August 9, 2023

Rex Lane
Kalamazoo District Supervisor
Michigan Department of Environment, Great Lakes and Energy (EGLE)
Air Quality Division
7953 Adobe Road
Kalamazoo, MI 49009

Subject: Otsego Paper Renewable Operating Permit (ROP) Renewal Application
Response to Information Request
Otsego Paper, Inc., SRN A0023
ROP Number MI-ROP-A0023-2019b

Dear Mr. Lane:

Otsego Paper, Inc. submitted renewal application for Renewable Operating Permit (ROP) No. MI-ROP-A0023-2019b for Otsego Paper on June 7th, 2023. On June 15, 2023, the Department of Environment, Great Lakes, and Energy (EGLE), Air Quality Division (AQD) sent a letter requesting the the startup/shutdown plan and the malfunction abatement plan (MAP) for EUTURBINE2 to administratively complete the application. Otsego Paper, Inc. respectfully submits the requested MAP, startup/shutdown procedures and relevant documents with a signed C-001 Certification form number EQP 5773.

Please direct any questions regarding this application to Eric Bock, Otsego Paper's Plant Manager, at (269) 384-6398 or via email at ebock@usg.com.

Sincerely,

Otsego Paper, Inc.

Eric Bock
Plant Manager – USG Otsego

Attachments

CC: Frank Knowles, USG
John Bolden, USG
Cody Yazzie, EGLE-AQD Kalamazoo District Office
Sultana Haque, TRC

EGLE Michigan Department of Environment, Great Lakes, and Energy - Air Quality Division

RENEWABLE OPERATING PERMIT APPLICATION
C-001: CERTIFICATION

This information is required by Article II, Chapter 1, part 55 (Air Pollution Control) of P.A. 451 of 1994, as amended, and the Federal Clean Air Act of 1990. Failure to provide this information may result in civil and/or criminal penalties. Please type or print clearly.

This form is completed and included as part of Renewable Operating Permit (ROP) initial and renewal applications, notifications of change, amendments, modifications, and additional information.

Form Type **C-001**	SRN A0023

Stationary Source Name	Otsego Paper, Inc	
City Otsego		County Allegan

SUBMITTAL CERTIFICATION INFORMATION

1. Type of Submittal *Check only one box.*

☐ Initial Application (Rule 210) ☐ Notification / Administrative Amendment / Modification (Rules 215/216)

☐ Renewal (Rule 210) ☒ Other, describe on AI-001

2. If this ROP has more than one Section, list the Section(s) that this Certification applies to ____

3. Submittal Media ☒ E-mail ☐ FTP ☐ Disk ☐ Paper

4. Operator's Additional Information ID - Create an Additional Information (AI) ID that is used to provide supplemental information on AI-001 regarding a submittal.

AI

CONTACT INFORMATION

Contact Name Frank Knowles		Title Environmental Compliance Supervisor
Phone number 269-384-6351	E-mail address Fknowles@usg.com	

This form must be signed and dated by a Responsible Official.

Responsible Official Name Eric A. Bock			Title Plant Manager - USG Otsego
Mailing address 320 North Farmer Street			
City Otsego	State MI	ZIP Code 49078	County Dickinson	Country USA

As a Responsible Official, I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this submittal are true, accurate and complete.

Signature of Responsible Official

8-9-23

Date

EGLE

RENEWABLE OPERATING PERMIT APPLICATION
AI-001: ADDITIONAL INFORMATION

This information is required by Article II, Chapter 1, Part 55 (Air Pollution Control) of P.A. 451 of 1994, as amended, and the Federal Clean Air Act of 1990. Failure to obtain a permit required by Part 55 may result in penalties and/or imprisonment. Please type or print clearly. Refer to instructions for additional information to complete this form.

SRN: A0023	Section Number (if applicable):

1. Additional Information ID
AI-001

Additional Information

2. Is This Information Confidential? ☐ Yes ☒ No

Startup/shutdown procedures and the malfuntion abatement plan (MAP) for turbine 2 are submitted in response to information request from EGLE AQD dated June 15, 2023 regarding Renewable Operating Permit (ROP) No. MI-ROP-A0023-2019b renewal application.

Malfunction Abatement Plan

South Combustion Turbine No. 2

July 2022

Prepared For:

Otsego Paper, Inc.
Otsego, Michigan
SRN A0023

Prepared By:

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108

TABLE OF CONTENTS

TABLES

APPENDICES

Acronym List

CEMS	Continuous Emissions Monitoring System
EUTURBINE2	South Combustion Turbine No.2
MAP	Malfunction Abatement Plan
PTI	Permit to Install

1.0 Introduction

This Malfunction Abatement Plan (MAP) has been prepared to comply with the requirements of Permit to Install (PTI) number 193-19A, Renewable Operating Permit (ROP) number MI-ROP-A0023-2019a and Michigan Administrative Code R. 336.1911 for the South Combustion Turbine No. 2 (EUTURBINE2) located at Otsego Paper, 320 North Farmer Street, Otsego, MI 49078. The purpose of this plan is to prevent, detect, and correct malfunctions or failures of the turbine resulting in emissions exceeding any applicable emission limitation.

Otsego Paper modified EUTURBINE2 to increase the maximum allowable heat input of combustion from 141.5 MMBtu/hr to 150.8 MMBtu/hr. The PTI and ROP requires Otsego Paper to submit, implement, and maintain a MAP as described in Rule 911(2) for EUTURBINE2 within 180 days of initial startup of the modified turbine. The MAP shall, at a minimum, specify the following:

a) A complete preventative maintenance program including identification of the supervisory personnel responsible for overseeing the inspection, maintenance, and repair of air-cleaning devices, a description of the items or conditions that shall be inspected, the frequency of the inspections or repairs, and an identification of the major replacement parts that shall be maintained in inventory for quick replacement.

b) An identification of the source and air-cleaning device operating variables that shall be monitored to detect a malfunction or failure, the normal operating range of these variables, and a description of the method of monitoring or surveillance procedures.

c) A description of the corrective procedures or operational changes that shall be taken in the event of a malfunction or failure to achieve compliance with the applicable emission limits.

2.0 Facility Contacts

Supervisory personnel responsible for overseeing the inspection, maintenance, and repair of air-cleaning devices is listed in Table 2-1 below.

Table 2-1: Facility Contact

Name, Title	Contact Information
Eric Bock, Engineering Manager	USG, Otsego Paper Inc. 320 North Farmer St. Otsego, MI 49078 (269) 384-6398 EBock@usg.com
Frank Knowles, Environmental Compliance Supervisor	USG, Otsego Paper Inc. 320 North Farmer St. Otsego, MI 49078 (269)-384-6351 Fknowles@usg.com

3.0 Source Description and Operating Variables

3.1 Source Description

EUTURBINE2 is a Solar Turbine MARS 100-16000S natural gas fired combustion turbine with a maximum of 150.8 MMBTU/hr heat input at maximum operating condition as measured on a HHV basis. The turbine is equipped with SoLoNOxTM dry low emission combustion system. A continuous emissions monitoring system (CEMS) is operated to monitor and record the NOx emissions and O2 or CO2 content of the exhaust gas from the turbine on a continuous basis.

3.2 Operational Variables

Operating variables to detect a malfunction or failure and the normal operating range of these variables and surveillance procedures are included in Appendix A.

3.3 Emission Limits

Emission limits applicable for the turbine is listed in Table 3-2.

Table 3-2: Emission Limits

Pollutant	Limit	Time Period / Operating Scenario
NOx	9.05 pph	Hourly, except during startup and shutdown and cold weather operations
NOx	55 tpy	12-month rolling time period as determined at the end of each calendar month
CO	9.2 pph	Hourly, except during startup and shutdown and cold weather operations
CO	57 tpy	12-month rolling time period as determined at the end of each calendar month
VOC	3.4 tpy	12-month rolling time period as determined at the end of each calendar month

4.0 Preventive Maintenance and Corrective Procedures

4.1 Preventive Maintenance

Inspection and scheduled maintenance of the turbine engine and control equipment are required to minimize corrective maintenance. Inspection and maintenance schedule recommended by the manufacturer is located in Appendix B.

4.2 Corrective Actions

If a malfunction occurs during plant operations which causes, or may cause, excess emissions, the equipment causing the (potential) excess emission will be evaluated as soon as practicable in accordance with safe operating procedures to determine the proper procedure to correct the issue or to determine that the malfunction will not cause excess emissions.

If a malfunction results in the possibility of an emissions exceedance, the unit will not allow normal operation and an alarm will sound. If the unit has any difficulty during operation, such as mechanical or control system failure which results in high emissions, the first step will be to validate the data in an expeditious manner and determine the cause of the deficiency.

Repairs or operational changes will be quickly assessed with the unit on-line for the purpose of minimizing emissions. Every reasonable and practical effort will be made to bring a malfunctioning unit back into compliance; however, if these efforts are unsuccessful or continued operation is dangerous either to equipment or personnel, the unit will be shut down and the problem corrected. If possible, the unit may be restarted during the calendar day and brought to normal operating loads to average in the lower emission of higher load operation along with the high emissions during start-up period to avoid any exceedances of the emission limits contained in the permit

4.3 Retention of Records

Otsego Paper will keep records of inspections and unscheduled maintenance activities which are outside normal operating ranges that include date, finding(s), and corrective action(s) taken or repair(s) made, if necessary

4.4 List of Major Replacement Parts

A spare parts list maintained by Otsego Paper for quick replacement is included in Appendix C.

Appendix A
Operating Variables

ALARMS

Tag Name	Description	Setpoint	Units	Type	
ENGINE AUXLILARY					**ACTION**
AL_PDT6310_H	Turbine Air Inlet Filter DP High	5	inH2O	Alarm	A&C
AL_Supply_Voltage_24Vdc_H	Control System 24 Vdc Supply Voltage High	32	Vdc	Alarm	A&C
AL_Supply_Voltage_24Vdc_L	Control System 24 Vdc Supply Voltage Low	21.5	Vdc	Alarm	A&C
AL_Supply_Voltage_2_24Vdc_H	Secondary Control System 24 Vdc Supply Voltage High	32	Vdc	Alarm	A&C
AL_Supply_Voltage_2_24Vdc_L	Secondary Control System 24 Vdc Supply Voltage Low	21.5	Vdc	Alarm	A&C
AL_Ngp_Slow_Roll_Speed_L	Ngp Slow Roll Speed Low	3.5	Hz	Alarm	A&C
AL_Import_Limit_Reached	Alarm Import Limit Reached	??	kW	Alarm	A
AL_GV_Force_H	Guide Vane Actuator Force High	450	lbf	Alarm	A
GENERATOR					
AL_TE4210_H	Generator Phase A Winding Temperature High	239	deg F	Alarm	A&C
AL_TE4213_H	Generator Phase B Winding Temperature High	239	deg F	Alarm	A&C
AL_TE4216_H	Generator Phase C Winding Temperature High	239	deg F	Alarm	A&C
GAS FUEL SYSTEM					
AL_Gas_Fuel_Main_Vlv_Cmd_H	Main Gas Fuel Valve Command High - Low Gas Fuel Pressure	95	%	Alarm	A&C
AL_Gas_Fuel_Main_Vlv_DP_L	Gas Fuel Main Valve DP Low - Low Gas Fuel Pressure	20	psid	Alarm	A&C
AL_Gas_Fuel_Pilot_Vlv_Cmd_H	Gas Fuel Pilot Valve Command High - Low Gas Fuel Pressure	95	%	Alarm	A&C
AL_Gas_Fuel_Pilot_Vlv_DP_L	Gas Fuel Pilot Valve DP Low - Low Gas Fuel Pressure	20	psid	Alarm	A&C
AL_Gas_Fuel_Temp_H	Gas Fuel Temperature High	200	deg F	Alarm	A&C
AL_Gas_Fuel_Temp_L	Gas Fuel Temperature Low	-18	deg F	Alarm	A&C
AL_PT2120_H	Gas Fuel Supply Pressure High	500	psig	Alarm	A&C
AL_PT2120_L	Gas Fuel Supply Pressure Low	65	psig	Alarm	A&C
AL_PT2121_H	Gas Fuel Shutoff Valves Pressure Alarm	500	psig	Alarm	A&C
AL_PT2126_H	Gas Fuel Control Valve Pressure High	500	psig	Alarm	A&C
BAM SYSTEM					
AL_XM_BAM_Band0_Peak_H	XM BAM Band 0 Max Peak Amplitude High	0.1	psi rms	Alarm	A
AL_XM_BAM_Band1_Peak_H	XM BAM Band 1 Max Peak Amplitude High	0.25	psi rms	Alarm	A
AL_XM_BAM_Band2_Peak_H	XM BAM Band 2 Max Peak Amplitude High	0.25	psi rms	Alarm	A
AL_XM_BAM_Band3_Peak_H	XM BAM Band 3 Max Peak Amplitude High	0.25	psi rms	Alarm	A
LUBE OIL SYSTEM					
AL_M3130_Fail	Main Lube Oil Pump 2 Failure	8	psig	Alarm	A
AL_M3110_Fail	Main Lube Oil Pump 1 Failure	8	psig	Alarm	A
AL_PDT3100_H	Lube Oil Tank DP High	8.5	inH2O	Alarm	A
AL_PDT3240_H	Lube Oil Filter DP High	30	psid	Alarm	A
AL_PT3200_H	Lube Oil Header Pressure High	45	psig	Alarm	A
AL_PT3200_L	Lube Oil Header Pressure Low	28	psig	Alarm	A&C
AL_TE3200_H	Lube Oil Header Temperature High	160	deg F	Alarm	A&C
AL_TE3200_L	Lube Oil Header Temperature Low	110	deg F	Alarm	A&C
AL_TE3200_LL	Lube Oil Header Temperature Low, Start Delayed For Warmup	52	deg F	Alarm	A&C
AL_Eng_Brg_1_Drn_Delta_Temp_H	Engine Bearing 1 Drain Delta Temperature High	45	delta deg F	Alarm	A,B&C
AL_Eng_Brg_2_3_Drn_Delta_Temp_H	Engine Bearing 2&3 Drain Delta Temperature High	110	delta deg F	Alarm	A,B&C
AL_Eng_Brg_4_5_Drn_Delta_Temp_H	Engine Bearing 4&5 Drain Delta Temperature High	45	delta deg F	Alarm	A,B&C
AL_Eng_GP_Thr_Brg_Delta_Temp_H	Engine GP Thrust Bearing Delta Temperature High	90	delta deg F	Alarm	A,B&C
AL_Eng_PT_Thr_Brg_Delta_Temp_H	Engine PT Thrust Bearing Delta Temperature High	90	delta deg F	Alarm	A,B&C
AL_Gbx_Brg_Drn_Temp_H	Gearbox Bearing Drain Temperature High	180	deg F	Alarm	A,B&C
AL_TE1260_H	Engine GP Thrust Bearing Temperature High	240	deg F	Alarm	A,B&C
AL_TE1270_H	Engine PT Thrust Bearing Temperature High	240	deg F	Alarm	A,B&C
AL_TE4230_H	Generator DE Bearing Temperature High	185	deg F	Alarm	A,B&C
AL_TE4240_H	Generator EE Bearing Temperature High	185	deg F	Alarm	A,B&C
VIBRATION					
AL_VE1210_H	Engine Bearing 1 X-Axis Radial Vibration High	2.5	mil pp	Alarm	A&B
AL_VE1211_H	Engine Bearing 1 Y-Axis Radial Vibration High	2.5	mil pp	Alarm	A&B
AL_VE1220_H	Engine Bearing 2 X-Axis Radial Vibration High	2.5	mil pp	Alarm	A&B
AL_VE1221_H	Engine Bearing 2 Y-Axis Radial Vibration High	2.5	mil pp	Alarm	A&B
AL_VE1230_H	Engine Bearing 3 X-Axis Radial Vibration High	2.5	mil pp	Alarm	A&B
AL_VE1231_H	Engine Bearing 3 Y-Axis Radial Vibration High	2.5	mil pp	Alarm	A&B
AL_VE1240_H	Engine Bearing 4 X-Axis Radial Vibration High	2.5	mil pp	Alarm	A&B
AL_VE1241_H	Engine Bearing 4 Y-Axis Radial Vibration High	2.5	mil pp	Alarm	A&B
AL_VE1250_H	Engine Bearing 5 X-Axis Radial Vibration High	2.5	mil pp	Alarm	A&B
AL_VE1251_H	Engine Bearing 5 Y-Axis Radial Vibration High	2.5	mil pp	Alarm	A&B
AL_VE4234_H	Generator DE Velocity Vibration High	0.15	in/s rms	Alarm	A&B
AL_VE4244_H	Generator EE Velocity Vibration High	0.15	in/s rms	Alarm	A&B
AL_VE4765_H	Gearbox Acceleration Input/Output Shaft Vibration High	10	g/rms	Alarm	A&B

