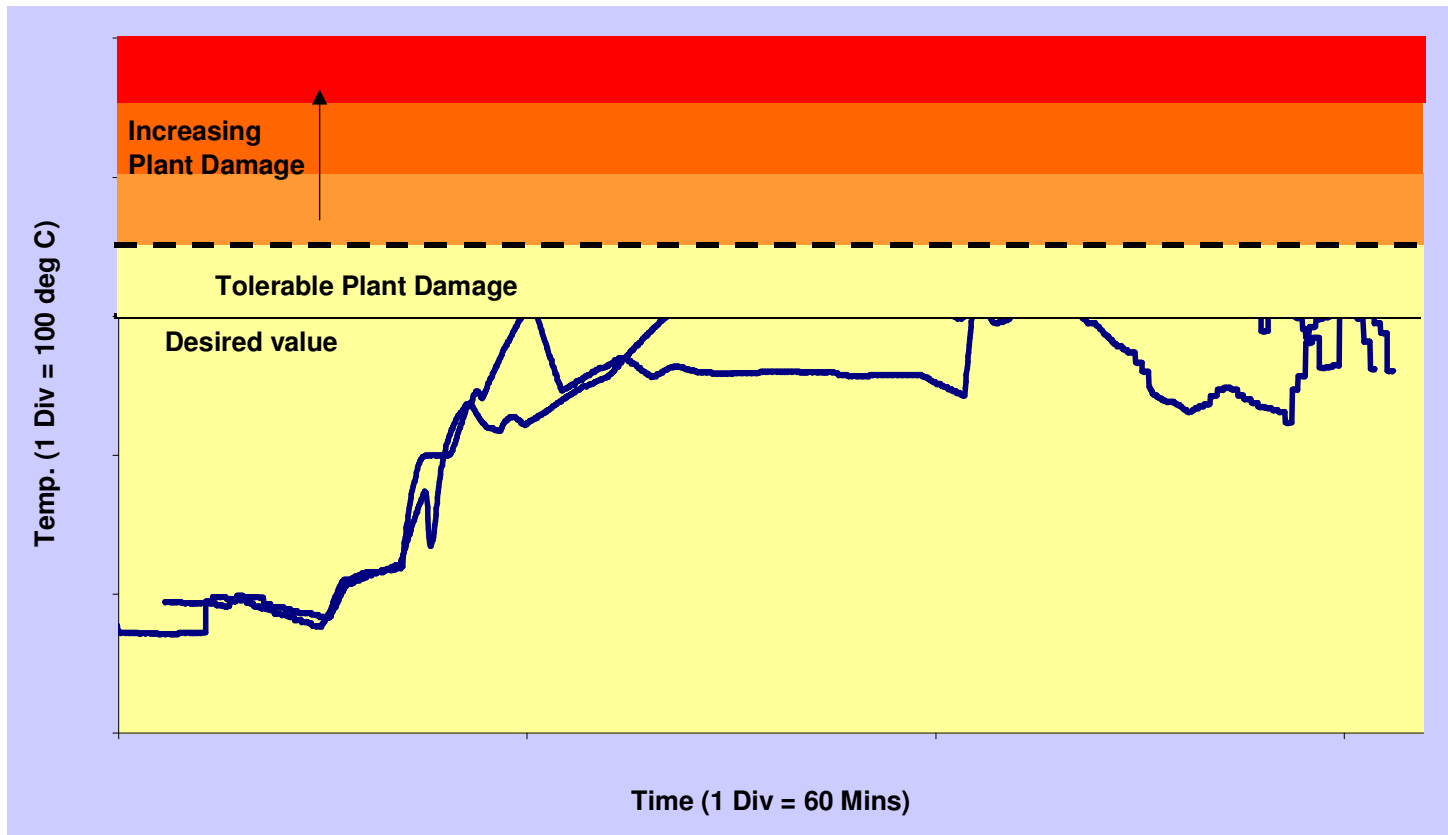
Variations in max. platen metal temperatures during manual starts



