EU-TURBINE Malfunction Abatement Plan

Prepared for:

Detroit Metropolitan Wayne County Airport

Romulus, Michigan

Project No. 05-3464.00
May 1, 2012

BT Environmental Consulting, Inc.
4949 Fernlee
Royal Oak, Michigan 48073
(248) 548-8070

TABLE OF CONTENTS

APPENDIX

1.0 Introduction

On October 28, 2010, The Air Quality Division (AQD) of Michigan's Department of Environmental Quality issued Permit No. 175-10 to Detroit Metropolitan Wayne County Airport (DTW) for the installation of a natural gas-fired turbine (EU-Turbine) at the DTW Powerhouse.

Regarding EU-Turbine, Permit No. 175-10 specifies that "The permittee shall not operate EU-Turbine unless a malfunction abatement plan (MAP) as described in Rule 911(2), has been submitted within 180 days of initial start-up, and is implemented and maintained. 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."

The purpose of this document is to summarize the malfunction abatement plan for the new DTW gas turbine. Section 2.0 of this document provides a description of EU-Turbine. Section 3.0 summarizes the preventative maintenance program for the turbine and Section 4.0 summarizes turbine operating variables. Section 5.0 summarizes corrective procedures.

2.0 Process Description

The new DTW gas turbine is a Titan Model 130-20501A Axial gas turbine manufactured by Solar Turbines. The gas turbine fires natural gas only and is nominally rated for a maximum heat input capacity of 145 MMBtu/hr. The generator is rated for a maximum electrical load of 15 MW at ISO Standard Day Conditions. Additional specifications for the Titan turbine are summarized in Appendix A.

In general, natural gas and combustion air are compressed and charged to the turbine combustor. The exhaust gases from the combustor pass through the power turbine. The single shaft through the power turbine section of the unit also drives the electrical generator. The turbine is equipped with Solar's SoLoNOx dry NOx control system. The emissions control is a lean premix combustion technology that is passive in nature and is effective provided that the turbine operating load and fuel/air mixture ratio are sufficient for the turbine to operate in SoLoNOx mode.

3.0 Preventative Maintenance Program

3.1 Identification of Supervisory Personnel

Overall supervision of the DTW Powerhouse is provided by:

John Philbrook
Power Plant Executive
Detroit Metropolitan Wayne County Airport
Building 611
Detroit, Michigan 48242
(734) 247-7146

3.2 Description of Items to Be Inspected

The turbine is periodically inspected for the condition of individual turbine components as summarized in Appendix B.

3.3 Frequency of Inspections

The inspections to be conducted and the frequency of the inspections are indicated on the maintenance/inspection checklist included in Appendix B.

3.4 Identification of Major Replacement Parts

Replacement of turbine components is not part of the normal operation of the turbine. Any major components that would need to be replaced would only be necessary in the case of catastrophic engine failure. In addition, the turbine is overhauled on a periodic schedule. Consequently, major replacement parts are not applicable to this unit.

4.0 Operating Variables

The only operating variable for the Titan Model 130-20501A Axial gas turbine is the turbine operating load. The SoLoNOx emissions control system will operate correctly provided that the turbine is operated at a load greater than 7.25 MW. To ensure that turbine operation is maintained in SoLoNOx mode, turbine operators will ensure that the turbine load is maintained above 7.25 MW using the form included as Appendix C.

5.0 Description of Corrective Procedures or Operational Changes

In the case of a turbine malfunction, the process will be shut down immediately until corrective actions are taken. If a malfunction occurs, information regarding the malfunction and the corresponding corrective action will be recorded on the form provided in Appendix D.

APPENDIX A
TITAN MODEL 130 SPECIFICATIONS

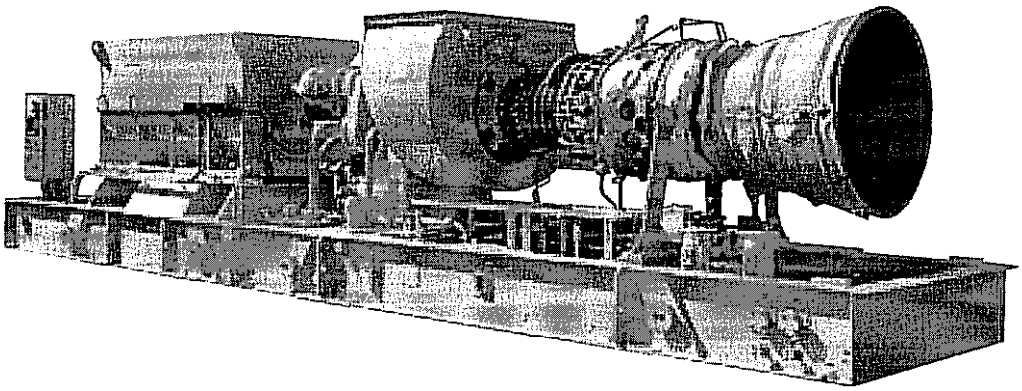
Solar Turbines

A Caterpillar Company

TITAN 130

Gas Turbine Generator Set

Power Generation



General Specifications

***Titan*™ 130 Gas Turbine**

- Industrial, Single-Shaft
- Axial Compressor
  - 14 Stages
  - Variable Geometry
  - Vertically Split Case
  - Pressure Ratio: 17.1:1
- Annular Combustion Chamber
  - Conventional or Lean-Premixed, Dry, Low Emission (*SoLoNOx*™)
  - 21 Fuel Injectors (Conventional)
  - 14 Fuel Injectors (*SoLoNOx*)
- Proximity Probe Vibration Transducers
- Turbine
  - 3 Stage, Axial Flow
  - Speed: 11,220

