

Sample - Plant Operations Procedures

Plant Configuration - 1 on 1

	STEAM TURBINE WARM START – 1ST Stage Outlet Metal Temperature 250 to 800 F	Comments
1	Verify steam turbine has been on turning gear for at least 4 hours and lube oil temperature is between 70 to 100 F.	
2	Verify BOP equipment has been setup and operating as required	See SU checklist
3	Verify HRSG HP, IP, and LP drum startup water levels suggested to be: <ol style="list-style-type: none"> 1. HP = -15 inches 2. IP = -15 inches 3. LP = -15 inches 	Need to verify actual values during commissioning
4	Verify HRSG and piping system valve alignment: <ol style="list-style-type: none"> 1. HP, RH, LP SU vents open 2. HP, IP, RH, LP SH drains open 3. HRSG HP, IP, LP MRV's in auto 4. Drip leg drain valves open (16 total for both units) by selecting Group open for unit being started. Close drain valves on unit not being started. 5. HRSG HP MOV block valve SGA-MBV-1708/2708 open 6. HRSG HP MOV block valve SGA-MBV-1709/2709 open 7. HP MOV block valve SGG-MUV-101/201 open 8. RH MOV block valve SGJ-MUV-101/201 open 9. CRH block valves MOV SGJ-MBV-111/211 open 10. CRH flow control valve FCV 112/212 in auto and open 11. IP SH outlet block valve SGA -MBV-1307/2307 open 12. IP SH outlet block valve SGA -MBV-1308/2308 open 13. LP SH outlet block valve SGA -MBV-1108/2108 open 14. LP SH outlet block valve SGA -MBV-1109/2109 open 15. LP MOV block valve SGG-MUV-101 or 201 open 16. Ventilator valve SGJ-ACV-315 in auto & setpoint DCS fixed at 725 F 17. Ventilator spray system; FWA-ABV-1087/2087 in auto and FWC-ACV-338 in auto (setpoint is calculated by DCS) 18. HP bypass spray system; FWA-ABV-1042/2042 open, in auto and FWA-ACV-1044/2044 TCV in auto with setpoint between 600 to 700 F 19. RH bypass spray system; FWA-ABV-1054/2054 open, in auto and FWA-ACV-1056/2056 TCV in auto (setpoint is calculated by DCS) 20. LP bypass spray system; FWC-ABV-1007/2007 open, in auto and FWC-ACV-1002/2002 TCV in auto (setpoint is calculated by DCS) 	<p>Valve selection will depend on which unit is being started.</p> <p>Group buttons are located on SGG/SGJ & SGL screens</p> <p>Ventilator valve will work in temperature control at a setpoint of 725 F when ST load is <27MW</p>
5	Verify Steam Turbine valve alignment: <ol style="list-style-type: none"> 1. Turbine Drains open (6) open – found on MHI ST DRAIN VALVE CONTROL-1 screen or DCS Screen 1TGC01CT 2. Steam seal regulator manual block valves open for operation 3. Seal steam pressure control valve TGC-ACV-315 in manual & closed 4. ST seal CRH supply block valve SGJ-ABV-121/221 open 5. Exhaust hood sprays TGA-ACV-304 in auto and setpoint at 160 F 6. Curtain hood sprays FWC-ABV-3052 in auto 7. Vacuum breaker valve HRB-ABV-3003 open 8. MSV's closed 9. MCV's closed 10. RHSV's closed 11. ICV's closed 12. LP stop valve closed 13. LP control valve closed 	