SHUTDOWNS

TAG NAME	DESCRIPTION	SETPOINT	UNITS	RANGE	TYPE	ACTION
CDNL	**COOL DOWN NON LOCKOUT**					
CN_PDT6310_HH	Turbine Air Inlet Filter DP High	7	inH2O	7 to 7	CDNL	D
CN_TE4210_HH	Generator Phase A Winding Temperature High	257	deg F	257 to 257	CDNL	D
CN_TE4213_HH	Generator Phase B Winding Temperature High	257	deg F	257 to 257	CDNL	D
CN_TE4216_HH	Generator Phase C Winding Temperature High	257	deg F	257 to 257	CDNL	D
CN_TE3200_HH	Lube Oil Header Temperature High	165	deg F	165 to 165	CDNL	D
CN_TE3200_LL	Lube Oil Header Temperature Low, Start Inhibited	52	deg F	52 to 52	CDNL	D
CDLO	**COOL DOWN LOCKOUT**					**ACTION**
CL_T5_TC_Fail	Multiple T5 Thermocouple Failure	17	3 or more	17 to 17	CDLO	D
CL_PDT3100_HH	Lube Oil Tank DP High	10	inH2O	10 to 10	CDLO	D
CL_Gas_Fuel_Temp_HH	Gas Fuel Temperature High	215	deg F	215 to 215	CDLO	D
FSNL	**FAST STOP NON LOCKOUT**					**ACTION**
FN_Flameout_Low_T5	[SAFETY CRITICAL]$NEngine Flameout Detected By Low Engine Temperature	0.15	%/s	0.15 to 0.15	FSNL	D
FN_Ngp_Accel_Rate_L	Gas Producer Acceleration Rate Low	105	%	105 to 105	FSNL	D
FN_Ngp_Over_Speed	[SAFETY CRITICAL]$NGas Producer Over Speed	65	%	65 to 65	FSNL	D
FN_Ngp_Under_Speed	Gas Producer Under Speed	5	%	5 to 5	FSNL	D
FN_Npt_Brkaway_Fail	Power Turbine Fail to Break Away	110.8	%	110.8 to 110.8	FSNL	D
FN_Npt_Max_Continuous	Power Turbine Maximum Continuous Speed Exceeded	112.5	%	112.5 to 112.5	FSNL	D
FN_Npt_Over_Speed	[SAFETY CRITICAL]$NPower Turbine Over Speed	90	%	90 to 90	FSNL	D
FN_Npt_Under_Speed	Power Turbine Under Speed	60	psig	60 to 60	FSNL	D
FN_PDS1500_Fail	Flameout Switch failure to transfer on shutdown	25	%	25 to 25	FSNL	D
FN_M3170_Fail	Backup Lube Oil Pump Failure	52	deg F	52 to 52	FSNL	D
FN_TE3100_LL	Lube Oil Tank Temperature Low Start Permissive	52	deg F	52 to 52	FSNL	D
FN_VE1210_HH	Engine Bearing 1 X-Axis Radial Vibration High	4.0000	mil pp	0 to 10	FSNL	D
FN_VE1211_HH	Engine Bearing 1 Y-Axis Radial Vibration High	4.0000	mil pp	0 to 10	FSNL	D
FN_VE1220_HH	Engine Bearing 2 X-Axis Radial Vibration High	3.2000	mil pp	0 to 10	FSNL	D
FN_VE1221_HH	Engine Bearing 2 Y-Axis Radial Vibration High	3.2000	mil pp	0 to 10	FSNL	D
FN_VE1230_HH	Engine Bearing 3 X-Axis Radial Vibration High	4.0000	mil pp	0 to 10	FSNL	D
FN_VE1231_HH	Engine Bearing 3 Y-Axis Radial Vibration High	4.0000	mil pp	0 to 10	FSNL	D
FN_VE1240_HH	Engine Bearing 4 X-Axis Radial Vibration High	4.0000	mil pp	0 to 10	FSNL	D
FN_VE1241_HH	Engine Bearing 4 Y-Axis Radial Vibration High	4.0000	mil pp	0 to 10	FSNL	D
FN_VE1250_HH	Engine Bearing 5 X-Axis Radial Vibration High	4.0000	mil pp	0 to 10	FSNL	D
FN_VE1251_HH	Engine Bearing 5 Y-Axis Radial Vibration High	4.0000	mil pp	0 to 10	FSNL	D
FN_VE4234_HH	Generator DE Velocity Vibration High	0.200	in/s rms	.2 t0 .2	FSNL	D
FN_VE4244_HH	Generator EE Velocity Vibration High	0.200	in/s rms	.2 t0 .2	FSNL	D
FN_VE4765_HH	Gearbox Acceleration Input Shaft Vibration High	15	g/rms	15 t0 15	FSNL	D
FN_VE4766_HH	Gearbox Acceleration Output Shaft Vibration High	15	g/rms	15 t0 15	FSNL	D
FN_Crank_Speed_H	Crank Speed High	15	%	15 to 15	FSNL	D
FN_Crank_Speed_L	Crank Speed Low	8	psig	8 to 8	FSNL	D
FSLO	**FAST STOP LOCKOUT**					**ACTION**
FL_Gas_Fuel_Peak_Temp_HH	Gas Fuel Temperature High	250	deg F	250 to 250	FSLO	D
FL_Gas_Fuel_Temp_LL	Gas Fuel Temperature Low	-20	deg F	-20 to -20	FSLO	D
FL_Ngp_Loss_Speed_Sig	Loss of Gas Producer Speed Signal	15	%	15 to 15	FSLO	D
FL_Ngp_Max_Momentary	Gas Producer Maximum Momentary Speed Exceeded	110	%	110 to 110	FSLO	D
FL_Npt_Max_Momentary	Power Turbine Maximum Momentary Speed Exceeded	121	%	121 to 121	FSLO	D
FL_PT2120_HH	[SAFETY CRITICAL]$NGas Fuel Supply Pressure High	505	psig	505 to 505	FSLO	D
FL_PT2121_HH	Gas Fuel Shutoff Valves Pressure High	505	psig	505 to 505	FSLO	D
FL_PT2126_HH	Gas Fuel Control Valve Pressure High	505	psig	505 to 505	FSLO	D
FL_T5_Inst_HH	T5 Instantaneous Temperature High	1440	deg F	0 to 1560	FSLO	D
FL_T5_TC_Delay_High	Delayed Single T5 Thermocouple High	1500	deg F	1500 to 1500	FSLO	D
FL_T5_TC_High	Single T5 Thermocouple High	1700	deg F	1700 to 1700	FSLO	D
FL_T5_TC_Light_Around_Fail	T5 Thermocouples Fail to Completely Light Around	15	None	15 to 15	FSLO	D
FL_BU_Sys_Relay_Failure	Backup System Relay Failure	8	psig	8 to 8	FSLO	D
FL_Possible_Bearing_Fail_Rotating	Possible Engine Bearing Failure Due to Low Header Pressure While Rotating	26	psig	0 to 26	FSLO	D
FL_PT3200_LL	Lube Oil Header Pressure Low	26	psig	0 to 26	FSLO	D
FL_Supply_Voltage_24Vdc_LL	Control System 24 Vdc Supply Voltage Low	21	Vdc	21 to 21	FSLO	D
FL_Supply_Voltage_2_24Vdc_LL	Secondary Control System 24 Vdc Supply Voltage Low	21	Vdc	21 to 21	FSLO	D
FL_GV_Force_HH	Guide Vane Actuator Force High	640	lbf	640 to 640	FSLO	D
FL_Eng_Brg_2_3_Drn_Delta_Temp_HH	Engine Bearing 2&3 Drain Delta Temperature High	125	delta deg F	50 to 50	FSLO	D
FL_Eng_Brg_4_5_Drn_Delta_Temp_HH	Engine Bearing 4&5 Drain Delta Temperature High	50	deg F	190 to 190	FSLO	D
FL_Gbx_Brg_Drn_Temp_HH	Gearbox Bearing Drain Temperature High	190	delta deg F	100 to 100	FSLO	D
FL_GP_Thr_Brg_Delta_Temp_HH	Engine GP Thrust Bearing Delta Temperature High	100	delta deg F	100 to 100	FSLO	D
FL_PT_Thr_Brg_Delta_Temp_HH	Engine PT Thrust Bearing Delta Temperature High	100	delta deg F	250 to 250	FSLO	D
FL_TE1260_HH	Engine GP Thrust Bearing Temperature High	250	deg F	250 to 250	FSLO	D
FL_TE1270_HH	Engine PT Thrust Bearing Temperature High	250	deg F	203 to 203	FSLO	D
FL_TE4230_HH	Generator DE Bearing Temperature High	203	deg F	203 to 203	FSLO	D
FL_TE4240_HH	Generator EE Bearing Temperature High	203	deg F	400 to 400	FSNL	D

OPERATOR ACTIONS:

A

Call Solar Representative

For any alarm please call the Solar representative for discussion.

B

Reduce load on unit.

Reducing load on unit may give you time to address the situation.

One example would be a high bearing temperature or high vibration alarm, by reducing the load on unit you may lower the bearing temperature and vibration.

C

Inspect auxiliary equipment.

There maybe an issue with a cooling fan, lube oil pump motor or other auxiliary equipment.

D= UNIT SHUTDOWN

Call Solar Representative

If a unit shutsdown take appropiate action according to the type of shutdown.

A corrective action might have to be taken in order for a restart of the unit.

Alarms (AL)

Alarms are initiated when limits are out of operating conditions.

Each alarm will need to be addressed accordingly in the manner they come in.

Cooldown Non-Lockout (CDNL)

Cooldown nonlockout shutdowns reduce turbine speed to idle for a preset cooldown period before initiating a shutdown. Cooldown nonlockout shutdowns include operator-initiated normal stops, operating conditions that reached a shutdown limit because maintenance was not done, a momentary disruption that causes an out-of-limits condition, and operating conditions that exceed alarm levels but are not serious enough to cause any immediate damage. Cooldown nonlockout shutdowns can be reset after corrective action has been taken or operating conditions revert to normal using the local or remote ACKNOWLEDGE and RESET switches or buttons.

Cooldown Lockout (CDLO)

Cooldown lockout shutdowns reduce turbine speed to idle for a preset cooldown period before initiating a shutdown. Cooldown lockout shutdowns typically result from a component failure and not because operating conditions have exceeded alarm or shutdown levels. Cooldown lockout shutdowns may not present immediate danger, but corrective action must be taken to avoid damage resulting from a component failure. Cooldown lockout shutdowns prevent turbine operation until the shutdown is acknowledged and reset using the local ACKNOWLEDGE and RESET switches or buttons. Remote ACKNOWLEDGE and RESET switches or buttons may NOT be used to reset cooldown lockout shutdowns.

Fast Stop Non-Lockout (FSNL)

Fast stop nonlockout shutdowns initiate an immediate shutdown of the turbine. Fast stop nonlockout shutdowns typically result from a disruption in operation due to abnormal operating conditions and may not require corrective action. Fast stop nonlockout shutdowns can be reset when operating conditions revert to normal using the local or remote ACKNOWLEDGE and RESET switches or buttons.

Fast Stop Lockout (FSLO)

Fast stop lockout shutdowns initiate an immediate shutdown of the turbine. Fast stop lockout shutdowns prevent turbine operation until the shutdown is acknowledged and reset using the local ACKNOWLEDGE and RESET switches or buttons. In addition to using the local ACKNOWLEDGE and RESET switches or buttons, fast stop lockout shutdowns initiated by a microprocessor failure, fire detection, backup overspeed, or pushing the EMERGENCY STOP Switch will require the backup relay system to be reset. Fast stop lockout shutdowns are the most severe shutdown types, and require corrective action before the turbine can be restarted. Remote ACKNOWLEDGE and RESET switches or buttons may NOT be used to reset fast stop lockout shutdowns.