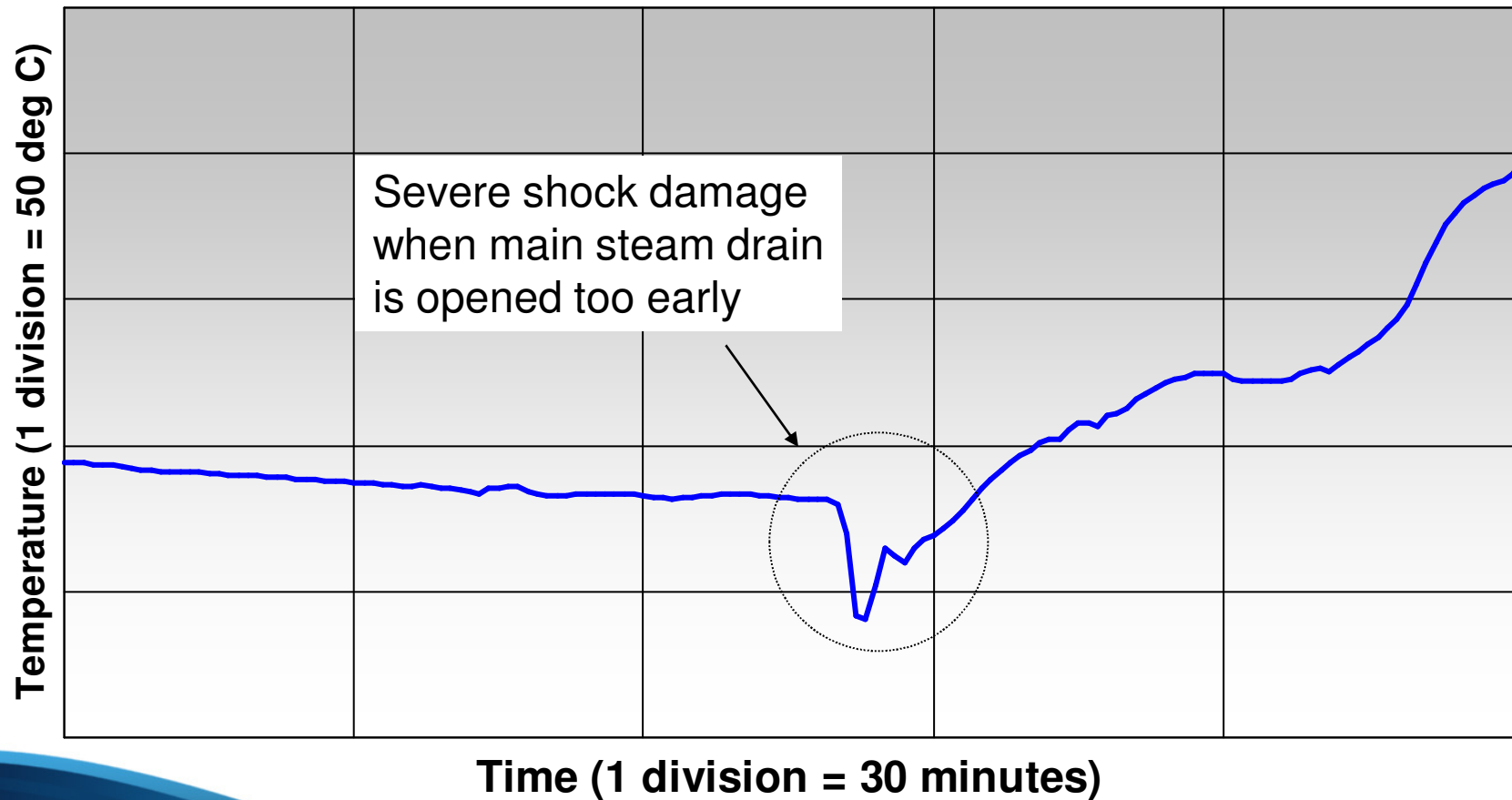
Variations in max. platen metal temperatures for automated starts