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	14. Lube oil temperature setpoint is 86 F (ECB-ACV-003 in auto)	
6	Verify HP bypass to CRH is in automatic mode, setpoint is 115 psig, and closed. SGG-ACV-103/203.	HP bypass valve will track HP drum metal temps and header pressure for auto operation
7	Verify RH bypass to condenser is in automatic mode, setpoint is 95 psig, and closed. SGJ-ACV-103/203	
8	Verify LP bypass to condenser is in automatic mode, setpoint is 70 psig, and closed. SGL-ACV-103/203	
9	Start a GT and hold at FSNL.	
10	Verify operation of HP bypass to CRH. Manually increase setpoint +100 psig every xxx minutes until 985 psig is obtained. Evaluate IP superheater outlet temperature SGA-TE-PO4, ensure that the steam from the HP bypass to CRH temperature SGG-TE-104/204 is within 200 F of this temperature.	Xxx to be determined during SU
11	Close HP vent.	
12	Evaluate steam piping systems for proper warming by looking at HRSG SH outlet temperatures and compare to temperatures in HP, RH, and LP steam piping as close to steam turbine as possible. Verify no steam temperature deviation alarms.	SGG-TE-310&309 @ST SGJ-TE-306&305 @ST SGJ-TE-104/204 @CRH
13	Start (1) of the gland steam condenser blowers. Select standby operation of second blower by placing controller in auto	MHI/DCS – Gland Steam Fan Control screen.
14	Initiate steam turbine seal operation: <ol style="list-style-type: none"> 1. Gland seal steam drip leg valves TGC-MBV-317/331 open 2. Gland seal spray system; FWC-ABV-3091 in auto and FWC-ACV-3063 in auto, setpoint of 570 F. 3. Open TGC-ACV-315 slowly until SSH is pressurized and regulating between 2 to 4 psig as seen by TGC-PT-303 4. Once SSH is regulating, place TGC-ACV-315 in automatic and setpoint at the current header pressure. 5. Close gland seal steam drip leg valves and open on high level alarm. 6. Increase TGC-ACV-315 setpoint until it is at 100 psig. 	DCS 1TGC01CT screen
15	Start HRB condenser vacuum system: <ol style="list-style-type: none"> 1. Verify (1) vacuum pump is in lead at DCS (second pump will automatically be selected as lag) 2. Select auto for both (2) vacuum pumps at DCS: both vacuum pumps will start and operate until 2 psia obtained – when 2 psia is reached both will stop – lead pump will now cycle between 2 and 2.5 psia – if > 3 psia is reached then lag pump will start 	DCS 1HRB01CT screen
16	Close condenser vacuum breaker valve HRB-ABV-3003	DCS 1HRB01CT screen
17	Verify RH bypass is operational and at setpoint. (Condenser must be < 7.5 inHg (3.7 psia on DCS) for bypass operation)	
18	Verify LP bypass is operational and at setpoint.	
19	Close RH and LP vents	
20	Increase load on GT keeping GT exhaust temperature between 725 and 800 F . This should occur around 40 MW's .	
21	Verify main steam header is at correct pressure and within temperature limits: <ol style="list-style-type: none"> 1. Pressure should be between 950 to 1000 psig with a target of 985 psig 2. HP steam temperature must be >700 but < 800 F. 	
22	Verify steam turbine eccentricity is < 3 mils	MHI – Turbine Supervisor Instruments-1 screen
23	Check / evaluate ST control system alarm page	
24	Evaluate steam turbine interlocks for permissives are met: <ol style="list-style-type: none"> 1. condenser vacuum < 7.5 in Hg 	

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	<ol style="list-style-type: none"> 2. HP steam inlet pressure > 853 psig 3. No steam turbine trip conditions active 	
25	<p>Evaluate steam turbine DCS interlocks for permissives are met:</p> <ol style="list-style-type: none"> 1. Emergency PB not tripped 2. HRSG1 HP drum level not HI-HI-HI (+7 inches) 3. HRSG2 HP drum level not HI-HI-HI (+7 inches) 4. HRSG1 IP drum level not HI-HI-HI (+7 inches) 5. HRSG2 IP drum level not HI-HI-HI (+7 inches) 6. HRSG1 LP drum level not HI-HI-HI (+7 inches) 7. HRSG2 LP drum level not HI-HI-HI (+7 inches) 8. Steam turbine not tripped 9. Any CT running 10. Steam turbine electrical not tripped 	As seen on DCS screen 1STMTRBP
26	Verify HRSG water quality meets specifications	See attached table 2
27	<p>Select either DEH or AEC control mode</p> <p>?? DEH = MHI operator station is used by Operator</p> <p>?? AEC = DCS operator station is used by Operator</p>	MHI – DEH Operation Screen
28	Select ATS, automatic turbine start, mode at MHI control system or DCS	On MHI ATS START_UP display. Refer to attached table 1 for SU conditions.
29	At MHI control system or DCS press BP-1 break point 1 – turbine reset mode. Turbine will reset and MCV's and RSV's will open	On MHI ATS START_UP display
30	Verify Steam Turbine trip by pressing either the red emergency trip button or local emergency trip button	NOT REQUIRED
31	At MHI control system or DCS press BP-2, break point 2, – turbine speed up mode. During run up main steam temp increase rate to be < 100 F/Hr.	On MHI ATS START_UP display
32	The steam turbine will automatically roll off turning gear and accelerated to control hold points at 100 rpm/min.	On MHI ATS START_UP display
33	Verify operation of both the MSV's and ICV's . These valves will open in parallel during steam turbine roll up.	
34	Verify steam turbine reaches hold point of 500 rpm. At this point a Rub check will automatically occur. All MSV's and ICV's will close and steam turbine will begin to coast down toward 0 speed.	On MHI ATS START_UP display
35	<p>Evaluate steam turbine for indications of rubs or abnormal operation:</p> <ol style="list-style-type: none"> 1. Differential expansion – alarm or trip 2. Eccentricity – alarm 3. Rotor position – alarm or trip 4. Bearing metal temperature – alarm or trip 5. Vibration – alarm or trip 6. Noise (locally at steam turbine by operator) 	<p>MHI – Turbine Supervisor Instruments-1 screen</p> <p>Limits on P 69-78</p> <p>If parameters are in alarm select “Hold” and troubleshoot.</p>
36	If no Rubs are present, select RUB OUT and turbine will automatically roll to 500 rpms and hold for 10 minutes. Eccentricity < 2 mils before increasing speed	On MHI ATS START_UP display
37	<p>At MHI control system or DCS enable STRESS CONTROL:</p> <p>?? Stress readings are good if Delta-T is –40 to +40 F.</p> <p>?? If stress readings during roll up exceed these values, the steam turbine will automatically enable HOLD</p> <p>?? If the HOLD is enabled during a critical speed, the steam turbine will continue rolling until the critical speed range is exceeded then will HOLD.</p> <p>?? Stress control will automatically disable when ST synchronizes</p>	On MHI DEH OPERATION SCREEN display
38	Verify DCS automatically changed lube oil temperature setpoint to 104 F on controller for ECB-ACV-003. (at 600 rpms)	DCS – 1ECB01CT screen
39	Verify steam turbine reaches hold point of 2000 rpm. This hold point will last	MHI – Turbine Supervisor

