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REGIONAL SEMINAR 2012

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The **Power** of **Data**



Power Plant Startup Monitoring and Optimization

Presented by **Steve Winsett, Entergy OIS Program
Manager**



Entergy's PI System Solutions

••••• Plant Real-time Monitoring & Diagnostics •••••

Unit Optimization & Equipment Monitors

• 16 plants •

OIS w/ EtaPRO™

PIsystem™

Fleet Optimization

• 22 plants •

Fleet Processes & Metrics

PIsystem™

Dispatch Support, Fuel Telemetry

PIsystem™

Event Detection & Alerting

• 22 plants •

PIsystem™

eCM™

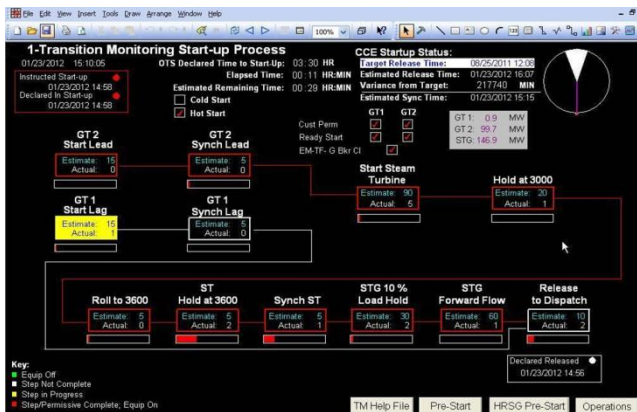
Mobile Performance Testing

• 5 support offices •

Incremental Heat Rate / Equipment Tests

PIsystem™

Power Plant Startup Monitoring and Optimization



Transition Monitor Detailed Startup Report

Plant: Unit: Analysis Date: 1/24/2012 9:14 AM

Startup ID	Duration (HR)	OTS Estimate (HR)	Variance from OTS
1 Startup 29-Apr-11 23:14:45	11:58	10.5	64.8 MIN (1.08 HR)
OTS Start Time	4/29/2011 11:14:20 PM		
End Time	4/30/2011 10:49:20 AM		
1st Stg Mtl Temp			

Phase	Start Time	End Time	Duration	TM Estimate	Variance from TM
OTV Fmpg	4/28/2011 12:06	---	---	---	---
FD Fan	4/29/2011 22:08	---	---	---	---
Startup	4/29/2011 23:14	4/30/2011 10:49:20 AM	695 MIN (11:58 HR)	366 MIN (6.1 HR)	329 MIN (5.48 HR)
Station Air Sys	4/30/2011 0:39	---	---	---	---
Condenser	4/30/2011 0:45	4/30/2011 12:05	80 MIN (1:33 HR)	0 MIN (0 HR)	80 MIN (1:33 HR)
Build Drum Pressure	4/30/2011 1:13	4/30/2011 1:14	0:08 MIN (0 HR)	180 MIN (3 HR)	-179:92 MIN (-3 HR)
Establish Vacuum	4/30/2011 1:14	4/30/2011 1:20	5:11 MIN (0:55 HR)	60 MIN (1 HR)	-9 MIN (-0:15 HR)
Satisfy Steam Conditions	4/30/2011 1:14	4/30/2011 2:02	48:08 MIN (0:8 HR)	30 MIN (0:5 HR)	18 MIN (0:3 HR)
Boiler	4/30/2011 2:01	4/30/2011 2:02	0:08 MIN (0 HR)	0 MIN (0 HR)	0:08 MIN (0 HR)
Turbine	4/30/2011 2:05	4/30/2011 2:28	23 MIN (0:38 HR)	0 MIN (0 HR)	23 MIN (0:38 HR)
Condenser	4/30/2011 2:28	4/30/2011 3:43	75 MIN (1:25 HR)	0 MIN (0 HR)	75 MIN (1:25 HR)
Establish Vacuum	4/30/2011 3:25	4/30/2011 3:43	18 MIN (0:30 HR)	60 MIN (1 HR)	15 MIN (0:25 HR)
Boiler	4/30/2011 3:25	4/30/2011 3:58	33 MIN (0:55 HR)	0 MIN (0 HR)	33 MIN (0:55 HR)
Satisfy Steam Conditions	4/30/2011 3:25	4/30/2011 3:58	33 MIN (0:55 HR)	30 MIN (0:5 HR)	3 MIN (0:05 HR)
Turbine	4/30/2011 3:58	4/30/2011 7:12	193:25 MIN (3:22 HR)	0 MIN (0 HR)	193:25 MIN (3:22 HR)
Roll to 2400	4/30/2011 4:10	4/30/2011 4:10	7:75 MIN (0:13 HR)	10 MIN (0:17 HR)	-2:25 MIN (-0:04 HR)
Achieve Strm Conditions for Hold	4/30/2011 4:18	4/30/2011 10:49	391:08 MIN (6:52 HR)	10 MIN (0:17 HR)	381:08 MIN (6:35 HR)
Condenser	4/30/2011 7:12	4/30/2011 7:23	11 MIN (0:18 HR)	0 MIN (0 HR)	11 MIN (0:18 HR)
Establish Vacuum	4/30/2011 7:12	4/30/2011 7:23	11 MIN (0:18 HR)	60 MIN (1 HR)	-49 MIN (-0:82 HR)
Turbine	4/30/2011 7:23	4/30/2011 7:23	89:25 MIN (1:49 HR)	0 MIN (0 HR)	89:25 MIN (1:49 HR)
Roll to 3300	4/30/2011 8:38	4/30/2011 8:50	11:75 MIN (0:2 HR)	9 MIN (0:15 HR)	2:75 MIN (0:05 HR)
Roll to 3600	4/30/2011 8:50	4/30/2011 8:52	2 MIN (0:03 HR)	3 MIN (0:05 HR)	-1 MIN (-0:02 HR)
Released	4/30/2011 10:48	---	---	---	---