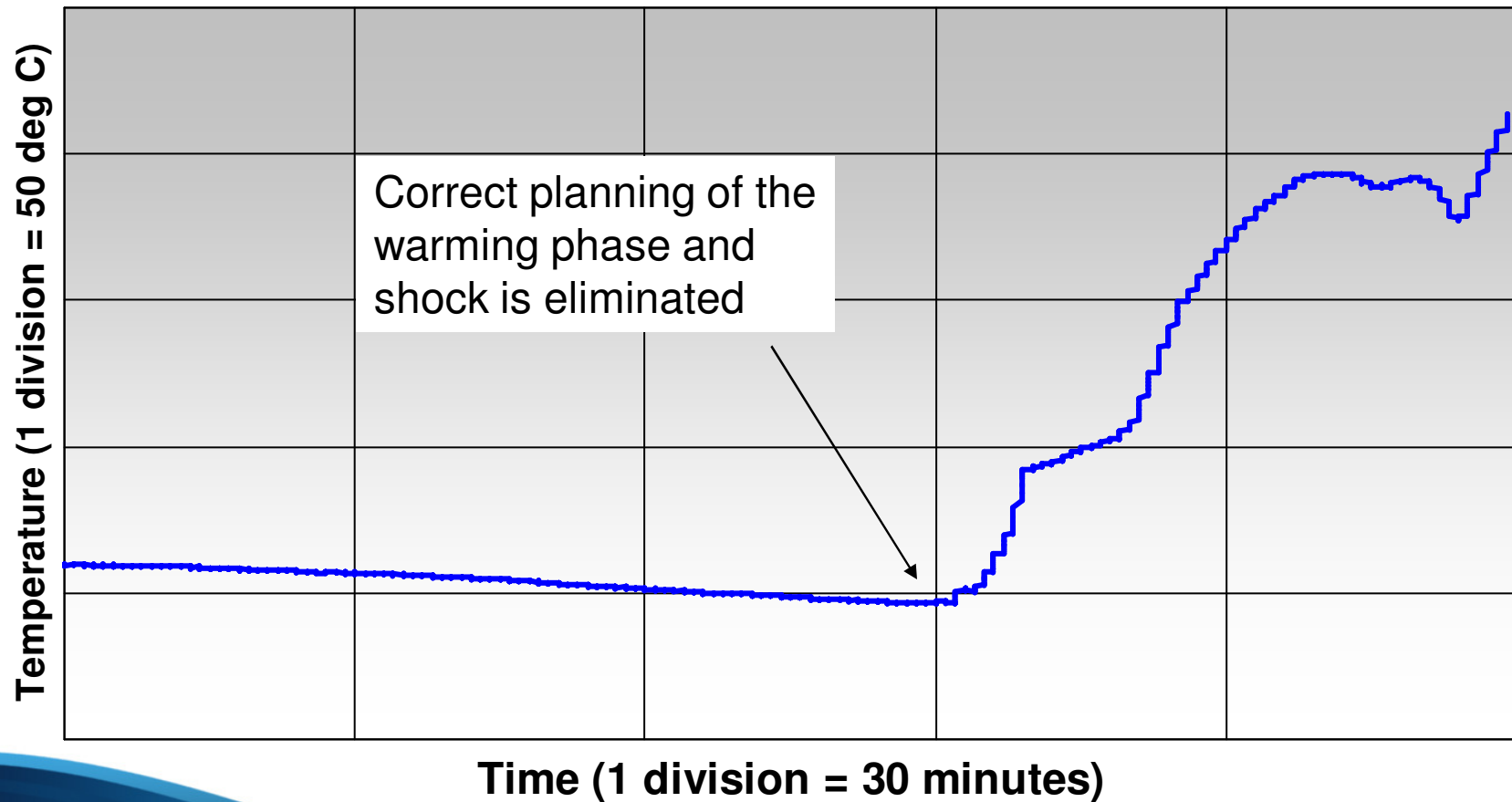
Consistency offers potential for further improvements