ALARMS					SHUTDOWNS				
Tag Name	Description	Setpoint	Units	Type	Tag Name	Description	Setpoint	Units	Type
ENGINE AUXLILARY									
AL_PDT6310_H	Turbine Air Inlet Filter DP High	5	inH2O	Alarm	CN_PDT6310_HH	Turbine Air Inlet Filter DP High	7	inH2O	CDNL
AL_Supply_Voltage_24Vdc_H	Control System 24 Vdc Supply Voltage High	32	Vdc	Alarm	Alarm only				
AL_Supply_Voltage_24Vdc_L	Control System 24 Vdc Supply Voltage Low	21.5	Vdc	Alarm	FL_Supply_Voltage_24Vdc_LL	Control System 24 Vdc Supply Voltage Low	21	Vdc	FSLO
AL_Supply_Voltage_2_24Vdc_H	Secondary Control System 24 Vdc Supply Voltage High	32	Vdc	Alarm	Alarm only				
AL_Supply_Voltage_2_24Vdc_L	Secondary Control System 24 Vdc Supply Voltage Low	21.5	Vdc	Alarm	FL_Supply_Voltage_2_24Vdc_LL	Secondary Control System 24 Vdc Supply Voltage Low	21	Vdc	FSLO
AL_Ngp_Slow_Roll_Speed_L	Ngp Slow Roll Speed Low	3.5	Hz	Alarm	Alarm only				
AL_GV_Force_H	Guide Vane Actuator Force High	450	lbf	Alarm	FL_GV_Force_HH	Guide Vane Actuator Force High	640	lbf	FSLO
GENERATOR									
AL_TE4210_H	Generator Phase A Winding Temperature High	239	deg F	Alarm	CN_TE4210_HH	Generator Phase A Winding Temperature High	257	deg F	CDNL
AL_TE4213_H	Generator Phase B Winding Temperature High	239	deg F	Alarm	CN_TE4213_HH	Generator Phase B Winding Temperature High	257	deg F	CDNL
AL_TE4216_H	Generator Phase C Winding Temperature High	239	deg F	Alarm	CN_TE4216_HH	Generator Phase C Winding Temperature High	257	deg F	CDNL
GAS FUEL SYSTEM									
AL_Gas_Fuel_Main_Vlv_Cmd_H	Main Gas Fuel Valve Command High - Low Gas Fuel Pressure	95	%	Alarm	Alarm only				
AL_Gas_Fuel_Main_Vlv_DP_L	Gas Fuel Main Valve DP Low - Low Gas Fuel Pressure	20	psid	Alarm	Alarm only				
AL_Gas_Fuel_Pilot_Vlv_Cmd_H	Gas Fuel Pilot Valve Command High - Low Gas Fuel Pressure	95	%	Alarm	Alarm only				
AL_Gas_Fuel_Pilot_Vlv_DP_L	Gas Fuel Pilot Valve DP Low - Low Gas Fuel Pressure	20	psid	Alarm	Alarm only				
AL_Gas_Fuel_Temp_H	Gas Fuel Temperature High	200	deg F	Alarm	CL_Gas_Fuel_Temp_HH	Gas Fuel Temperature High	215	deg F	CDLO
AL_Gas_Fuel_Temp_L	Gas Fuel Temperature Low	-18	deg F	Alarm	FL_Gas_Fuel_Temp_LL	Gas Fuel Temperature Low	-20	deg F	CDLO
AL_PT2120_H	Gas Fuel Supply Pressure High	500	psig	Alarm	FL_PT2120_HH	Gas Fuel Supply Pressure High	505	psig	
AL_PT2120_L	Gas Fuel Supply Pressure Low	65	psig	Alarm	Alarm only				
AL_PT2121_H	Gas Fuel Shutoff Valves Pressure Alarm	500	psig	Alarm	FL_PT2121_HH	Gas Fuel Shutoff Valves Pressure High	505	psig	
AL_PT2126_H	Gas Fuel Control Valve Pressure High	500	psig	Alarm	FL_PT2126_HH	Gas Fuel Control Valve Pressure High	505	psig	
BAM SYSTEM									
AL_XM_BAM_Band0_Peak_H	XM BAM Band 0 Max Peak Amplitude High	0.1	psi rms	Alarm	Alarm only				
AL_XM_BAM_Band1_Peak_H	XM BAM Band 1 Max Peak Amplitude High	0.25	psi rms	Alarm	Alarm only				
AL_XM_BAM_Band2_Peak_H	XM BAM Band 2 Max Peak Amplitude High	0.25	psi rms	Alarm	Alarm only				
AL_XM_BAM_Band3_Peak_H	XM BAM Band 3 Max Peak Amplitude High	0.25	psi rms	Alarm	Alarm only				
LUBE OIL SYSTEM									
AL_M3130_Fail	Main Lube Oil Pump 2 Failure	8	psig	Alarm	Alarm only				
AL_M3110_Fail	Main Lube Oil Pump 1 Failure	8	psig	Alarm	Alarm only				
AL_PDT3100_H	Lube Oil Tank DP High	8.5	inH2O	Alarm	CL_PDT3100_HH	Lube Oil Tank DP High	10	inH2O	CDLO
AL_PDT3240_H	Lube Oil Filter DP High	30	psid	Alarm	Alarm only				
AL_PT3200_H	Lube Oil Header Pressure High	45	psig	Alarm	Alarm only				
AL_PT3200_L	Lube Oil Header Pressure Low	26	psig	Alarm	FL_PT3200_LL	Lube Oil Header Pressure Low	26	psig	FSLO
AL_TE3200_H	Lube Oil Header Temperature High	160	deg F	Alarm	CN_TE3200_HH	Lube Oil Header Temperature High	165	deg F	CDNL
AL_TE3200_L	Lube Oil Header Temperature Low	110	deg F	Alarm	Alarm only				
AL_TE3200_LL	Lube Oil Header Temperature Low, Start Delayed For Warmup	52	deg F	Alarm	CN_TE3200_LL	Lube Oil Header Temperature Low, Start Inhibited	52	deg F	CDNL
AL_Eng_Brg_1_Drn_Delta_Temp_H	Engine Bearing 1 Drain Delta Temperature High	45	delta deg F	Alarm	Alarm only				
AL_Eng_Brg_2_3_Drn_Delta_Temp_H	Engine Bearing 2&3 Drain Delta Temperature High	110	delta deg F	Alarm	FL_Eng_Brg_2_3_Drn_Delta_Temp_HH	Engine Bearing 2&3 Drain Delta Temperature High	125	delta deg F	FSLO
AL_Eng_Brg_4_5_Drn_Delta_Temp_H	Engine Bearing 4&5 Drain Delta Temperature High	45	delta deg F	Alarm	FL_Eng_Brg_4_5_Drn_Delta_Temp_HH	Engine Bearing 4&5 Drain Delta Temperature High	50	deg F	FSLO
AL_Eng_GP_Thr_Brg_Delta_Temp_H	Engine GP Thrust Bearing Delta Temperature High	90	delta deg F	Alarm	FL_GP_Thr_Brg_Delta_Temp_HH	Engine GP Thrust Bearing Delta Temperature High	100	delta deg F	FSLO
AL_Eng_PT_Thr_Brg_Delta_Temp_H	Engine PT Thrust Bearing Delta Temperature High	90	delta deg F	Alarm	FL_PT_Thr_Brg_Delta_Temp_HH	Engine PT Thrust Bearing Delta Temperature High	100	delta deg F	FSLO
AL_Gbx_Brg_Drn_Temp_H	Gearbox Bearing Drain Temperature High	180	deg F	Alarm	FL_Gbx_Brg_Drn_Temp_HH	Gearbox Bearing Drain Temperature High	190	delta deg F	FSLO
AL_TE1260_H	Engine GP Thrust Bearing Temperature High	240	deg F	Alarm	FL_TE1260_HH	Engine GP Thrust Bearing Temperature High	250	deg F	FSLO
AL_TE1270_H	Engine PT Thrust Bearing Temperature High	240	deg F	Alarm	FL_TE1270_HH	Engine PT Thrust Bearing Temperature High	250	deg F	FSLO
AL_TE4230_H	Generator DE Bearing Temperature High	185	deg F	Alarm	FL_TE4230_HH	Generator DE Bearing Temperature High	203	deg F	
AL_TE4240_H	Generator EE Bearing Temperature High	185	deg F	Alarm	FL_TE4240_HH	Generator EE Bearing Temperature High	203	deg F	
VIBRATION									
AL_VE1210_H	Engine Bearing 1 X-Axis Radial Vibration High	2.5	mil pp	Alarm	FN_VE1210_HH	Engine Bearing 1 X-Axis Radial Vibration High	4	mil pp	
AL_VE1211_H	Engine Bearing 1 Y-Axis Radial Vibration High	2.5	mil pp	Alarm	FN_VE1211_HH	Engine Bearing 1 Y-Axis Radial Vibration High	4	mil pp	
AL_VE1220_H	Engine Bearing 2 X-Axis Radial Vibration High	2.5	mil pp	Alarm	FN_VE1220_HH	Engine Bearing 2 X-Axis Radial Vibration High	3.2	mil pp	
AL_VE1221_H	Engine Bearing 2 Y-Axis Radial Vibration High	2.5	mil pp	Alarm	FN_VE1221_HH	Engine Bearing 2 Y-Axis Radial Vibration High	3.2	mil pp	
AL_VE1230_H	Engine Bearing 3 X-Axis Radial Vibration High	2.5	mil pp	Alarm	FN_VE1230_HH	Engine Bearing 3 X-Axis Radial Vibration High	4	mil pp	
AL_VE1231_H	Engine Bearing 3 Y-Axis Radial Vibration High	2.5	mil pp	Alarm	FN_VE1231_HH	Engine Bearing 3 Y-Axis Radial Vibration High	4	mil pp	
AL_VE1240_H	Engine Bearing 4 X-Axis Radial Vibration High	2.5	mil pp	Alarm	FN_VE1240_HH	Engine Bearing 4 X-Axis Radial Vibration High	4	mil pp	
AL_VE1241_H	Engine Bearing 4 Y-Axis Radial Vibration High	2.5	mil pp	Alarm	FN_VE1241_HH	Engine Bearing 4 Y-Axis Radial Vibration High	4	mil pp	
AL_VE1250_H	Engine Bearing 5 X-Axis Radial Vibration High	2.5	mil pp	Alarm	FN_VE1250_HH	Engine Bearing 5 X-Axis Radial Vibration High	4	mil pp	
AL_VE1251_H	Engine Bearing 5 Y-Axis Radial Vibration High	2.5	mil pp	Alarm	FN_VE1251_HH	Engine Bearing 5 Y-Axis Radial Vibration High	4	mil pp	
AL_VE4234_H	Generator DE Velocity Vibration High	0.15	in/s rms	Alarm	FN_VE4234_HH	Generator DE Velocity Vibration High	0.2	in/s rms	
AL_VE4244_H	Generator EE Velocity Vibration High	0.15	in/s rms	Alarm	FN_VE4244_HH	Generator EE Velocity Vibration High	0.2	in/s rms	
AL_VE4765_H	Gearbox Acceleration Input/Output Shaft Vibration High	10	g/rms	Alarm	FN_VE4765_HH	Gearbox Acceleration Input Shaft Vibration High	15	g/rms	
AL_VE4766_H	Gearbox Acceleration Input/Output Shaft Vibration High	10	g/rms	Alarm	FN_VE4766_HH	Gearbox Acceleration Output Shaft Vibration High	15	g/rms	

Appendix B
Inspection and Maintenance Schedule

1.5 MAINTENANCE SCHEDULE

Inspection and scheduled maintenance of the turbine engine and control equipment are required at established intervals. A check of servicing needs, under operating conditions, will establish the most practical inspection and maintenance schedules (not necessarily the inspection intervals listed). Thorough maintenance scheduled at specific times will minimize the need for corrective maintenance.

Scheduled maintenance frequency is based on hours of equipment operation per year and is divided into three categories: operational, intermediate, and major.

1.5.1 Operational Maintenance

Operational maintenance is a walkaround inspection to ensure that the equipment is functioning properly and to detect early signs of deterioration. On unattended, continuous–operation, or remotely–operated installations, the operational inspection procedures need not be carried out daily. It is recommended that they be done as often as practical. For operational maintenance, the equipment need not be shut down.

1.5.2 Intermediate Maintenance

Intermediate maintenance emphasizes protective systems checkout and engine compressor cleaning and ensures optimum equipment performance. Intermediate maintenance requires that the equipment be shut down for most of the inspection. Regardless of the actual hours of operation per year, it is recommended that this maintenance be performed after six months of operation. Maintenance intervals for subsequent operation should then be established on the basis of experience gained during the first year, with due regard to the possibility that changing operating conditions may dictate other and more practical intervals.

1.5.3 Major Maintenance

Major maintenance involves disassembly of selected subsystem components for inspection and visual inspection of engine gas path components with borescope instruments. Major maintenance should be performed at 8000–hour intervals. However, operating conditions will establish the most practical interval for inspection and maintenance.

Elements that have malfunctioned or have been defective in the past, and all other discrepancies observed during previous inspections, should receive renewed attention regardless of whether or not they are included in the list of maintenance tasks. The keeping of detailed records is important and useful as a means of detecting a component defect, pinpointing malfunctions to a particular component, and detecting a malfunction before it has progressed to the stage where performance is affected. For major maintenance, the equipment must be shut down.

1.5.4 Scheduled Performance Tasks

Table 1.5.1 lists the required scheduled performance tasks and is tabulated as follows:

Column 1 – Equipment

This column lists the assemblies which require periodic maintenance.

Column 2 – Intervals

This column contains a list of all scheduled maintenance actions contained in this manual. The following symbols are used: O (Operational), I (Intermediate), and M (Major).

Column 3 – Description

This column lists the maintenance action to be performed.

Table 1.5.1 Scheduled Performance Tasks

Equipment	Intervals O	I	M	Description
TURBINE–DRIVEN PACKAGE	X	X	X	Check entire installation for abnormal operating conditions.
	X	X	X	Check for discoloration, cracks, chafing of wires and lines, oil leaks, air leaks, and unusual noises and vibration.
	X	X	X	Check for any loose mechanical fasteners.
	X	X	X	Record engine systems performance.
	X	X	X	Check piping arrangement and verify that all piping and ducting supports, fasteners, and hardware are secure.
	X	X	X	Maintain highest possible standards of cleanliness.
	X	X	X	Inspect all pressure gages for leaks.
Before Shutdown		X	X	Record engine and system performance figures and compare results with previous analysis.
		X	X	Perform vibration analysis.
After Shutdown		X	X	Perform borescope inspection.
		X	X	Check entire package externally.