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	for 40 minutes . There is no displayed timer therefore the operator will need to get a time stamp of hold start. Evaluate turbine parameters: <ol style="list-style-type: none"> 1. Differential expansion 2. Rotor position 3. Steam turbine metal temperatures 4. Bearing metal temperature 5. Vibration 	Instruments-1 screen Limits on P 69-78 If parameters are in alarm select "Hold" and troubleshoot.
40	Steam turbine automatically increase speed after hold and will reach synchronize speed of 3600 rpms – evaluate turbine parameters: <ol style="list-style-type: none"> 1. Differential expansion 2. Rotor position 3. Steam turbine metal temperatures 4. Bearing metal temperature 5. Vibration 	MHI – Turbine Supervisor Instruments-1 screen Limits on P 69-78 If parameters are in alarm select "Hold" and troubleshoot.
41	Verify LP exhaust steam temperature is <160 F.	
42	Verify during steam turbine roll up, HP inlet control will transfer from MSV's to MCV's.	
43	Verify switchyard breaker selection to either 8602 or 8676	ST Electrical Bldg
44	Select BP-3 – break point 3 - auto synchronize, field breaker closes	MHI – ATS Startup screen
45	Steam turbine will synchronize by closing breaker selected in step 46 and load to 9 MW automatically. AEC may close the breaker not selected in step 46.	
46	Verify LP stop valve LPSV is open.	Automatically closes @trip
47	Verify load hold at 9MW for 20 minutes. After this hold ATS is complete and automatically disabled. During hold main steam inlet temperature increase rate to be < 300 F/Hr.	Adjust GT load to limit temperature increase
48	Close BOP steam system drip leg drain valves at the end of 9 MW ST load hold	Group close on SGG, SGJ and SGL screens
49	Verify HP bypass to CRH pressure control mode is controlling to 985 psig.	
50	Verify RH bypass to Condenser pressure control mode is controlling to 95 psig.	
51	Verify MCV's ,HP steam turbine inlet pressure control, IPC setpoint of 985 psig.	
52	Verify ICV's ,IP steam turbine inlet pressure control, IPC setpoint of 95 psig.	
53	Manually change TCM, turbine control mode, to IPC for HP/IP Systems.	
54	DCS will automatically close both the HP and RH bypass valves at the same time. Verify MCV and ICV opens to regulate header pressure during this process.	Rate of closure will be determined during commissioning
55	When HP and RH bypass valves reach full close, each controller will automatically increase setpoint to header pressure plus 30 psig. Verify this occurred.	Controllers now in cascade mode
56	Raise GT load according to dispatch schedule – minimum dispatchable load by AIR PERMIT is 70% load. There is no time limit to reach 70% load but this load must be reached within the normal operation constraints of this facility. Keep steam turbine load increase to < 3.6 MW/min and First stage steam temp increase rate to < 300 F/Hr. The GT loading rates to maintain this steam turbine load criteria will be determined during system commissioning.	Using unit master controller as seen on DCS 1UNITMAS screen – select operator MW control and input desire MW's
57	Steam turbine load will increase as GT load is increased. Verify steam turbine drain valves close automatically at > 36 MW steam turbine load	
58	On the MHI control system or DCS Enable steam turbine IPR, initial pressure regulation, at steam turbine load > 45MW. <ol style="list-style-type: none"> 1) IPR watches for sustained ST inlet steam pressure drop and will automatically close MCV's and ICV's to recover inlet pressure. 2) Valves will be closed at a rate of –200% per minute following a 	