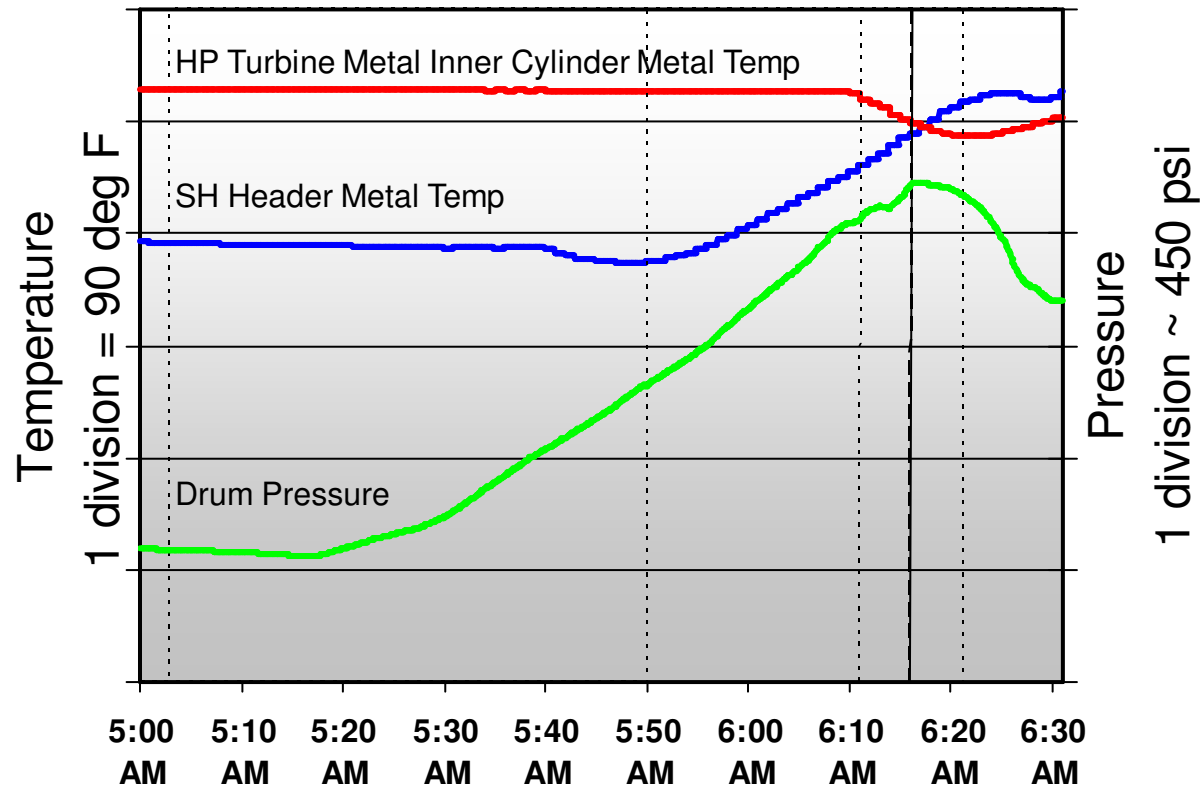
Main steam temperature during a manual start-up