Table 1.5.1 Scheduled Performance Tasks, Contd

Equipment	Intervals O	I	M	Description
TURBINE	X	X	X	Inspect engine intake and exhaust ducting, engine intake screen, and all transition pieces for signs of contamination and damage.
	X	X	X	Check air inlet filters for obstructions and signs of contamination.
		X	X	Check engine compressor as required.
		X	X	Clean or replace air filters as necessary.
		X	X	Inspect thermocouple harness for breakage and general condition.
		X	X	Inspect engine compressor variable vane mechanism for general condition.
		X	X	At start–up, record engine and system performance and perform no–load Pcd check.
		X	X	Clean and inspect magnetic speed pickups.
		X	X	Inspect and clean engine combustor bleed air valve.
			X	Disassemble and check engine–to–driven equipment interconnect shafts and splines.
			X	Check condition of the vibration protection system, if used (monitor, probes, and velocity transducers and accelerometers).
GENERATOR		X	X	Inspect and clean as necessary to maintain proper operation.
START SYSTEM	X	X	X	Check oil supply in reservoir.
		X	X	Clean strainers in supply lines to start system, if applicable.
			X	Check start system and associated wiring and controls.

Table 1.5.1 Scheduled Performance Tasks, Contd

Equipment	Intervals O	I	M	Description
FUEL SYSTEM	X	X	X	Check fuel supply pressure.
		X	X	Clean strainers in supply lines to fuel system.
		X	X	Remove and inspect fuel injectors.
		X	X	Inspect fuel system components for proper operation.
		X	X	Remove and inspect torch assembly and igniter plug.
		X	X	Remove and inspect gas fuel servo loader supply screen and orifice.
			X	Check throttle valve linkage riggings.
LUBE OIL SYSTEM	X	X	X	Check oil supply in reservoir.
	X	X	X	Check oil filter operation. Replace elements as necessary.
	X	X	X	Check all pressure gages on gage panel(s).
	X	X	X	Check lube oil flow glass to ensure lube oil is flowing.
		X	X	Check lube oil for possible degradation. Take a lube oil sample every six months for laboratory analysis.
CONTROL CONSOLE	X	X	X	Check control console electrical connections for security.
		X	X	Test and calibrate alarm, malfunction, and shutdown systems.
			X	Inspect junction boxes for good material condition and signs of condensation.
			X	Perform a check of the malfunction and protection system to ensure signal continuity (and signal loss) at selected setpoints.

Appendix C
List of Major Replacement Parts

USG Otsego Paper
List of Replacement Parts

Model	Description	Manufacturer	Specifications	Qty on Hand	No	Model	Description
1022447	SEAL,LIP	SOLAR	LIP SEAL	2	Yes	1022447	SEAL, OIL, 1022447
1030794-1	VALVE,CHECK,0.375 IN	SOLAR	CHECK VALVE	1	Yes	1030794-1	VALVE, CHECK, 1030794-1
1030794-12	VALVE,CHECK,0.375 IN,2 PSIG	SOLAR	CHECK VALVE, 0.375 IN, 2 PSIG	1	Yes	1030794-12	VALVE, CHECK, 1030794-12
1031741-4	RELAY,SYNC CHECK	SOLAR	SYNC CHECK RELAY	1	Yes	1031741-4	RELAY, SYNC CHECK, 1031741-4
1031757-109	VALVE ASSY,BLEED	PARKER	COMPRESSOR BLEED VALVE ASSEMBLY	1	Yes	1031757-109	VALVE, COMPRESSOR BLEED, 1031757-109
1042018-4300	VALVE,CONTROL,GAS FUEL,ELECTRIC,600 PSI	SOLAR	CONTROL VALVE, GAS FUEL	1	Yes	1042018-4300	VALVE, CONTROL, 1042018-4300
1043265-3	FUSE,2.0 A,600 V	SOLAR	FUSE, 2 A	5	Yes	1043265-3	FUSE, 2A, 1043265-3
1043265-4	FUSE,5.0 A,600 V	SOLAR	FUSE, 5 A	5	Yes	1043265-4	FUSE, 5A, 1043265-4
1043265-5	FUSE,10 A,600 V	SOLAR	FUSE, 10 A	4	Yes	1043265-5	FUSE, 10A, 1043265-5
1043265-6	FUSE,15 A,600 V	SOLAR	FUSE, 15 A	5	Yes	1043265-6	FUSE, 15A, 1043265-6
1043265-7	FUSE,20 A,600 V	SOLAR	FUSE, 20 A	5	Yes	1043265-7	FUSE, 20A, 1043265-7
1043265-8	FUSE,25 A,600 V	SOLAR	FUSE, 25 A	5	Yes	1043265-8	FUSE, 25A, 1043265-8
1046415-30	CONNECTOR	SOLAR	CONNECTOR	10	Yes	1046415-30	CONNECTOR, 1046415-30
1046415-75	MODULE,CONTROLLER,CONTROLNET	SOLAR	CONTROLNET CONTROL MODULE	1	Yes	1046415-75	MODULE, CONTROL, 1046415-75
1051931-67	BASE,TERMINAL,SPRING,-20-+70 C	SOLAR	TERMINAL BASE, SPRING, -20 - +70 C	2	Yes	1051931-67	BASE, TERMINAL, 1051931-67
1051931-69	BASE,TEMPERATURE,SPRING,-20-+70 C	SOLAR	TEMPERATURE BASE, SPRING	3	Yes	1051931-69	BASE, TEMPERATURE, 1051931-69
1051931-71	BASE,GENERIC,SPRING,-20-+70 C	SOLAR	GENERIC BASE, SPRING, -20 - +70 C	1	Yes	1051931-71	BASE, GENERIC, 1051931-71
1052120-1	TRANSMITTER,DP,25 IN-H2O,DIGITAL	SOLAR	TRANSMITTER, DP, 25 IN-H2O	1	Yes	1052120-1	TRANSMITTER, 1052120-1
1052120-4	TRANSMITTER,DP,300 PSI,DIGITAL	SOLAR	TRANSMITTER, DP, 300 PSI, DIGITAL	1	Yes	1052120-4	TRANSMITTER, 1052120-4
1052168-2	TRANSMITTER,PRESS,150 PSI,DIGITAL	SOLAR	PRESSURE TRANSMITTER, 150 PSI	1	Yes	1052168-2	TRANSMITTER, 1052168-2
1052168-23	TRANSMITTER,PRESS,800 PSI,DIGITAL	SOLAR	PRESSURE TRANSMITTER, 800 PSI	2	Yes	1052168-23	TRANSMITTER, 1052168-23
1053834-14	MONITOR,CONTROL,BU OVERSPEED	SOLAR	CONTROL MONITOR, BU OVERSPEED	1	Yes	1053834-14	MONITOR, CONTROL, 1053834-14
1053929-16	SWITCH,DP,2 PSIG,DPDT,AIR,GF,LF,WATER	SOLAR	SWITCH, DP, 500 PSI, 125 V, DPDT	1	Yes	1053929-16	SWITCH, 1053929-16
1057387	HOSE ASSY,1.5 IN X 25.0 IN,O-RING	SOLAR	HOSE ASSEMBLY, 1.5" x 25"	1	Yes	1057387	ASSEMBLY, HOSE, 1057387
1059148-2	DRIVER,PROBE,VIB,7200	SOLAR	PROBE DRIVER, VIB, 7200	1	Yes	1059148-2	DRIVER, PROBE, 1059148-2
1060367-2	CONTROL BOARD,BATTERY CHARGER	SOLAR	CONTROL BOARD, BATTERY CHARGER	1	Yes	1060367-2	BOARD, CONTROL, 1060367-2
1060367-3	CONTROL BOARD,BATTERY CHARGER	SOLAR	CONTROL BOARD, BATTERY CHARGER	1	Yes	1060367-3	BOARD, CONTROL, 1060367-3
1060367-4	CONTROL BOARD,BATTERY CHARGER	SOLAR	CONTROL BOARD, BATTERY CHARGER	1	Yes	1060367-4	BOARD, CONTROL, 1060367-4
1061979-1	RELAY,DPDT,6 A	SOLAR	RELAY, DPDT, 8A	25	Yes	1061979-1	RELAY, 1061979-1
1062257-1	VALVE,SOLENOID,3-WAY,0.25 IN,145 PSIG,24 VDC	SOLAR	SOLENIOD VALVE	1	Yes	1062257-1	VALVE, SOLENIOD, 1062257-1
1062257-2	VALVE,SOLENOID,QUICK EXH,0.375 IN,174 PSIG	SOLAR	QUICK EXHAUST VALVE	1	Yes	1062257-2	VALVE, QUICK EXHAUST, 1062257-2
1062883-100	VALVE ASSY,BALL,PNEU	SOLAR	BALL VALVE ASSEMBLY, PNEUMATIC	1	Yes	1062883-100	VALVE, BALL, 1062883-100
1062883-3	ACTUATOR,ROTARY,PNEU	SOLAR	ROTARY ACTUATOR, PNEUMATIC	1	Yes	1062883-3	ACTUATOR, ROTARY, 1062883-3
1067311-1	VALVE,SOLENOID,3-WAY PSI	SOLAR	SOLENIOD VALVE,3-WAY	2	Yes	1067311-1	VALVE, SOLENOID, 1067311-1
1071327-1	TRANSDUCER,PRESS,1000 PSI	SOLAR	TRANSDUCER, PRESS, 1000 PSI	1	Yes	1071327-1	TRANSDUCER, 1071327-1
1071411-1	RELAY,TIMER,ADJUSTABLE,WATCHDOG,24 VDC	SOLAR	TIMER RELAY, MULTIFUNCTION	2	Yes	1071411-1	RELAY, TIMER, 1071411-1
1071411-3	RELAY,TIMER,WATCHDOG,24 VDC,2 A	SOLAR	TIMER RELAY, WATCHDOG	1	Yes	1071411-3	RELAY, TIMER, 1071411-3
1076251-1	RELAY,24 VDC,10 A	SOLAR	RELAY, 24 VDC, 10 A	1	Yes	1076251-1	RELAY, 1076251-1
1076251-2	SOCKET,RELAY,24 VDC,10 A	SOLAR	RELAY SOCKET, 24 VDC, 10A	1	Yes	1076251-2	SOCKET, RELAY, 1076251-2
1088209-1300	VALVE,CONTROL,GAS FUEL,ELECTRIC,600 PSI	SOLAR	CONTROL VALVE, GAS FUEL	1	Yes	1088209-1300	VALVE, CONTROL, 1088209-1300
1088442-1	MODULE,VIB,COMMUNICATION,XM,CONTROLNET	SOLAR	COMMUNICATION MODULE, VIB, XM	1	Yes	1088442-1	MODULE, COMMUNICATION, 1088442-1
1088442-4	POWER SUPPLY,92 W,24 VAC,24 VDC	SOLAR	POWER SUPPLY, 92 W, 24 VAC,	1	Yes	1088442-4	POWER SUPPLY, 1088442-4
1088442-8	MODULE,VIB,XM,XM NET	SOLAR	MODULE, VIB, XM, XM NET	2	Yes	1088442-8	MODULE, 1088442-8
1089240-10	MODULE,FLEX,FAST ANALOG,2 IN /2 OUT,ISOLATED	SOLAR	FLEX FAST ANALOG MODULE, 2 IN	1	Yes	1089240-10	MODULE, FLEX ANALOG, 1089240-10
1089240-11	MODULE,FLEX,FAST ANALOG,4 OUT,ISOLATED	SOLAR	FLEX FAST ANALOG MODULE, 4 OUT	1	Yes	1089240-11	MODULE, FLEX ANALOG, 1089240-11
1089240-2	MODULE,FLEX,DISCRETE,16 IN	SOLAR	FLEX DISCRETE MODULE, 16 IN	2	Yes	1089240-2	MODULE, FLEX DISCRETE, 1089240-2
1089240-29	MODULE,FLEX,FAST COUNTER,2 IN	SOLAR	FLEX COUNTER MODULE, 2 IN	1	Yes	1089240-29	MODULE, FLEX COUNTER, 1089240-29
1089240-3	MODULE,FLEX,DISCRETE,10 IN/6 OUT	SOLAR	FLEX DISCRETE MODULE, 10 IN/6	1	Yes	1089240-3	MODULE, FLEX DISCRETE, 1089240-3
1089240-30	MODULE,FLEX,ADAPTER	SOLAR	FLEX ADAPTER MODULE,	2	Yes	1089240-30	MODULE, FLEX ADAPTER, 1089240-30
1089240-31	MODULE,FLEX,FAST RTD/TC,8 IN,ISOLATED	SOLAR	FLEX FAST RTD/TC MODULE, 8 IN	2	Yes	1089240-31	MODULE, FLEX RTD/TC, 1089240-31
1089240-4	MODULE,FLEX,DISCRETE,8 OUT	SOLAR	FLEX DISCRETE MODULE, 8 OUT	0	Yes	1089240-4	MODULE, FLEX DISCRETE, 1089240-4
1089240-5	MODULE,FLEX,DISCRETE,16 OUT	SOLAR	FLEX DISCRETE MODULE, 16 OUT	1	Yes	1089240-5	MODULE, FLEX DISCRETE, 1089240-5
1089240-7	MODULE,FLEX,ANALOG,8 IN,NON-ISOLATED	SOLAR	FLEX ANALOG MODULE, 8 IN	1	Yes	1089240-7	MODULE, FLEX ANALOG, 1089240-7
1089240-9	MODULE,FLEX,FAST ANALOG,4 IN,ISOLATED	SOLAR	FLEX ANALOG MODULE, 4 IN	2	Yes	1089240-9	MODULE, FLEX ANALOG, 1089240-9
1089241-28	POWER SUPPLY,42 W,24 VDC	SOLAR	POWER SUPPLY, 42 W, 24 VDC	1	Yes	1089241-28	POWER SUPPLY, 1089241-28
1089241-30	MODULE,CONTROLLER	SOLAR	CONTROL MODULE, CONTROLNET,	1	Yes	1089241-30	MODULE, CONTROL, 1089241-30
1089241-36	MODULE,COMMUNICATION,ETHERNET	SOLAR	COMMUNICATION MODULE, ETHERNET	1	Yes	1089241-36	MODULE, COMMUNICATION, 1089241-36
1089241-4	MODULE,COMMUNICATION,CONTROLNET	SOLAR	COMMUNICATION MODULE,	1	Yes	1089241-4	MODULE, COMMUNICATION, 1089241-4
1091605-200	VALVE,SOLENOID,3-WAY,0.5 IN,24 VDC	SOLAR	SOLENIOD VALVE, 3-WAY, .5 IN,	1	Yes	1091605-200	VALVE, SOLENIOD, 1091605-200
1098092	VALVE,HAND,NEEDLE,0.25 IN,5000 PSIG	SOLAR	NEEDLE VALVE, 1/4 SWAGE, NACE	1	Yes	1098092	VALVE, NEEDLE, 1098092
1098569	HOSE ASSY,2.00 IN X 29.00 IN,O-RING	SOLAR	HOSE ASSEMBLY, 2" x 29"	1	Yes	1098569	ASSEMBLY, HOSE, 1098569
1110429-300	STARTER MOTOR ASSY,ELEC AC,60 HZ,380 VAC	SOLAR	START MOTOR	1	Yes	1110429-300	MOTOR, START, 1110429-300
1112178-2403	COMPUTER SYS,TT4000 SGL UNIT,12IN. INTEGRATED,TOUCHSCREEN,PANEL MOUNT	SOLAR	COMPUTER SYSTEM, TT4000 SGL UNIT	1	Yes	1112178-2403	COMPUTER, 1112178-2403
1114470-11	SWITCH,PRESSURE,1300 PSI,DPDT,125 V,OIL,AIR,WATER,DUAL FUEL	SOLAR	PRESSURE SWITCH, 1300 PSI, DPDT	1	Yes	1114470-11	SWITCH, PRESSURE, 1114470-11
1119585-300	ACTUATOR,LINEAR,ELEC	SOLAR	LINEAR ACTUATOR, ELECTRIC	1	Yes	1119585-300	ACTUATOR, LINEAR, 1119585-300
1126803	BREAKER,CIRCUIT,20 A,DPST,RAIL MNT,SCREW,500 VDC	SOLAR	CIRCUIT BREAKER, 20 A, DPST, RAIL	1	Yes	1126803	BREAKER, CIRCUIT, 1126803
117901-103	FC-VALVE ASSY	SOLAR	PANCAKE VALVE	1	Yes	117901-103	VALVE, 117901-103