Business Challenges

- Startups for each unit were occasional and inconsistent
- Personnel can be shared plant-to-plant
- Aging workforce/new employees

Solution

- Implemented series of PI ProcessBook displays
- Using PI Batch, created Batches to track startups and times
- Developed reporting spreadsheet using the PI SDK

Results

- Startups easier to track outside of plant
- More procedurally consistent startups
- **Startup accuracy improved by roughly 95%**

Power Plant Startup Monitoring and Optimization

PI ProcessBook & PI Performance Equations:

- Determine/display start-up progress
- Accumulate actual elapsed time
- Calculate “% complete”
- Track status of plant equipment & conditions

PI Batch:

- “Back-bone” of the start-up monitor
- Facilitates reporting

PI Manual Logger (Future):

- To capture water analysis from grab samples during start-up

PI DataLink/PI SDK:

- Start-up Reports

Power Plant Startup Monitoring and Optimization

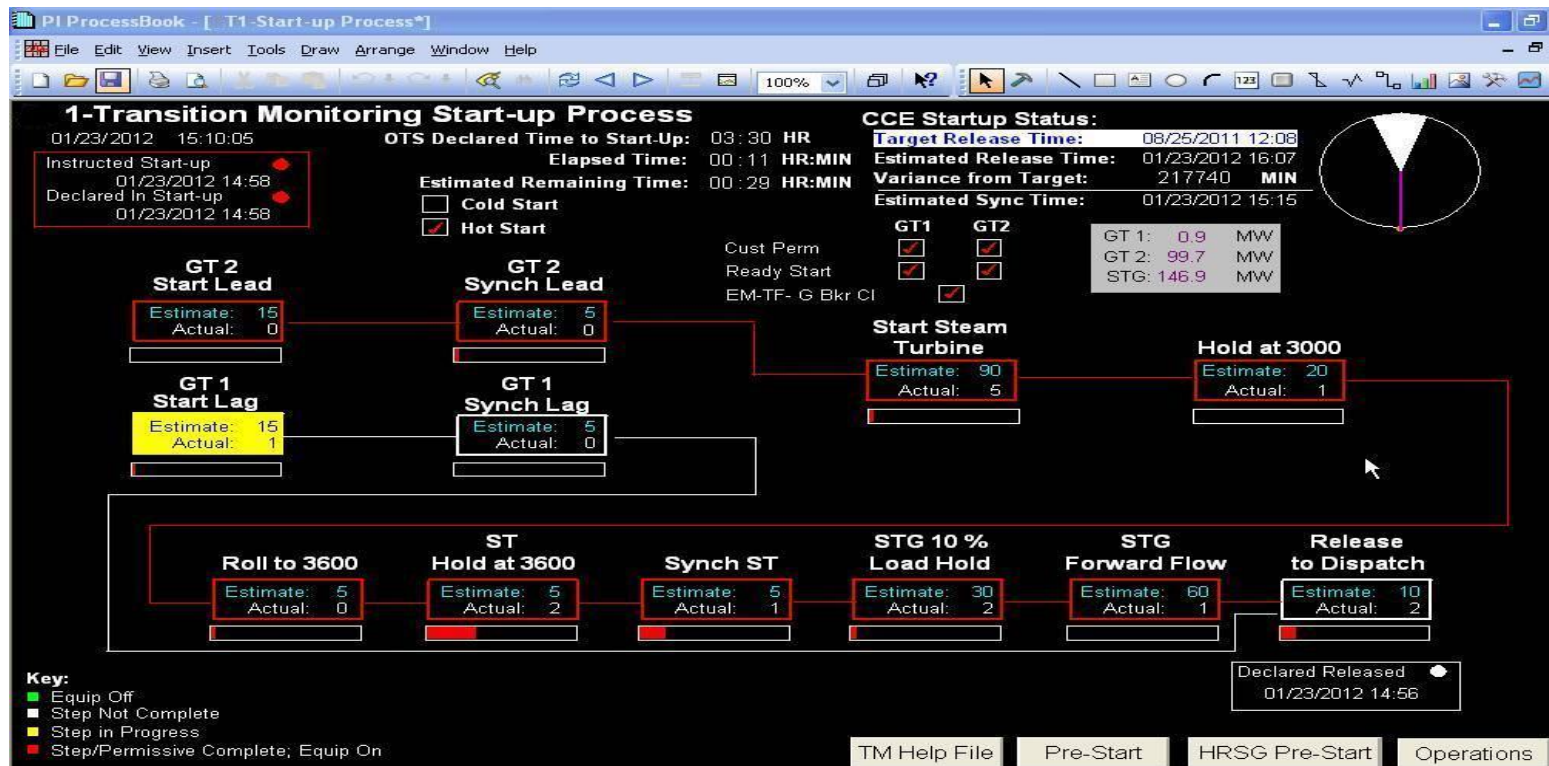
PI ProcessBook

- Graphically illustrate the start-up process
- Track progress
 - Durations, milestones, “time remaining”



- Link to operating procedures
- Display key process data
- “Replay” startups for process improvement

Power Plant Startup Monitoring and Optimization



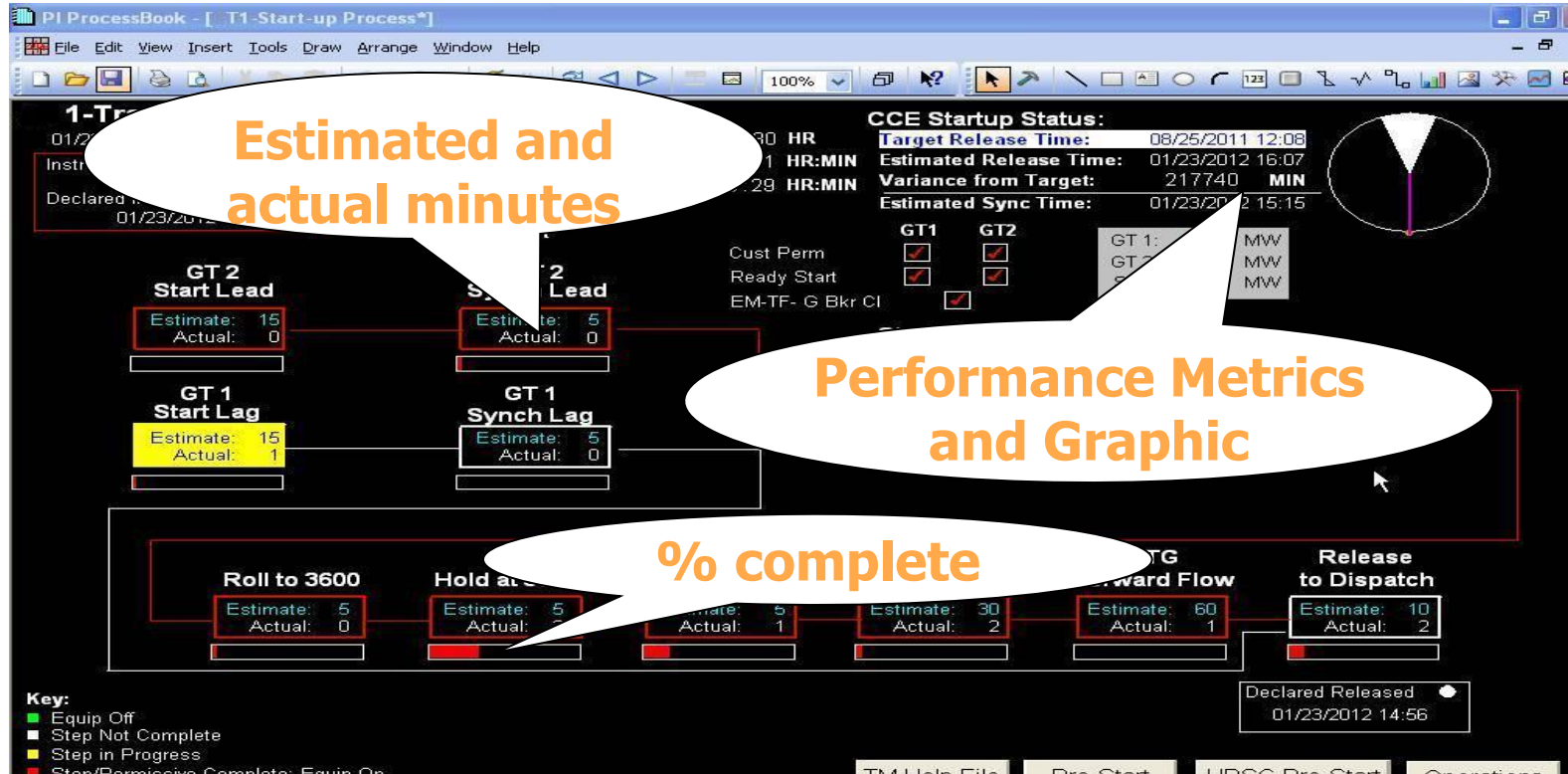
Power Plant Startup Monitoring and Optimization