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	pressure vs load schedule and will stop when at desired pressure.	
	3) Once recovered, IPC mode can be re-selected.	
59	Continue increasing GT load until the steam turbine load hold point of 54 MW is reached. Hold at this load for 30 minutes .	Expected to take 248,000 lb/hr of HP steam to achieve 54 MW load
60	At 54 MW ST load, the DCS will switch the ventilator valve controller from auto to manual and close the ventilator valve if valve is not already close.	
61	Resume ramping of GT load	
62	When steam turbine is at a load of 90MW, LP steam admission can be selected.	LP steam/LP metal temp Delta-T < 150F
63	Verify LP bypass to Condenser pressure control mode is controlling to 70 psig.	
64	Verify LPCV's ,LP steam turbine inlet pressure control, IPC setpoint of 70 psig.	
65	Manually change TCM, turbine control mode, to IPC for LP system.	
66	The DCS will automatically close the LP bypass valve. When LP bypass is 100% closed, the DCS will automatically increase controller setpoint to header pressure plus 20 psig. Verify this occurred.	
67	Once steam turbine MCV's have reached full open, the HP steam inlet pressure will continue to rise as GT load is increased. This is estimated to occur at 90 MW steam turbine generator load.	
68	Once GT has reached 70% load, the unit is dis-patchable	

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TABLE-1 START UP SCHEDULE AND PARAMETERS

	Starting Mode	Cold Start	Warm Start	Hot Start
	Operation			
1	Mode Selecting Condition (1) First Stage Metal Temp. (2) Shut Down Period	< 250°F more than 72 hrs	250°F ~ 800°F 8 ~ 72 hrs	> 800°F less than 8 hrs
2	Turning Period	4 hrs min.	4 hrs min.	Continuous
3	Gland Steam Source	Auxiliary steam 570°F	Auxiliary steam 570°F	Auxiliary steam 570°F
4	Steam Condition at Start-up (psia) x (°F)	HP IP LP 1000 x 650 ~ 800 200 x -	1000 x 700 ~ 800 200 x -	1000 x 850~1050 200 x -
5	Low Speed Warming (@ 500 rpm)	10 min.	10 min.	-
6	Speed Up Rate	100 rpm/min.	100 rpm/min.	200 rpm/min.
7	Medium Speed Warming (2000 rpm)	2-3 hrs	40 min	-
8	Steam Temp. Inc. Rate Inlet steam	< 100°F/H Max. 800°F	< 100°F/H	< 100°F/H
9	Initial Load	5%	5%	5%
10	Initial Load Hold Time	30 min.	20 min.	10 min.
11	Steam Temp Inc. Rate Inlet steam	Max. 300°F/H	Max. 300°F/H	Max. 300°F/H
12	Load Up Rate	1%/min.	1-2%/min.	2%/min.
13	First Stage Steam Temp Inc. Rate	Max. 300°F/H	Max. 300°F/H	Max. 300°F/H

Turbine start-up parameters above will be determined finally after studying field operation results.

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TABLE 2 STEAM PURITY RECOMMENDATIONS

CONTROL PARAMETERS	NOTES	NORMAL OPERATION	LIMITING CONDITIONS	
			TWO WEEKS	24 HOURS *
Degassed Cation Conductivity, micromhos/cm	b, c	< 0.5		0.5 ~ 1.0
Dissolved Oxygen, ppb	b, c	< 10	10 ~ 30	30 ~ 100
Sodium, ppb	b, c	< 5	5 ~ 10	10 ~ 20
Chlorides, ppb	b, c	< 5	5 ~ 10	10 ~ 20
Silica, ppb	b	< 20		20 ~ 50
Copper, ppb	a	< 2		
Iron, ppb	a	< 20		
Na/PO ₄ Molar Ratio	a, e	2.3 ~ 2.7		
Sulfites and Sulfates	d			

* Operation beyond the upper limits should be avoided for any duration.
Immediate corrective action should be taken.

NOTES:

- a. Typical value, should be analyzed at least once a week.
- b. Used for chemistry control by continuous direct analysis of condensed inlet steam or as recalculated from steam generator water and mechanical plus vaporous carryover.
- c. Continuous analysis recommended.
- d. Less than minimum detectable, should be analyzed at least once a week.
- e. For units with phosphate water treatment.