USG Otsego Paper
List of Replacement Parts

124907-14	GROMMET,0.965 OD	SOLAR	GROMMET	1	Yes	124907-14	GROMMET, 124907-14
124907-20	GROMMET,0.965 OD	SOLAR	INSTRUMENT SEALING GROMMET	2	Yes	124907-20	GROMMET, 124907-20
1286570-1	POWER SUPPLY,1260 W,28 VDC	SOLAR	POWER SUPPLY	1	Yes	1286570-1	POWER SUPPLY, 1286570-1
131230-6	DETECTOR,TEMP,RESISTANCE,PLATINUM 100 OHM (PT)	SOLAR	TEMPERATURE SENSOR, RESISTANCE	1	Yes	131230-6	SENSOR, TEMPERATURE, 131230-6
136625-3	BOLT,HEX,0.375-24 X 0.828 IN,AISI 4140	SOLAR	WEIGHT CONTROLED BOLT	6	Yes	136625-3	BOLT, 136625-3
136856-1	GASKET,2.425 ID,2.752 OD,NON-METALLIC,COPPER	SOLAR	11 STAGE BLEED INJECTOR GASKET	6	Yes	136856-1	GASKET, 136856-1
154554-9	FAN,SINGLE,VENT,24 VDC	SOLAR	SINGLE VENT FAN, 24 VDC	1	Yes	154554-9	FAN, 154554-9
172435-1	GASKET,16.85 X 11.96IN,.03125,GYLON OFF-WHITE,PELTON WHEEL	SOLAR	NON ASBESTOS GASKET	1	Yes	172435-1	GASKET, NON ASBESTOS, 172435-1
172439-2	PACKING,BLEED AIR	SOLAR	BLEED AIR GASKET	4	Yes	172439-2	GASKET, BLEED AIR, 172439-2
172525-2	PACKING,OIL DRAIN	SOLAR	2/3 DRAIN PACKING	6	Yes	172525-2	PACKING, 172525-2
172780-100	GASKET,2.00 ID,3.39 OD,0.06 IN,METALLIC,304 SS,COPPER,PYROMETER	SOLAR	PYROMETER GASKET	7	Yes	172780-100	GASKET, PYROMETER, 172780-100
173942-1	GASKET,3.32 ID,3.68 OD,0.049 IN,METALLIC,COPPER,TORCH IGNITOR	SOLAR	TORCH GASKET	5	Yes	173942-1	GASKET, TORCH, 173942-1
186232-2900	VALVE ASSY,BALL,PNEU,2.0 IN,675 PSI,2-WAY	SOLAR	BALL VALVE ASSEMBLY, PNEUMATIC, 2"	2	Yes	186232-2900	VALVE, BALL, 186232-2900
186273-42	REGULATOR,PRESS,POPPET,0.25 IN,35 PSI	SOLAR	PRESSURE REGULATOR, POPPET, .25"	1	Yes	186273-42	REGULATOR, PRESSURE, 186273-42
186273-43	REGULATOR,PRESS,POPPET,0.25 IN,10 PSI	SOLAR	PRESSURE REGULATOR, POPPET, .25"	1	Yes	186273-43	REGULATOR, PRESSURE, 186273-43
186273-44	REGULATOR,PRESS,POPPET,0.25 IN,90 PSI	SOLAR	PRESSURE REGULATOR, POPPET, .25 IN	1	Yes	186273-44	REGULATOR, PRESSURE, 186273-44
186426-5	VALVE,HAND,0.25 IN,0.50 IN,200F/6000 PSIG	SOLAR	HAND VALVE, .25", .50"	1	Yes	186426-5	VALVE, HAND, 186426-5
190247-5	ELEMENT,FLTR,CYL,FGL	SOLAR	FILTER ELEMENT, AIR GAS FUEL	2	Yes	190247-5	ELEMENT, FILTER, 190247-5
190247-9	O-RING,SAE 223,FLUOROCARBON	SOLAR	VITON O-RING	1	Yes	190247-9	O-RING, VITON, 190247-9
190817-150	DRIVER,PROBE,VIB,3300XL	SOLAR	PROBE DRIVER, VIB, 3300XL	2	Yes	190817-150	DRIVER, PROBE, 190817-150
195017-1	GASKET,5.18 ID,5.84 OD,0.032 IN,METALLIC,COPPER,FUEL INJ,CU	SOLAR	FUEL INJECTOR GASKET	3	Yes	195017-1	GASKET, FUEL INJECTOR, 195017-1
301479-1	COUPLING,SPLINED	SOLAR	SPLINED COUPLING	1	Yes	301479-1	COUPLING, SPLINED, 301479-1
600357C1	KIT,REPAIR,VALVE	SOLAR	REPAIR KIT, VALVE	1	Yes	600357C1	KIT, REPAIR, 600357C1
600375C1	BREAKER,CIRCUIT,25 A,240 VAC	SOLAR	CIRCUIT BREAKER, 25 A, 240 VAC	1	Yes	600375C1	BREAKER, CIRCUIT, 600375C1
600755C1	KIT,REPAIR,VALVE,SEATS/PACKING	SOLAR	SEATS/PACKING, REPLACEMENT	1	Yes	600755C1	PACKING, 600755C1
602094C1	FILTER,ELECTRONIC,EMI	SOLAR	ELECTRONIC EMI FILTER	1	Yes	602094C1	FILTER, 602094C1
701417C1	O-RING,SAE 117,KALREZ (PERFLUOROELASTOMER),3/32	SOLAR	2/3 OIL FEED O-RING	4	Yes	701417C1	O-RING, 701417C1
903253C1	O-RING,SAE 245,VITON (FLUOROCARBON),4.375 ID,1/8	SOLAR	4/5 DRAIN O-RING	0	Yes	903253C1	O-RING, 903253C1
903266C1	O-RING,SAE 904,VITON (FLUOROCARBON),0.351 ID,0.072	SOLAR	O-RING, SEA 904, 0.346 ID	25	Yes	903266C1	O-RING, 903266C1
903316C1	SPARK PLUG	SOLAR	SPARK PLUG	3	Yes	903316C1	PLUG, SPARK, 903316C1
903732C1	O-RING,SAE 225,VITON,1.859 ID,.139	SOLAR	O-RING, SEA 225, 1.859 ID	15	Yes	903732C1	O-RING, 903732C1
908539C1	TRANSFORMER	SOLAR	TRANSFORMER	1	Yes	908539C1	TRANSFORMER, 908539C1
908579C1	DIODE,RECTIFIER	SOLAR	RECTIFIER DIODE	25	Yes	908579C1	DIODE, RECTIFIER, 908579C1
912137C1	RESISTOR,0.25 W,10000 OHM,+/-1%	SOLAR	RESISTOR, .25 W, 10000 OHM	25	Yes	912137C1	RESISTOR, 912137C1
912642C1	O-RING,SAE 228,VITON (FLUOROCARBON),2.25 ID,1/8	SOLAR	O-RING, SAE 228, 2.234 ID	10	Yes	912642C1	O-RING, 912642C1
918777C1	DETECTOR,TEMP,RESISTANCE,PLATINUM 100 OHM (PT)	SOLAR	TEMPERATURE PROBE	2	Yes	918777C1	PROBE, TEMPERATURE, 918777C1
918801C1	DETECTOR,TEMP,RESISTANCE,PLATINUM 100 OHM (PT),SINGLE ELEMENT,6.0 IN	SOLAR	TEMPERATURE SENSOR, RESISTANCE	3	Yes	918801C1	SENSOR, TEMPERATURE, 918801C1
919340C2	CABLE,IGNITION,59.0 IN	SOLAR	IGNITION CABLE	1	Yes	919340C2	CABLE, IGNITION, 919340C2
945718C1	GASKET,HSG,STARTER,GAS	SOLAR	STARTER GASKET, GAS	2	Yes	945718C1	GASKET, STARTER, 945718C1
950001C1	O-RING,SAE 460,VITON (FLUOROCARBON),15.5 ID,1/4	SOLAR	PT SHAFT COVER O-RING	4	Yes	950001C1	O-RING, 950001C1
950208C1	COUPLING,2.0 PIPE 4.0 LONG VIT	SOLAR	PIPE COUPLING, 2"	2	Yes	950208C1	COUPLING, 950208C1
950470C1	CLAMP,BAND,V,HOSE	SOLAR	COUPLING CLAMP	2	Yes	950470C1	CLAMP, COUPLING, 950470C1
959839C1	DETECTOR,TEMP,RESISTANCE,PLATINUM 100 OHM (PT),SINGLE ELEMENT,9.0 IN	SOLAR	TEMPERATURE PROBE	1	Yes	959839C1	PROBE, TEMPERATURE, 959839C1
964192C1	DETECTOR,TEMP,RESISTANCE,PLATINUM 100 OHM (PT),SINGLE ELEMENT,4.0 IN	SOLAR	TEMPERATURE SENSOR, RESISTANCE	2	Yes	964192C1	SENSOR, TEMPERATURE, 964192C1
967664C1	VALVE,RELIEF,0.375 IN PSI	SOLAR	RELIEF VALVE, .375" PSI	1	Yes	967664C1	VALVE, RELIEF, 967664C1
992049C1	RECTIFIERS (FOWARD)	SOLAR	RECTIFIER ASSEMBLY, GENERATOR FORWARD	2	Yes	992049C1	ASSEMBLY, RECTIFIER, 992049C1
992050C1	RECTIFIERS (REAR)	SOLAR	RECTIFIER ASSEMBLY, GENERATOR REAR	1	Yes	992050C1	ASSEMBLY, RECTIFIER, 992050C1
994401C1	DIODE,FORWARD	SOLAR	RECTIFIER ASSEMBLY, GENERATOR	9	Yes	994401C1	ASSEMBLY, RECTIFIER, 994401C1
997674C1	COUPLING,CUSHION,PMP/MTR,LUBE	SOLAR	LUBE PUMP COUPLING	1	Yes	997674C1	COUPLING, 997674C1
997692C1	KIT,REPAIR,REGULATOR,PRESSURE	SOLAR	REPAIR KIT, PRESSURE REGULATOR	1	Yes	997692C1	KIT, REPAIR, 997692C1
998968C1	INDUCTOR,BATTERY CHARGER	SOLAR	BATTERY CHARGER INDUCTOR	1	Yes	998968C1	INDUCTOR, 998968C1

Appendix D
Turbine Specifications

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: MARS 100-16000S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: SD NATURAL GAS; Water Injection: NO
Run By: Christopher J Stroble; Date Run: 10-Jan-18	Engine Emissions Data: REV. 1.0

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
1 — 12303 kW 100.0% Load — Elev. 721 ft — Rel. Humidity 60.0% — Temperature 0 Deg. F			
PPMvd at 15% O2	15.00	25.00	25.00
ton/yr	33.26	33.75	19.33
lbm/MMBtu (Fuel LHV)	0.060	0.061	0.035
lbm/(MW-hr)	0.62	0.63	0.36
(gas turbine shaft pwr) lbm/hr	7.59	7.70	4.41
2 — 11927 kW 100.0% Load — Elev. 721 ft — Rel. Humidity 60.0% — Temperature 20.0 Deg. F			
PPMvd at 15% O2	15.00	25.00	25.00
ton/yr	32.21	32.68	18.72
lbm/MMBtu (Fuel LHV)	0.060	0.061	0.035
lbm/(MW-hr)	0.62	0.63	0.36
(gas turbine shaft pwr) lbm/hr	7.35	7.46	4.27
3 — 11435 kW 100.0% Load — Elev. 721 ft — Rel. Humidity 60.0% — Temperature 40.0 Deg. F			
PPMvd at 15% O2	15.00	25.00	25.00
ton/yr	30.99	31.45	18.01
lbm/MMBtu (Fuel LHV)	0.060	0.061	0.035
lbm/(MW-hr)	0.62	0.63	0.36
(gas turbine shaft pwr) lbm/hr	7.08	7.18	4.11

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not necessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg C, and between 50% and 100% load for gas, fuel, and between 65% and 100% load for liquid fuel (except f or the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg C and betwee
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: MARS 100-16000S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: SD NATURAL GAS; Water Injection: NO
Run By: Christopher J Stroble; Date Run: 10-Jan-18	Engine Emissions Data: REV. 1.0