Process boxes are outlined in white if the step has not started

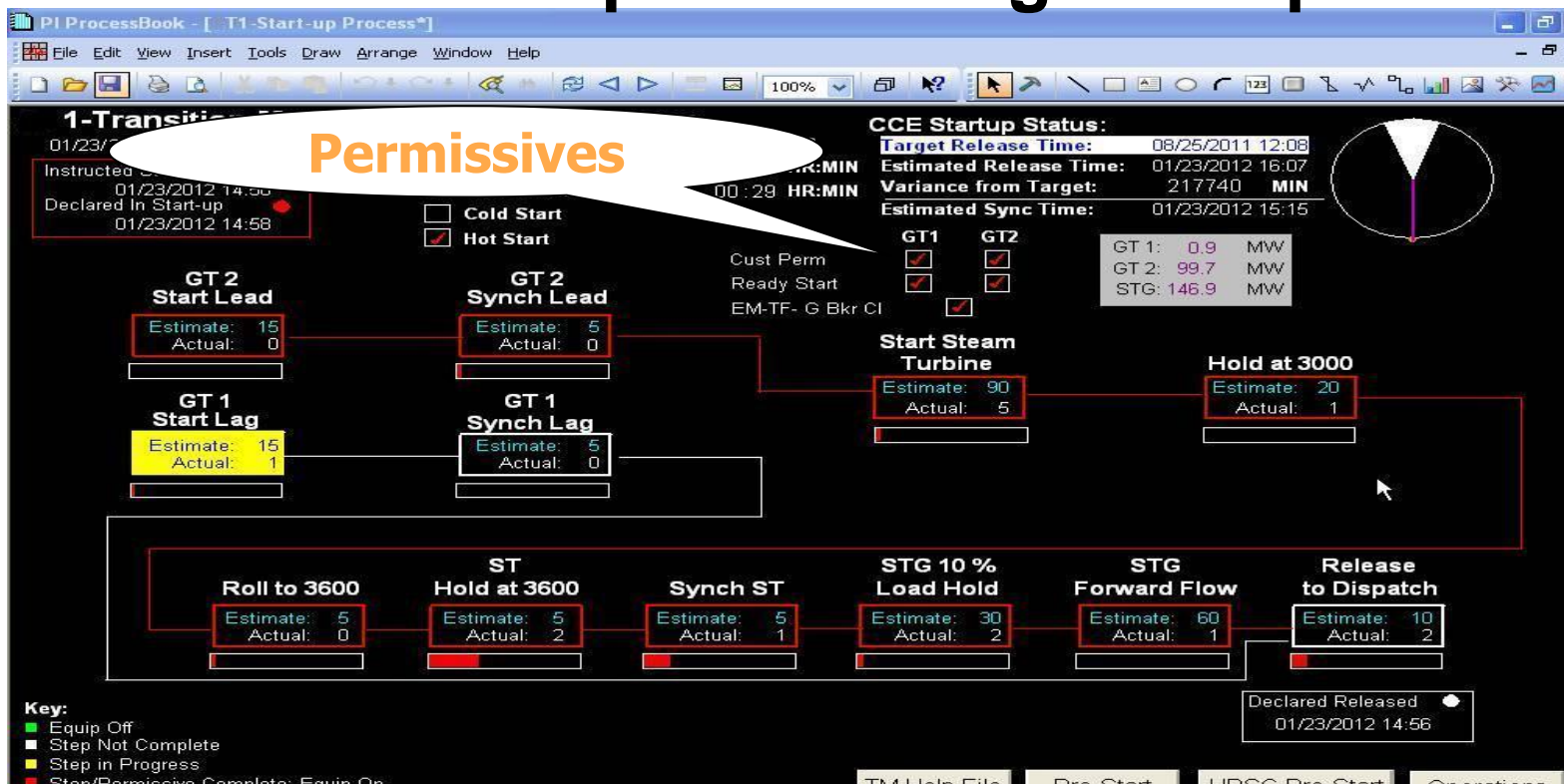
... are yellow while active,