Main steam temperature during an automated start-up



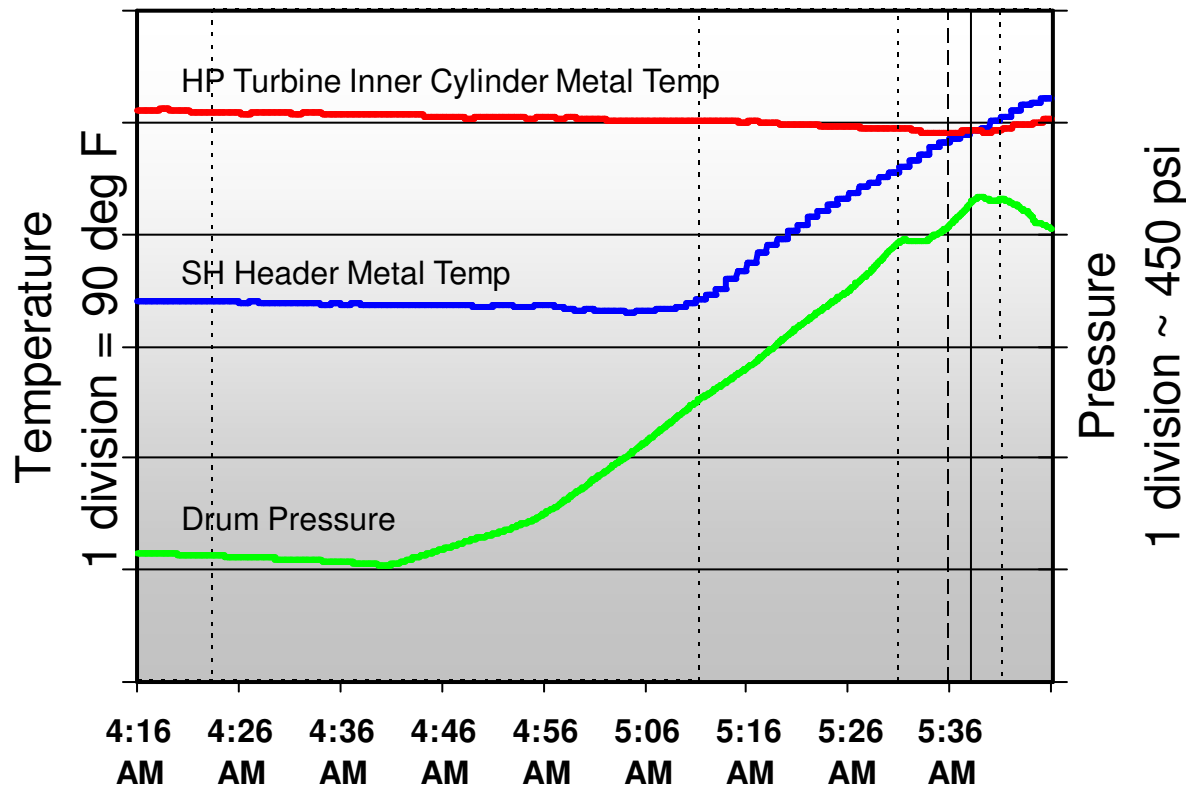
HP turbine chilling in poorly planned start



Key Times

- 5:03 ID Fans Start
- 5:17 Oil Burners In
- 5:22 1st Mill In
- 5:38 Final Drains Open
- 5:50 Boiler Stops Open
- 6:08 Turbine Running Up
- 6:15 Turbine at Speed
- 6:16 Synchronized