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
4 — 10824 kW 100.0% Load; Elev. 721 ft; Rel. Humidity 60.0%; Temperature 60.0 Deg. F			
PPMvd at 15% O2	15.00	25.00	25.00
ton/yr	29.60	30.04	17.21
lbm/MMBtu (Fuel LHV)	0.060	0.061	0.035
lbm/(MW-hr)	0.62	0.63	0.36
(gas turbine shaft pwr) lbm/hr	6.76	6.86	3.93
5 — 10055 kW 100.0% Load; Elev. 721 ft; Rel. Humidity 60.0%; Temperature 80.0 Deg. F			
PPMvd at 15% O2	15.00	25.00	25.00
ton/yr	27.91	28.32	16.22
lbm/MMBtu (Fuel LHV)	0.059	0.060	0.034
lbm/(MW-hr)	0.63	0.64	0.37
(gas turbine shaft pwr) lbm/hr	6.37	6.47	3.70
6 — 9204 kW 100.0% Load; Elev. 721 ft; Rel. Humidity 60.0%; Temperature 100.0 Deg. F			
PPMvd at 15% O2	15.00	25.00	25.00
ton/yr	26.06	26.44	15.14
lbm/MMBtu (Fuel LHV)	0.059	0.060	0.034
lbm/(MW-hr)	0.65	0.66	0.38
(gas turbine shaft pwr) lbm/hr	5.95	6.04	3.46

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not necessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg C, and between 50% and 100% load for gas, fuel, and between 65% and 100% load for liquid fuel (except f or the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg C and betwee
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED ENGINE PERFORMANCE

Customer	Model: MARS 100-16000S
Job ID	Package Type: CS/MD
Run By: Christopher J Stroble — Date Run: 10-Jan-18	Match: STANDARD
Engine Performance Code: REV. 4.18.1.20.12 — Engine Performance Data: REV. 1.0	Fuel System: GAS
	Fuel Type: SD NATURAL GAS

DATA FOR MINIMUM PERFORMANCE

Elevation	feet	721
Inlet Loss	in H2O	4.0
Exhaust Loss	in H2O	8.0
Accessory on GP Shaft	kW	20.7

		1	2	3	4	5	6
Engine Inlet Temperature	deg F	0	20.0	40.0	60.0	80.0	100.0
Relative Humidity	%	60.0	60.0	60.0	60.0	60.0	60.0
Driven Equipment Speed	RPM	9359	9285	9177	9027	8828	8593
Specified Load	kW	FULL	FULL	FULL	FULL	FULL	FULL
Net Output Power	kW	12303	11927	11435	10824	10055	9204
Fuel Flow	mmBtu/hr	126.28	122.42	118.01	113.12	107.35	101.43
Heat Rate	Btu/kW-hr	10264	10265	10319	10451	10676	11020
Therm Eff	%	33.244	33.242	33.065	32.648	31.960	30.962
Engine Exhaust Flow	lbm/hr	357409	348677	338008	324790	309208	290810
PT Exit Temperature	deg F	867	880	895	912	928	948
Exhaust Temperature	deg F	867	880	895	912	928	948

Fuel Gas Composition (Volume Percent)

Methane (CH4)	92.79
Ethane (C2H6)	4.16
Propane (C3H8)	0.84
N-Butane (C4H10)	0.18
N-Pentane (C5H12)	0.04
Hexane (C6H14)	0.04
Carbon Dioxide (CO2)	0.44
Hydrogen Sulfide (H2S)	0.0001
Nitrogen (N2)	1.51

Fuel Gas Properties

LHV (Btu/Scf)	939.2	Specific Gravity	0.5970	Wobbe Index at 60F	1215.6

This performance was calculated with a basic inlet and exhaust system. Special equipment such as low noise silencers, special filters, heat recovery systems or cooling devices will affect engine performance. Performance shown is "Expected" performance at the pressure drops stated, not guaranteed.

Duct Burner and Solar Mars 100 Startup, Shutdown Procedures

- DUCT BURNER WILL KICK OUT WHEN DRUM PRESSURE > 275 LBS,
- DUCT BURNER WILL NOT KICK OUT DURING SHEET BREAKS MUFFLER VALVE WILL BE USED TO CONTROL HEADER PRESSURE.

7.3 Operation and Control

7.3.1 Duct Burner Systems

During normal operation, gas turbine exhaust is the primary source of heat for steam generation in each HRSG boiler. The amount of heat that the duct burner must produce varies with steam usage as well as the temperature and flow rate of the gas turbine exhaust. When steam usage is high, the DCS increases the flow rate of fuel gas to the duct burner to keep up with the steam demand. When steam usage is low, the DCS decreases the flow rate of fuel gas to the duct burner.

During "paper break," steam demand will decrease considerably, and the pressure in the main steam header will increase. If the pressure in the main steam header increases to 265 psig, the muffler valve on the main steam header will open and release steam to the atmosphere. During this period, the HRSGs will continue to produce steam, but at a low rate. After "paper break," steam demand increases, and the pressure in the main steam header will decrease. When the pressure decreases below 265 psig, the muffler valve will close. The DCS will then increase the firing rate of the HRSGs to meet the steam demand.

7.3.1.1 Limits

The following limits must be satisfied for each duct burner to operate:

- Gas turbine speed greater than 90%
- Gas turbine exhaust pressure greater than 4.0 in. water column
- Fuel gas pressure between 8 and 11 psig
- Instrument air pressure above 20 psig

If all of the above limits are satisfied, the "limits satisfied" light (*IL-64*) should be on. In the event of a limit failure, the burner will shut down, the alarm horn (*AH-27*) will sound, and the "flame out reset" illuminated push-button (*IL-74/PB-36*) will come on. Silence the alarm by pressing the "alarm silence" push-button (*PB-35*).

To re-start the burner after a limit failure, the operator can press the "flame out reset" push-button (*PB-36*) and the "purge start" push-button (*IL-65/PB-34*) to initiate pre-purge timing. Upon completion of the one-minute purge, the "purge" light (*IL-65*) goes

out as the "purge completed" light (*IL-66*) comes on. The pilot establishing period will now begin, and the "pilot on" light (*IL-18*) will come on. The electrical transformer will provide a spark to light the pilot. When the pilot flame is detected, the "main fuel on" light (*IL-19*) will come on and the burner establishing period will begin. The "pilot on" light (*IL-18*) should then go off and the burner should light. After the burner lights, the fuel control valve leaves the "low fire light" position and is controlled from the DCS.

The pilot and burner establishing periods are limited to 10 seconds. If the pilot flame or burner flame is not detected within that period of time, the burner system will shut down, the local alarm will sound, and the "flame out reset" illuminated push-button (*IL-74/PB-36*) will come on. If flame out occurs, press the "flame out reset" push-button (*IL-74/PB-36*) and repeat the purge and light process.

7.3.1.2 Burner Off - On

Turning the burner selector (*SS-48*) to the "off" position will cause the burner to shut down, but no alarm will sound. Turning the burner selector back to the "on" position will initiate an automatic burner light, provided that the limits are satisfied.

7.3.1.3 Emergency Trip

Depressing the "emergency trip" push-button (*PB-19*) will result in a flame out shutdown. The alarm horn (*AH-27*) will sound, and the "flame out reset" illuminated push-button (*IL-74/PB-36*) will come on. Silence the alarm by pressing the "alarm silence" push-button (*PB-35*).

To re-start the burner after an emergency trip, press the "flame out reset" push-button (*PB-36*). The burner should automatically re-light after this push-button is pressed.

7.3.1.4 Steam Demand

The "steam demand" light (*IL-67*) will be on when the burner is operating properly and when the pressure in the steam drum is below the 275 psig set pressure of *PSHH-0806* on *HRSG-1* (*PSHH-1006* on *HRSG-2*). If the steam pressure in the steam drum rises above this point, the "steam demand" light will turn off, and the duct burner will shut down. The burner should automatically re-start when the pressure decreases to the switch's reset pressure.

Note: Since the automatic re-start of the duct burner occurs slowly, the main steam system is designed to vent steam to the atmosphere during low steam demand to keep the duct burners from shutting down. The muffler valve in the main steam header should release steam to the atmosphere before the pressure in the main steam header reaches 275 psig. Therefore, during normal operation, the steam demand light should remain on at all times.

7.3.1.5 Flame Out

Each HRSG's burner is equipped with redundant flame scanners and flame detection modules (*FMD-3/6*). During burner operation, if one of the two modules fails to monitor the flame, the alarm will sound, and the "scanner failure" light (*IL-75*) will be illuminated. Silence the alarm by pressing the "alarm silence" push-button (*PB-35*).

If neither flame scanner detects a flame, the burner will shut down, the alarm horn (*AH-27*) will sound, and the "flame out reset" illuminated push-button (*IL-74/PB-36*) will come on. Silence the alarm by pressing the "alarm silence" push-button (*PB-35*).

To re-start the burner after a flame failure, press the "flame out reset" push-button (*PB-36*). The burner should automatically re-light after this push-button is pressed.

7.3.1.6 Scanner Cooler Blowers

The scanner cooler blowers are the primary sources of cooling air for the flame scanners. During normal operation, the scanner cooling blowers are running, and the "scanner blower" illuminated push-buttons (*IL-62/PB-37*) are on. *PSL-0708* on *HRSG-1* (*PSL-0908* on *HRSG-2)* monitors the discharge pressure of the blower. If the pressure decreases below 0.75 psig, the duct burner control system will automatically shut down the scanner cooler blower and switch over to instrument air for scanner cooling. The "auxiliary scanner cooling air valve on" light (*IL-77*) indicates that instrument air is being used for scanner cooling.

7.3.2 HRSG Boilers and Economizers

7.3.2.1 Level Control

The liquid level in the steam drum rises and falls with steam production and pressure variations. Feed water flow must be properly controlled to maintain the level of the water as close as is possible to the normal water level (NWL) set point. The DCS controls the liquid level by using a combination of single- and three-element control. For more information on steam drum level control, refer to Section 3.5 of this manual.

Level gauges *LG-0801* and *LG-0802* on *HRSG-1* (*LG-1001* and *LG-1002* on *HRSG-2*) indicate the liquid level in the steam drum for visual confirmation by the operator. The operating level should register near the middle of the level gauge. If the liquid level rises or falls to a level outside of the normal operating range, an alarm will be sent to the DCS. If the liquid level drops below the lowest level for safe operation, *LSLL-0803* and *LSLL-0809* on *HRSG-1* (*LSLL-1003* and *LSLL-1009* on *HRSG-2*) will shut down the duct burner and gas turbine, and an alarm will sound.

7.3.2.2 Steam Pressure Control

The pressure in the steam drum varies with steam demand, the firing rate of the duct burners, and the amount of waste heat in the exhaust from the gas turbines. The DCS controls the firing rate and steam pressure. For more information on steam pressure control and firing rates, refer to Section 3.5 of this manual.

7.3.3 Boiler Water Blowdown

Boiler water is blown down to remove some of the concentrated water from the mud drum and steam drum while the vessel is under pressure. The removed water, which contains suspended solids, is replaced with relatively pure feed water so that a lowering of the solids concentration occurs. Solids are brought in with the feed water even though the water is treated prior to use through external processes designed to remove the unwanted substances, which contribute to scale and deposit formations. Regardless of their high efficiency, none of these processes is capable of removing all solids, so a small amount of solids will always enter into the boiler water. The solids become less soluble due to the high temperatures in the boiler, and, as the water boils off as relatively pure steam, the remaining water becomes thicker with suspended or dissolved solids. These solids can become scale if not properly treated.

Internal chemical treatment, based on water analysis, is used primarily to precipitate many of the solids and to maintain them as sludge in a fluid form. This sludge, along with suspended solids that may be present, must be removed in the blowdown process. If the concentration of solids is not lowered by blowdown, foaming and priming will occur, and scale and other harmful deposits will form.

The scale-forming salts tend to concentrate and crystallize on the heating surfaces. Scale has a low heat transfer value, so it acts as an insulation barrier and retards heat transfer. This process not only results in low operating efficiency and higher fuel consumption but also increases the likelihood of overheating the boiler metal. The result of such overheating can be tube failure or other pressure vessel metal damage.

There are two types of blowdown, intermittent and continuous.

7.3.3.1 Intermittent Blowdown

Normally, the intermittent blowdown system will be operated once per shift. The operator manually opens the blowdown valves located at the bottom of the mud drum. This action allows accumulated solids to exit the steam system through Blowdown Tank *T-5B* for *HRSG-1 (T-5C* for *HRSG-2)*.

The two blowdown valves for each HRSG are of a special type designed for high pressures and high flow rates.

Follow these steps to perform an intermittent blowdown for one HRSG (be sure to observe the water level throughout the blowdown process):

1. Open the blowdown valve that is nearer to the HRSG boiler.

2. Slowly crack open the blowdown valve that is farther from the HRSG boiler, allowing the steam line to heat up.

3. Open the cracked blowdown valve fully. Close it after about 20 seconds.

4. Quickly close the blowdown valve nearer to the boiler.

Note: As water treating experience is gained, it may be necessary to shorten or lengthen the blowdown period.

7.3.3.2 Continuous Blowdown

Continuous blowdown is the continuous and automatic removal of concentrated boiler water. Each HRSG boiler is equipped with an internal continuous blowdown pipe. The collector portion of the blowdown pipe is located several inches below the normal water level, at a point where the most concentrated water is found. A small amount of blowdown flows through a sample cooler, in which it is cooled. A conductivity analyzer, *AT-0817* on *HRSG-1* (*AT-1017* on *HRSG-2*), measures the conductivity of the blowdown. The DCS then controls the blowdown rate by opening or closing the automatic continuous blowdown valve.

7.4 Start-Up and Shutdown

7.4.1 *HRSG-1* Start-Up

Follow these steps to start *HRSG-1*:

1. At the duct burner skid (*DBS-1*), place the control power circuit breaker (*CB-1*) in the "on" position. Power should now be available to the control panel, and the "power on" light (*IL-2*) should be illuminated.

2. Start the scanner cooler blower (*SCB-1*) by depressing and holding in the "scanner cooler blower start" push-button (*IL-62/PB-37*) for about ten seconds. When the scanner cooler blower starts, the push-button should illuminate. If the blower does not start within five seconds after the "start" push-button is pressed, the auxiliary scanner cooling air solenoid valve will be energized, and the "auxiliary scanner cooling air valve on" light (*IL-77*) should come on.