... and are outlined in red once complete.

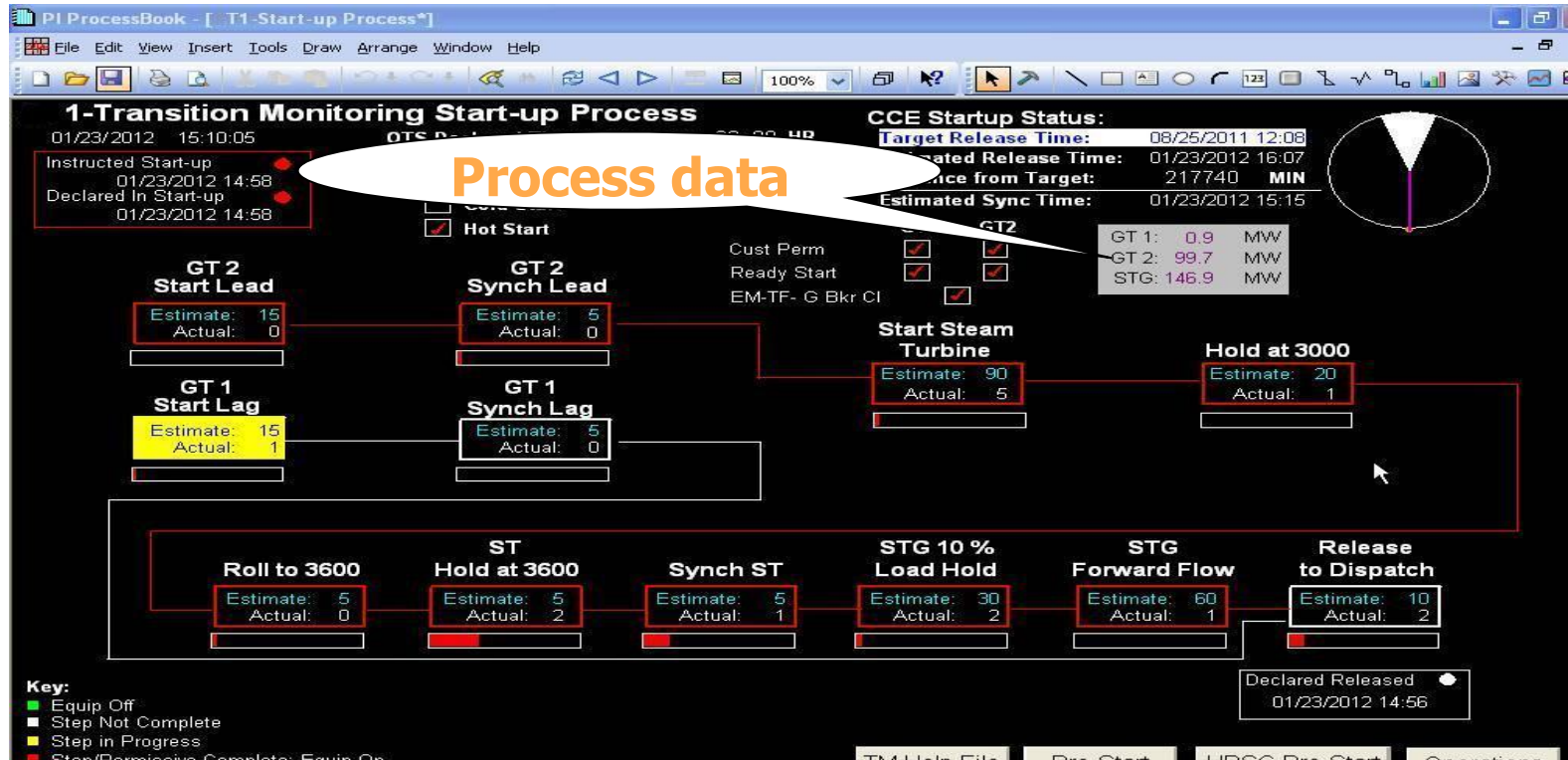
New PI System Solution: Transition Monitor