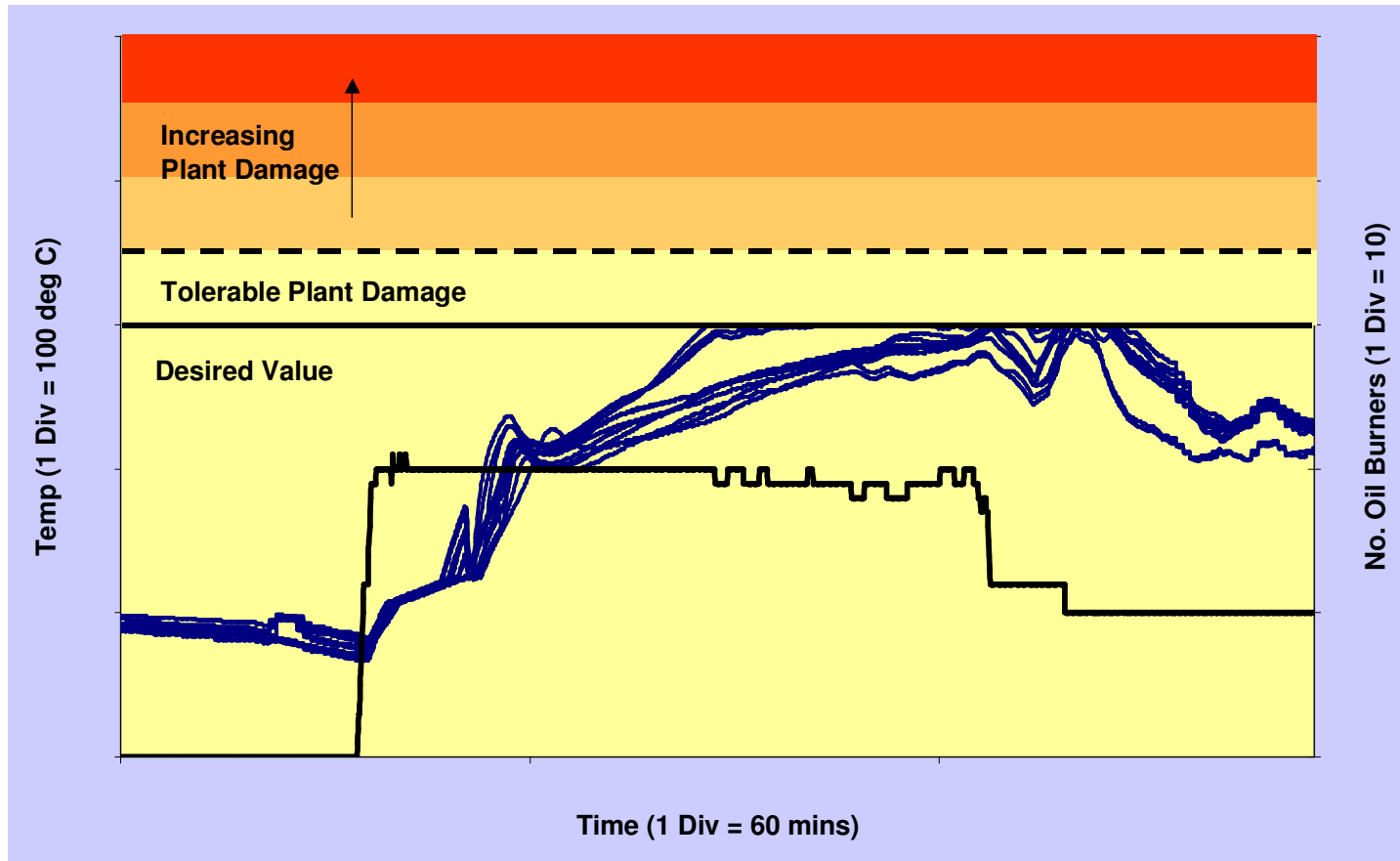
HP turbine chilling eliminated in optimized start



Key Times

- 4:23 ID Fans Start
- 4:40 Oil Burners In
- 4:52 1st Mill In
- 4:55 Final Drains Open
- 5:10 Boiler Stops Open
- 5:34 Turbine Running Up
- 5:36 Turbine at Speed
- 5:38 Synchronized

Intelligent Oil Burner Control



Scope of Automation

- All automatable tasks from topping up drum all the way through to minimum load, including:
 - preparing & purging the gas passes
 - inserting & managing oil burners
 - inserting & managing coal mills
 - actively controlling pressure & temperatures
 - establishing cooling water systems
 - pulling vacuum
 - running up the turbine
 - engaging desuperheater sprays

In Summary

- Consistency provides scope for further optimization
- Corporate memory is captured and preserved
- *“STARTIM has reduced a complicated plant procedure to a few mouse clicks.”*