3. At the *HRSG-1* boiler, check and close the manual blowdown valves on the mud drum.

4. Check and close the continuous blowdown valves.

5. Check and close the gauge cocks and the water column and gauge glass drain valves.

6. Open the upper drum vent valve, the water column shut-off valves, the gauge glass shut-off valves, and the steam pressure gauge valve.

7. Confirm that the block valve downstream of the check valve in the steam outlet line is open. Confirm that the block valve upstream of the check valve in the steam outlet line is closed.

8. Open the isolation valve just downstream of the feed water level control valve. By manually operating Level Control Valve *LV-0810*, slowly fill the *HRSG-1* boiler steam drum with treated water. The filling rate depends on the temperature of the water. The feed water temperature should be close to that of the boiler's metal to prevent metal stresses that may cause tube leakage. The minimum recommended feed water temperature is 70 °F. Fill the drum slowly and vent it fully to prevent pressure build-up due to flashing of warm feed water. Fill the drum to just below the normal operating level to leave room for the water to expand when it is brought up to temperature.

9. Blow down the gauge glasses and watch the return of the liquid to make sure that the gauge glasses are clear and functioning properly. The gauge cocks should then be operated to verify the water level.

10. When the unit is filled and the level is stabilized, place the feed water level control valve *(LV-0810)* in "automatic."

11. Start the gas turbine (*CT-1*) in accordance with Section 6 of this manual.

12. Observe the steam drum vent to detect steam generation. When the pressure in the steam drum increases to 20 psig, close the vent valve and open the block valve upstream of the check valve in the steam outlet line.

13. Place the continuous blowdown valves back in operation and check the water level in the steam drum.

> NOTE: The gas turbine exhaust should provide enough heat to bring the HRSG up to operating temperature and pressure. To keep the HRSG from being heated too rapidly, do not fire the duct burner until the HRSG reaches operating temperature and pressure. Once the HRSG reaches operating temperature and pressure, proceed with the following steps.

14. From the DCS, place *HIC-0712* in the "manual" mode and set it to about 20%.

15. At the duct burner skid (*DBS-1*), confirm that the "limits satisfied" light (*IL-64*) on the duct burner control panel is illuminated.

16. Turn the burner switch (*SS-48*) to "on."

17. Press the "purge start" push-button (*IL-65/PB-34*) to initiate the pre-purge timing. Upon completion of the one-minute purge, the "purge" light (*IL-65*) should go out as the "purge completed" light (*IL-66*) comes on. The pilot establishing period will begin, and the "pilot on" light (*IL-18*) will come on. When the pilot flame is detected, the "main fuel on" light (*IL-19*) will come on, and the burner establishing period will now begin. The "pilot on" light (*IL-18*) should then go off, and the burner should light. After the burner lights, the fuel control valve leaves the "low fire light" position and is controlled from the DCS.

    The pilot and burner establishing periods are limited to ten seconds. If the pilot flame or burner flame is not detected within that period of time, the burner system will shut down, the local alarm will sound, and the "flame out reset" illuminated push-button (*IL-74/PB-36*) will come on. If flame out occurs, press this push-button and repeat the purge and light process.

18. From the DCS, place *HIC-0712* in the "automatic" mode.

7.4.2 *HRSG-1* Shutdown

Follow these steps to shut down *HRSG-1*:

1. At the duct burner skid (*DBS-1*), turn the "duct burner off-on" switch (*SS-48*) to "off."

2. Shut down the gas turbine (*CT-1*).

3. At the *HRSG-1* boiler, blow down the boiler and the gauge glasses.

4. Close the continuous blowdown valve.

5. Close the isolation valve just downstream of the feed water level control valve.

6. Close the block valve upstream of the check valve in the steam outlet line. The steam pressure should be allowed to drop naturally. Do not open the vents or initiate any intentional means of taking steam from the unit to speed the lowering of the steam pressure. Excessive opening of vents (which can raise the cooling rate) should be avoided to limit drum distortion and resulting strains on the tube joints. The cooling rate should not exceed 150 °F per hour.

7. When the steam pressure drops to 15 to 20 psig, open the steam drum vent.

8. At the duct burner skid, place the control power circuit breaker (*CB-1*) in the "off" position.

9. If needed, drain the boiler. The boiler should be drained only after the water has cooled.

7.4.3 *HRSG-2* Start-Up

Follow these steps to start *HRSG-2*:

1. At the duct burner skid (*DBS-2*), place the control power circuit breaker (*CB-1*) in the "on" position. Power should now be available to the control panel, and the "power on" light (*IL-2*) should be illuminated.

2. Start the scanner cooler blower (*SCB-2*) by depressing and holding in the "scanner cooler blower start" push-button (*IL-62/PB-37*) for about ten seconds. When the scanner cooler blower starts, the push-button should illuminate. If the blower does not start within five seconds after the "start" push-button is pressed, the auxiliary scanner cooling air solenoid valve will be energized, and the "auxiliary scanner cooling air valve on" light (*IL-77*) should come on.

3. At the *HRSG-2* boiler, check and close the manual blowdown valves on the mud drum.

4. Check and close the continuous blowdown valves.

5. Check and close the gauge cocks and the water column and gauge glass drain valves.

6. Open the upper drum vent valve, the water column shut-off valves, the gauge glass shut-off valves, and the steam pressure gauge valve.

7. Confirm that the block valve downstream of the check valve in the steam outlet line is open. Confirm that the block valve upstream of the check valve in the steam outlet line is closed.

8. Open the isolation valve just downstream of the feed water level control valve. By manually operating Level Control Valve *LV-1010,* slowly fill the *HRSG-2* boiler steam drum with treated water. The filling rate depends on the temperature of the water. The feed water temperature should be close to that of the boiler's metal to prevent metal stresses that may cause tube leakage. The minimum recommended feed water temperature is 70 °F. Fill the drum slowly and vent it fully to prevent pressure build-up due to flashing of warm feed water. Fill the drum to just below the normal operating level to leave room for the water to expand when it is brought up to temperature.

9. Blow down the gauge glasses and watch the return of the liquid to make sure that the gauge glasses are clear and functioning properly. The gauge cocks should then be operated to verify the water level.

10. When the unit is filled and the level is stabilized, place the feed water level control valve *(LV-1010)* in "automatic."

11. Start the gas turbine (*CT-2*) in accordance with Section 6 of this manual.

12. Observe the steam drum vent to detect steam generation. When the pressure in the steam drum increases to 20 psig, close the vent valve and open the block valve upstream of the check valve in the steam outlet line.

13. Place the continuous blowdown valves back in operation and check the water level in the steam drum.

> NOTE: The gas turbine exhaust should provide enough heat to bring the HRSG up to operating temperature and pressure. To keep the HRSG from being heated too rapidly, do not fire the duct burner until the HRSG reaches operating temperature and pressure. Once the HRSG reaches operating temperature and pressure, proceed with the following steps.

14. From the DCS, place *HIC-0912* in the "manual" mode and set it to about 20%.

15. At the duct burner skid (*DBS-2*), confirm that the "limits satisfied" light (*IL-64*) on the duct burner control panel is illuminated.

16. Turn the burner switch (*SS-48*) to "on."

17. Press the "purge start" push-button (*IL-65/PB-34*) to initiate the pre-purge timing. Upon completion of the one-minute purge, the "purge" light (*IL-65*) should go out as the "purge completed" light (*IL-66*) comes on. The pilot establishing period will begin, and the "pilot on" light (*IL-18*) will come on. When the pilot flame is detected, the "main fuel on" light (*IL-19*) will come on, and the burner establishing period will now begin. The "pilot on" light (*IL-18*) should then go off, and the burner should light. After the burner lights, the fuel control valve leaves the "low fire light" position and is controlled from the DCS.

    The pilot and burner establishing periods are limited to 10 seconds. If the pilot flame or burner flame is not detected within that period of time, the burner system will shut down, the local alarm will sound, and the "flame out reset" illuminated push-button (*IL-74/PB-36*) will come on. If flame out occurs, press this push-button and repeat the purge and light process.

18. From the DCS, place *HIC-0912* in the "automatic" mode.

7.4.4 *HRSG-2* Shutdown

Follow these steps to shut down *HRSG-2*:

1. At the duct burner skid (*DBS-2*), turn the "duct burner off-on" switch (*SS-48*) to "off."
2. Shut down the gas turbine (*CT-2*).
3. At the *HRSG-2* boiler, blow down the boiler and the gauge glasses.
4. Close the continuous blowdown valve.
5. Close the isolation valve just downstream of the feed water level control valve.
6. Close the block valve upstream of the check valve in the steam outlet line. The steam pressure should be allowed to drop naturally. Do not open the vents or initiate any intentional means of taking steam from the unit to speed the lowering of the steam pressure. Excessive opening of vents (which can raise the cooling rate) should be avoided to limit drum distortion and resulting strains on the tube joints. The cooling rate should not exceed 150 °F per hour.
7. When the steam pressure drops to 15 to 20 psig, open the steam drum vent.
8. At the duct burner skid, place the control power circuit breaker (*CB-1*) in the "off" position.
9. If needed, drain the boiler. The boiler should be drained only after the water has cooled.

4.3.2 Preparation For Start

WARNING

Before starting the turbine and driven equipment, contact maintenance personnel or use written records to make sure that all maintenance items have been completed. Physically inspect the turbine and driven equipment to make sure that there are no maintenance tags attached to any equipment that indicate equipment should not be energized or started. Injury to personnel or damage to equipment may result if warning is not obeyed.

This subsection gives the procedures to prepare the turbine and driven equipment for a start at the unit control panel.

1. Contact maintenance personnel and make sure that all maintenance items have been completed and that there are no maintenance tags attached to any equipment that indicate equipment should not be energized or started.

2. Do the unit control panel activation procedures listed in Subsection 4.3.1.

3. At the unit control panel, click the *TCP* button. When you click the *TCP* button, the Turbine Control Panel window opens. Make sure [Local] is shown on the Turbine Control Panel window for ACTIVE CONTROL.

4. Go to the Maintenance screen, and click the *Lamp Test* button. When you click the *Lamp Test* button, a pop-up window opens. Click the *Lamp Test* button in the pop-up window. When you click the *Lamp Test* button in the pop-up window, a dialog window opens. Click the *OK* button. Make sure the background of the *Lamp Test* button changes to green and that all indicator lights come on.

5. Go to the Fuel System or Gas Fuel Details screen, and make sure that the fuel pressure is within operating limits.

NOTE

An alarm or shutdown will be indicated on the Alarm Bar if the fuel pressure is out of operating limits.

6. To acknowledge and clear any alarm or shutdown indications, do one of the following procedures:

   - On the unit control panel software screen, click the *TCP* button. When you click the *TCP* button, the Turbine Control Panel window opens. Click the *Acknowledge* button, and then click the *Reset* button.

   - At the unit control panel, push the ACKNOWLEDGE Switch (SB0473), and then push the RESET Switch (SB0474).

7. Go to the Alarm Bar, and check for alarm and shutdown indications. Correct any alarm and shutdown indications that remain.

NOTE

For a list of alarms and shutdowns, refer to the Software Cause and Effect Drawing that is provided in the RSLogix/9000_999/Reports folder of the Project CD-ROM.

8. At the unit control panel, make surethat [Ready] shows on the screen header.

NOTE

If all shutdown indications have not been cleared from the Alarm Bar, [Ready] will not show on the screen header.

4.3.3 Start Procedures

This subsection gives the procedures to start the turbine and driven equipment at the unit control panel.

NOTE

You can do a restart one minute after the turbine speed drops to 15 percent. In case of a malfunction shutdown, do not attempt another restart until the cause of the malfunction has been determined and the condition has been corrected. After three attempted starts have been unsuccessful, it is possible you will have to do additional troubleshooting.

NOTE

In the following procedure, screen indications are shown in brackets [ ].

1. Do the prestart procedures listed in Subsection 4.3.2.
2. Go to the Maintenance screen, and click the *Fail To Load Shutdown* button. When you click the *Fail To Load Shutdown* button, a pop-up window opens.
3. On the Fail To Load Shutdown pop-up window, click the *Enable* button. When you click the *Enable* button, a dialog window opens. Click the *OK* button. Make sure the background of the *Enable* button changes to green.
4. Go to the Yard Valves screen, and click the *Auto* button for Seal System. When you click the *Auto* button, a dialog window opens. Click the *OK* button. Make sure the background of the *Auto* button changes to green.
5. On the Yard Valves screen, click the *Auto* button for Yard Valve. When you click the *Auto* button, a dialog window opens. Click the *OK* button. Make sure the background of the *Auto* button changes to green.
6. Go to the Compressor Surge screen, and click the *Auto* button for Anti-Surge Control. When you click the *Auto* button, a dialog window opens. Click the *OK* button. Make sure the background of the *Auto* button changes to green.
7. Go to the Engine Summary screen to monitor the turbine during the start sequence.
8. Start the turbine.

    a. To start the turbine, do one of the following procedures:

    - On the unit control panel software screen, click the *TCP* button. When you click the *TCP* button, the Turbine Control Panel window opens. Click the *Start* button. When you click the *Start* button, a dialog window opens. Click the *OK* button.
    - At the unit control panel, push the START/STARTING Switch/Light (SH0471).

    b. The following events will occur:

    - The START/STARTING Switch/Light (SH0471) begins flashing, and [Starting] shows on the screen header.

- The backup lube oil pump is tested for operation. The pre/post lube oil pump starts, and the prelubrication cycle begins.
- The control system begins a fuel system check.
- The start system is energized.
- After the prelube cycle is complete, the turbine begins to crank.
- After the starter has cranked the turbine to 15 percent speed, the purge timer provides a preselected period of exhaust system purging via turbine airflow. [Purge Crank] shows on the screen header.
- After the purge cycle is completed, fuel is admitted into the combustor chamber, where it is mixed with compressed air and ignited. Lightoff occurs within the next few seconds and combustion begins.

NOTE

Before the start sequence can begin, the control system must receive start permissive signals from the system safeties. If the signals are not received, the control system will inhibit the turbine start. Fuel will not be admitted into the combustor chamber and the ignition sequence will be aborted.

- The turbine accelerates, and T5 increases to 400°F (204°C). [Ignition] shows on the screen header.
- The fuel ramp is activated, and the ignition is de-energized.
- The ENGINE HOURS/START COUNTER Meter (PC0470) registers a successful start.
- The turbine speed increases to starter dropout speed.
- The engine-driven lube oil pump pressure increases, and the pre/post lube oil pump stops.
- The start system is de-energized, and the starter clutch overruns.
- The turbine speed increases to idle speed.
- The ENGINE HOURS/START COUNTER Meter (PC0470) begins to log turbine operating hours.
- The START/STARTING Switch/Light (SH0471) goes out, and [Running] shows on the screen header.