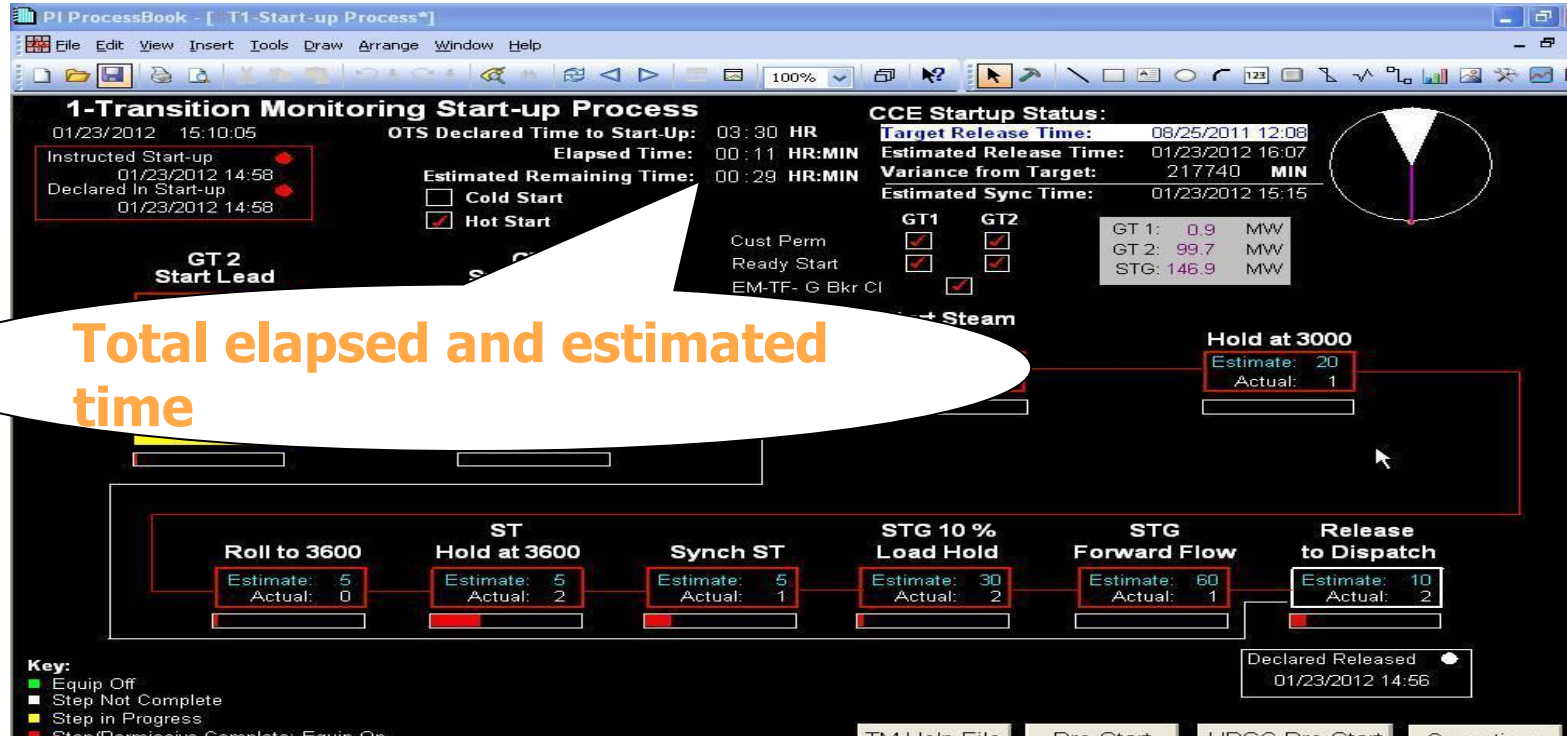
Power Plant Startup Monitoring and Optimization



Power Plant Startup Monitoring and Optimization



Power Plant Startup Monitoring and Optimization



Total elapsed and estimated time

Power Plant Startup Monitoring and Optimization

1-Startup Details - Roll To 3600
01/23/2012 13:57:35

Permissives: Lube Oil Header Temp > 100 Deg F
RH Bowl > 250 Deg F
Differential temp of RH Metal temp and Steam temp < 500

Steps:

- Select speed rate of 720 rpm/min. and select 3600 rpm target.

NOTE: Select speed of 720 rpm/min so that turbine goes through critical at 1200 to 3200 rpm at a faster pace.

- STG at 3600 rpm.

Estimate: 5 MIN
Actual: 0 MIN

Current Value:

Lube Oil Header Temp:	122.97	°F
RH Bowl Temp:	791	°F
RH Steam Temp:	944	°F
	<u>1</u>	<u>2</u>
HP Turb Inlet Stm Temp:	1046	1048 °F
1st Stg Bowl Upper Inner Mtl Temp:	1023	1020 °F
RH Bowl Lower Inner Mtl Temp:	799	125 °F
RH Bowl Upper Inner Mtl Temp:	997	°F
HP Turb Stop Viv Pos:	100	100 %
IP Turb Stop Viv Pos:	100	100 %
GT1 MW:	0.0	MW
GT1 MVARs:	-9	MVAR
Plant Net MW:	30.5	MW
HRSG 1 HP Stm Flow:	0	LB/HR
HRSG 1 IP Stm Flow:	Bad	LB/HR
HRSG 1 LP Stm Flow:	0	LB/HR
HRSG 1 RH SH Outlet Temp:	1025	°F
HRSG 1 HP SH Out Stm Press:	1271	PSIG
HRSG 1 HP SH Outlet Temp:	1046	°F
HRSG 1 IP SH Press:	324	PSIG
IP Turb Inlet Stm Press:	272	PSIG
HP Turb Inlet Stm Press:	1252	PSIG
IP Turb Inlet Stm Temp:	939	°F
Lube Oil Tank Temp:	148	°F
1st Stg Bowl Lower Inner Mtl Temp:	1043	°F
ST Eccentricity:	8.67	MILS
HRSG 1 Preheater Temp Cntrl Setpt:	85	°F
ST Speed:	3600	RPM

Completion: ST Speed >= 3600 RPM

Hold at 3000

Hold at 3600

Start-up

Operations

Power Plant Startup Monitoring and Optimization

1-Startup Details - Roll To 3600
01/23/2012 13:57:35

Permissives: Lube Oil Header Temp > 100 Deg F
RH Bowl > 250 Deg F
Differential temp of RH Metal temp and Steam temp < 500

Steps:
1. Select speed rate of 720 rpm/min. select 3600 rpm target.
2. Select speed of 720 rpm/min. select turbine goes through critical at 1200 to 3200 rpm at a rate of 100 rpm.
3. Select speed of 3600 rpm.

Completion: ST Speed >= 3600 RPM

Current Value:

Lube Oil Header Temp:	122.97	°F
RH Bowl Temp:	791	°F
Differential Temp:	944	°F
1st Stg Bowl Upper Inner Mtl Temp:	1046	1048 °F
RH Bowl Lower Inner Mtl Temp:	1023	1020 °F
RH Bowl Upper Inner Mtl Temp:	799	125 °F
HP Turb Stop Viv Pos:	100	100 %
IP Turb Stop Viv Pos:	100	100 %
GT1 MW:	0.0	MW
GT1 MVARs:	-9	MVAR
Plant Net MW:	30.5	MW
HRSG 1 HP Stm Flow:	0	LB/HR
HRSG 1 IP Stm Flow:	Bad	LB/HR
HRSG 1 LP Stm Flow:	0	LB/HR
HRSG 1 SH Outlet Temp:	1025	°F
HRSG 1 Stm Press:	1271	PSIG
HRSG 1 IP Stm Temp:	1046	°F
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HRSG 1 LP Stm Temp:	272	PSIG
HRSG 1 SH Outlet Temp:	1252	PSIG
HRSG 1 Stm Temp:	939	°F
HRSG 1 Lower Inner Mtl Temp:	148	°F
HRSG 1 Lower Inner Mtl Temp:	1043	°F
ST Eccentricity:	8.67	MILS
HRSG 1 Preheater Temp Cntrl Setpt:	85	°F
ST Speed:	3600	RPM

Buttons: Hold at 3000, Hold at 3600, Start-up, Operations

Selected plant process data

Steps completed by operations

Permissive and completion events

Tracking Start-ups using PI Batch

Design Requirements:

- Well-defined start and end points
 - Valve open/closed
 - Flow > set limit
 - Pump on/off
- Consistently-followed procedures

Power Plant Startup Monitoring and Optimization

TRANSITION MONITOR Startup Report

Analysis Date 1/24/2012 9:14 AM

Plant: Unit

Unit:

From: To:

Select startup for details

Details

To view a detail

the desired startup

Startup ID	Declaration (HR)	OTS Start Time	End Time	OTS Estimate (HR)	TM Estimate (HR)	Variance from OTS	Variance from TM
1 Startup 12-Feb-11 23:31:45	3.07	2/12/2011 11:31:20 PM	2/13/2011 2:35:20 AM	2.99	6.1	4.8 MIN (0.08 HR)	-181.8 MIN (-3.03 HR)
1 Startup 29-Apr-11 23:14:45	11.58	4/29/2011 11:14:20 PM	4/30/2011 10:49:20 AM	10.5	6.1	64.8 MIN (1.08 HR)	328.8 MIN (5.48 HR)
1 Startup 22-Nov-11 09:14:45	2.88	11/22/2011 9:14:23 AM	11/22/2011 12:07:22 PM	2.01	9.16	52.2 MIN (0.87 HR)	-376.8 MIN (-6.28 HR)
1 Startup 22-Nov-11 13:13:45	1.52	11/22/2011 1:13:22 PM	11/22/2011 2:44:22 PM	1.01	6.1	30.6 MIN (0.51 HR)	-274.8 MIN (-4.58 HR)

Power Plant Startup Monitoring and Optimization

Analysis Date

1/24/2012 9:14 AM

Plant:

Unit

Unit:

1

	Duration (HR)	OTS Estimate (HR)	Variance from OTS
Startup ID	1 Startup 29-Apr-11 23:14:45	11.58	64.8 MIN (1.08 HR)
OTS Start Time	4/29/2011 11:14:20 PM		
End Time	4/30/2011 10:49:20 AM		
1st Stg Mtl Temp			

Phase	Start Time	End Time	Duration	TM Estimate	Variance from TM
CW Pmp	4/28/2011 12:06	----	----	----	----
FD Fan	4/29/2011 22:08	----	----	----	----
Startup	4/29/2011 23:14	4/30/2011 10:49:20 AM	695 MIN (11.58 HR)	366 MIN (6.1 HR)	329 MIN (5.48 HR)
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Build Drum Pressure	4/30/2011 1:13	4/30/2011 1:14	0.08 MIN (0 HR)	180 MIN (3 HR)	-179.92 MIN (-3 HR)
Establish Vacuum	4/30/2011 1:14	4/30/2011 2:05	51 MIN (0.85 HR)	60 MIN (1 HR)	-9 MIN (-0.15 HR)
Satisfy Steam Conditions	4/30/2011 1:14	4/30/2011 2:02	48 MIN (0.8 HR)	30 MIN (0.5 HR)	18 MIN (0.3 HR)
Boiler	4/30/2011 2:01	4/30/2011 2:02	0.08 MIN (0 HR)	0 MIN (0 HR)	0.08 MIN (0 HR)
Turbine	4/30/2011 2:05	4/30/2011 2:28	23 MIN (0.38 HR)	0 MIN (0 HR)	23 MIN (0.38 HR)
Condenser	4/30/2011 2:28	4/30/2011 3:43	75 MIN (1.25 HR)	0 MIN (0 HR)	75 MIN (1.25 HR)
Establish Vacuum	4/30/2011 2:28	4/30/2011 3:43	75 MIN (1.25 HR)	60 MIN (1 HR)	15 MIN (0.25 HR)
Boiler	4/30/2011 3:25	4/30/2011 3:58	33 MIN (0.55 HR)	0 MIN (0 HR)	33 MIN (0.55 HR)
Satisfy Steam Conditions	4/30/2011 3:25	4/30/2011 3:58	33 MIN (0.55 HR)	30 MIN (0.5 HR)	3 MIN (0.05 HR)
Turbine	4/30/2011 3:58	4/30/2011 7:12	193.25 MIN (3.22 HR)	0 MIN (0 HR)	193.25 MIN (3.22 HR)
Roll to 2400	4/30/2011 4:10	4/30/2011 4:18	7.75 MIN (0.13 HR)	10 MIN (0.17 HR)	-2.25 MIN (-0.04 HR)
Achieve Stm Conditions for Hold	4/30/2011 4:18	4/30/2011 10:49	391.08 MIN (6.52 HR)	10 MIN (0.17 HR)	381.08 MIN (6.35 HR)
Condenser	4/30/2011 7:12	4/30/2011 7:23	11 MIN (0.18 HR)	0 MIN (0 HR)	11 MIN (0.18 HR)
Establish Vacuum	4/30/2011 7:12	4/30/2011 7:23	11 MIN (0.18 HR)	60 MIN (1 HR)	-49 MIN (-0.82 HR)

Questions?

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THANK YOU

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