9. Do the operational checkout procedures listed in Subsection 4.3.4.
10. Read the following NOTE:

NOTE

The control system adjusts Ngp based upon the selected Ngp setpoint source. The Gas Producer Speed box on the Speed Control screen shows the selected Ngp setpoint source. After [Ready to Load] is shown on the screen header, the operator can adjust Ngp. Refer to NGP SETPOINT ADJUSTMENT procedure in Subsection 4.3.5.

4.3.4 Operational Checkout

For safe operation, do the following operational checkout procedures each time the turbine and driven equipment are started. If the turbine is continuously running, do an operational checkout daily to verify normal operation.

1. Record turbine and driven equipment speeds, pressures, temperatures, and vibration readings for comparison with normal or designed operating values. If deviations exist, shut down the turbine and driven equipment, and determine the cause.

2. Record seal gas differential pressure, buffer air differential pressure, suction primary seal leakage flow, discharge primary seal leakage flow, seal gas filter differential pressure, and buffer air filter differential pressure for comparison with established norms. If deviations exceed norms, shut down the turbine and driven equipment, and determine the cause.

3. Check for leaks from air, oil, and fuel plumbing.

4. Make sure you operate the unit safely at all times.

4.3.5 Manual Ngp Control Procedures

NGP SETPOINT SOURCE SELECTION

This subsection gives the procedure to select the desired Ngp setpoint source from the unit control panel.

NOTE

An external setpoint source lets the control system use an external, customer-furnished, 4 to 20 milliampere input signal as an Ngp or process setpoint source. If you disable the external setpoint source, the unit control system will use the Ngp or process setpoint of the active control panel, whether it is from the unit control panel, the auxiliary unit control panel, or the remote unit control panel. The unit control system lets only one control panel be active at a time.

The buttons for the external setpoint source appear on the Setpoints pop-up window under the heading **Hardwired/External Setpoints**.

1. At the unit control panel, go to the Speed Control or Control System screen.

2. Click the *Setpoints* button. When you click the *Setpoints* button, a Setpoints pop-up window opens.

3. Select the setpoint source that you want:

   - Click the Hardwired/External Setpoints *Disable* button if you want the setpoint source to be the active unit control panel.

   - Click the Hardwired/External Setpoints *Enable* button if you want the setpoint source to be a hardwired or external 4 to 20 milliampere input signal.

4. Make sure the button you selected changes to green.

NGP SETPOINT ADJUSTMENT

This subsection gives the procedure to manually adjust the Ngp setpoint from the unit control panel.

NOTE

On the Speed Control screen, make sure the Gas Producer Speed setpoint source that you want shows in the Gas Producer Speed box. If [External SP] is shown in the Gas Producer Speed box, do the NGP SETPOINT SOURCE SELECTION procedure listed in Subsection 4.3.5 to disable the external setpoint source.

Do one of the following procedures to adjust the Ngp setpoint from the unit control panel.

- From the Gas Producer Speed box on the Speed Control screen:
    1. At the unit control panel, go to the Speed Control screen.
    2. In the Gas Producer Speed box, click in the Speed entry field. When you click in the Gas Producer Speed entry field, a setpoint pop-up window opens.
    3. In the setpoint pop-up window, enter the new Ngp setpoint.
    4. Click the *OK* button.
    5. Make sure the new value appears in the Gas Producer Speed box.
- From the *Setpoints* button on the Speed Control or Control System screen:
    1. At the unit control panel, go to the Speed Control or Control System screen.
    2. Click the *Setpoints* button. When you click the *Setpoints* button, a Setpoints pop-up window opens.
    3. Click in the entry field for Speed. When you click in the entry field for Speed, a setpoint pop-up window opens.
    4. In the setpoint pop-up window, enter the new Ngp setpoint.
    5. Click the *OK* button.
    6. Make sure the new value appears in the Setpoints pop-up window.
- At the unit control panel, rotate the SPEED / LOAD DECREASE / INCREASE Switch (SA0471) as needed to achieve the Ngp setpoint you want.

4.3.6 Customer Setpoint Tracking

This subsection gives the procedure to enable or to disable the Customer Setpoint (CSP) Tracking feature from the unit control panel.

When CSP Tracking is enabled, the control system continually transmits all Ngp and process control setpoints from the active control panel (local, auxiliary, or remote) to the customer control device. This feature makes sure that all control devices have the same setpoints so that unit speed does not change when control is transferred between devices.

1. At the unit control panel, go to the Speed Control or Control System screen.
2. Click the *Setpoints* button. When you click the *Setpoints* button, a pop-up window opens.
3. In the Setpoints pop-up window, click the CSP Tracking *Enable* button to enable customer setpoint tracking, or click the CSP Tracking *Disable* button to disable customer setpoint tracking.

4. Make sure the button you selected changes to green.

4.3.7 Shutdown Procedures

This subsection gives the shutdown procedures for the turbine and driven equipment. There are four types of shutdown procedures: normal stop, pressurized fast stop, emergency stop, and control system stop.

NORMAL STOP

A normal stop shutdown sequence includes a cooldown period, which allows the turbine and driven equipment to run with no load for a preset period before the turbine is stopped.

NOTE

In the following procedure, screen indications are shown in brackets [ ].

To do a normal stop from the unit control panel, do one of the following procedures:

- On the unit control panel software screen, click the *TCP* button. When you click the *TCP* button, the Turbine Control Panel window opens. Click the *Normal Stop* button. When you click the *Normal Stop* button, a dialog window opens. Click the *OK* button.
- At the unit control panel, push the STOP/STOPPING Switch/Light (SH0470).

The following events will occur:

- The [Cooldown] indication shows on the Operation Sequence screenand the surge control valve opens.
- The turbine slows to idle speed and continues to run for a preset cooldown cycle.

NOTE

You can restart the turbine during the cooldown cycle by pushing the ACKNOWLEDGE Switch (SB0473) and then the START/STARTING Switch (SH0471), or by clicking the *Acknowledge* and *Start* buttons on the Turbine Control Panel window.

It is not necessary to do a reset for any unit that has a normal stop shutdown.

- After the preset cooldown cycle, the fuel system valves close, combustion ceases, and the turbine begins to decelerate. The [Cooldown] indication no longer shows on the Operation Sequence screen.

WARNING

Do not do any maintenance tasks on the turbine and driven equipment while the turbine is in Slow Roll mode. Execution of such tasks during Slow Roll mode can result in serious injury and/or death.

- When the turbine speed decreases below 25 percent, [Slow Roll] shows on the Operation Sequence screen.

NOTE

The variable frequency drive (VFD) commands the start motor to a speed of ~2 to 3.5 percent Ngp. As the turbine speed continues to slow from 25 percent, the overrunning clutch continues to overrun until the turbine speed matches the starter speed. The clutch engages and the starter maintains the commanded speed until the slow roll timer times out.

To bypass the Slow Roll cycle, do the following steps:

1. Go to the Maintenance screen, and click the *Slow Roll* button. When you click the *Slow Roll* button, a pop-up window opens.
2. Click the *Interrupt* button. When you click the *Interrupt* button, a dialog window opens.
3. Click the *OK* button.
4. Make sure the background of the *Interrupt* button changes to green.

- After the preset slow roll cycle, the start motor is de-energized. The STOP/STOPPING Switch/Light (SH0470) comes on. The [Slow Roll] indication no longer shows and [Stopping] shows on the Operation Sequence screen.
- The gas compressor suction valve and discharge valve close, and the vent valve remains closed, to maintain pressure in the gas compressor and process piping for a preselected pressurization hold time period.
- The [Running] indication no longer shows on the Operation Sequence screen. The ENGINE HOURS/START COUNTER Meter (PC0470) stops logging operating time.
- After the turbine coasts to a stop and the rundown timer expires, a preset postlubrication cycle begins.
- After the preselected pressurization hold time period ends, the vent valves and blowdown valves open to depressurize the compressors and process piping, and the seal system is de-energized.

PRESSURIZED FAST STOP

NOTE

The unit control panel system does not include a pressurized fast stop switch. However, a FAST STOP Switch (SB7513) is installed at another location, and a pressurized fast stop can be activated.

A pressurized fast stop causes the unit to stop with the compressor pressurized, while the vent valves and blowdown valves remain closed.

NOTE

In the following procedure, screen indications are shown in brackets [ ].

To do a pressurized fast stop, go to the location of the FAST STOP Switch (SB7513), and push the switch. The following events will occur:

- The compressor suction and discharge valves close, and the vent and blowdown valves remain closed, to maintain pressure in the gas compressors and process piping for a preselected pressurization hold time period.
- The turbine shuts down immediately with no cooldown cycle. The slow roll cycle is bypassed, and [Stopping] shows on the screen header.
- The ENGINE HOURS/START COUNTER Meter (PC0470) stops logging operating time.
- After the turbine coasts to a stop and the rundown timer expires, a preset postlubrication cycle begins.

- After the preselected pressurization hold time period ends, the vent valves and blowdown valves open to depressurize the compressors and process piping, and the seal system is de-energized.

EMERGENCY STOP

An emergency stop does not include a cooldown period, which allows the turbine and driven equipment to run with no load for a preset period before the turbine is stopped. Do an emergency stop shutdown only when plant conditions require an immediate shutdown.

NOTE

An emergency stop prevents turbine operation until the emergency stop shutdown is acknowledged and reset (by pushing the local ACKNOWLEDGE and RESET switches or buttons) and the backup relay system is reset.

NOTE

In the following procedure, screen indications are shown in brackets [ ].

To do an emergency stop from the unit control panel, push the EMERGENCY STOP Switch (SB0472). The following events will occur:

- The pressurized hold sequence is bypassed. The compressor suction valve closes, the discharge valve closes, and the vent valve opens.
- The turbine shuts down immediately with no cooldown cycle. The slow roll cycle is bypassed, the STOP/STOPPING Switch/Light (SH0470) comes on, and [Stopping] shows on the screen header.
- The ENGINE HOURS/START COUNTER Meter (PC0470) stops logging operating time.
- After the turbine coasts to a stop and the rundown timer expires, a preset postlubrication cycle begins.

CONTROL SYSTEM STOP

There are two types of control system stops: cooldown stop and fast stop. If an unsafe operating condition is detected by the control system, the control system initiates a shutdown. Depending upon the severity of the shutdown, the control system initiates either a cooldown stop or a fast stop. If the control system stop was initiated due to a condition that is self-correcting, the turbine can be restarted after the condition returns to normal. If the control system stop was initiated due to a condition that is not self-correcting, contact maintenance personnel to do the corrective actions.

NOTE

For a list of alarms and shutdowns, refer to the Software Cause and Effect Drawing that is provided in the RSLogix/9000_999/Reports folder of the Project CD-ROM.

Cooldown Stop

If a cooldown stop has been initiated, the turbine and driven equipment are unloaded and shut down in the same manner as a normal stop. There are two types of cooldown stops: cooldown nonlockout and cooldown lockout.

- **Cooldown Nonlockout (CN) -** Cooldown nonlockout shutdowns reduce turbine speed to idle for a preset cooldown period before initiating a shutdown. Cooldown nonlockout shutdowns include operator-initiated normal stops, operating conditions that reached a shutdown limit because maintenance was not done, a

momentary disruption that causes an out-of-limits condition, and operating conditions that exceed alarm levels but are not serious enough to cause any immediate damage. Cooldown nonlockout shutdowns can be reset after corrective action has been taken or operating conditions revert to normal using the local or remote ACKNOWLEDGE and RESET switches or buttons.

- **Cooldown Lockout (CL) -** Cooldown lockout shutdowns reduce turbine speed to idle for a preset cooldown period before initiating a shutdown. Cooldown lockout shutdowns typically result from a component failure and not because operating conditions have exceeded alarm or shutdown levels. Cooldown lockout shutdowns may not present immediate danger, but corrective action must be taken to avoid damage resulting from a component failure. Cooldown lockout shutdowns prevent turbine operation until the shutdown is acknowledged and reset using the local ACKNOWLEDGE and RESET switches or buttons.

NOTE

Remote ACKNOWLEDGE and RESET switches or buttons cannot acknowledge or reset cooldown lockout shutdowns.

Fast Stop

If a fast stop has been initiated, the turbine and driven equipment are unloaded and shut down in the same manner as an emergency stop. There are two types of fast stops: fast stop nonlockout and fast stop lockout.

WARNING

When a fast stop shutdown has been initiated due to fire detection, the postlube oil pump will remain energized for a preset rundown period. After the preset rundown period expires, the postlube oil pump(s) will be de-energized for 10 minutes. After the 10-minute time period expires, the postlube pump will cycle on and off for a preset postlube period.

On units that use pneumatically powered lube oil pump motor(s), if an unsafe condition still exists, the operator must manually abort the post lube cycle by closing the pneumatic supply valve(s) for the lube oil pump motor(s).

On units that use electrically powered lube oil pump motor(s), if an unsafe condition still exists, the operator must manually abort the post lube cycle by opening the facility contactor(s) for the lube oil pump motor(s).

NOTE

For a list of alarms and shutdowns, refer to the Software Cause and Effect Drawing that is provided in the RSLogix/9000_999/Reports folder of the Project CD-ROM.

- **Fast Stop Nonlockout (FN) -** Fast stop nonlockout shutdowns initiate an immediate shutdown of the turbine. Fast stop nonlockout shutdowns typically result from a disruption in operation due to abnormal operating conditions and may not require corrective action. Fast stop nonlockout shutdowns can be reset when operating conditions revert to normal using the local or remote ACKNOWLEDGE and RESET switches or buttons.

- **Fast Stop Lockout (FL) -** Fast stop lockout shutdowns initiate an immediate shutdown of the turbine. Fast stop lockout shutdowns prevent turbine operation until the shutdown is acknowledged and reset using the local ACKNOWLEDGE and RESET switches or buttons. In addition to using the local ACKNOWLEDGE and RESET switches or buttons, fast stop lockout shutdowns initiated by a microprocessor failure, fire detection, backup overspeed, or pushing the EMERGENCY STOP Switch will

require the backup relay system to be reset. Fast stop lockout shutdowns are the most severe shutdown types, and require corrective action before the turbine can be restarted.

NOTE

Remote ACKNOWLEDGE and RESET switches or buttons cannot acknowledge or reset fast stop lockout shutdowns.