Main Reduction Drive

- Epicyclic
  - 1500 or 1800 rpm (50 or 60 Hz)
  - Acceleration Vibration Transducer

Generator

- Continuous Duty Rating
- Salient Pole, 3 Phase, 6 Wire, Wye Connected, Synchronous with Brushless Exciter
- Open Drip-Proof Construction
- Sleeve Bearings
- Velocity Vibration Transducers
- Permanent Magnet Generator
- NEMA Class F Insulation with F Rise

Package

- Steel Base Frame with Drip Pans
- Direct-Drive AC Start System
- Natural Gas Fuel System
- *Turbotronic*™ 4 Control System
  - ControlLogix Controller
  - Standard Display with Discrete Event Log, Strip Chart, Historical Trend, Maintenance Screen
  - Gas Turbine and Generator Control
  - Vibration and Temperature Monitoring
  - CGCM (Combination Generator Control Module) with Load Share, Auto Synchronization, Voltage Control, Reactive Power Control, kW Control
- Integrated Lube Oil System
  - Turbine-Driven Lube Pump
  - Pre/Post Lube Pump
  - Backup Lube Pump
  - Air/Oil Cooler
  - Integral Lube Oil Tank
  - Lube Oil Tank Heater
  - Oil Mist Eliminator
  - Simplex Lube Oil Filter
- Documentation
  - Drawings
  - Quality Control Data Book
  - Inspection and Test Plan
  - Test Reports
  - Operation and Maintenance Manuals
- Factory Testing of Turbine and Package

Optional Equipment

- Generator Options:
  - Standard Voltages: 11,000 V (50 Hz); 12,470, 13,200 or 13,800 V (60 Hz)
- Fuel Systems
  - Liquid
  - Dual (Gas/Liquid)
  - Alternate Fuels (such as naphtha, propane, low Btu gas)
- Lube Oil System
  - Water/Oil Lube Oil Cooler
  - Duplex Lube Oil Filters
  - Vent Flame Trap
- Control System
  - Auxiliary and Remote Display/Control Terminal
  - Heat Recovery Application Interface
  - Serial Link Supervisory Interface
  - Turbine Performance Map
  - Printer/Logger
  - Field Programming Terminal
  - Unfired Waste Heat Recovery System Control (Stand-Alone Panel)
  - Multi-Unit Applications: Load Shed Control (Stand-Alone Panel), Import/Export, kW/KVAR Control (Stand-Alone Panel)
- Accessory Equipment
  - 120-VDC Battery/Charger System
  - Turbine Cleaning System: On-Crank and On-Line
- Weatherproof Acoustic Enclosure
- Ancillary Equipment
  - Inlet and Exhaust Silencers
  - Self-Cleaning or Prefilter/Barrier Air Inlet Filter
  - Inlet Evaporative Cooler
  - Inlet Chiller Coils

Solar Turbines

A Caterpillar Company

TITAN 130

Gas Turbine Generator Set

Power Generation

Performance

Output Power	15 000 kWe
Heat Rate	10 230 kJ/kWe-hr (9695 Btu/kWe-hr)
Exhaust Flow	179 250 kg/hr (395,180 lb/hr)
Exhaust Temp.	495°C (925°F)

Nominal rating – per ISO
At 15°C (59°F), at sea level

No inlet/exhaust losses

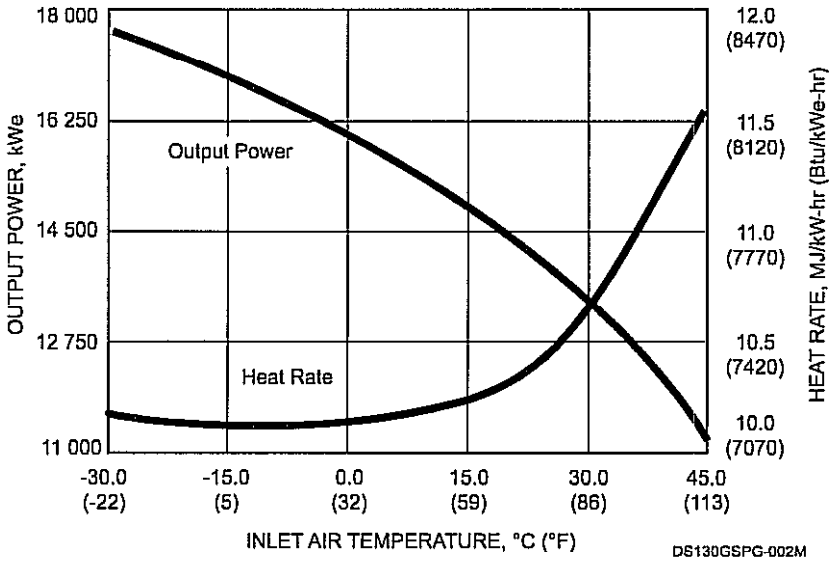
Relative humidity 60%

Natural gas fuel with
LHV = 35 MJ/nm³ (940 Btu/scf)

No accessory losses

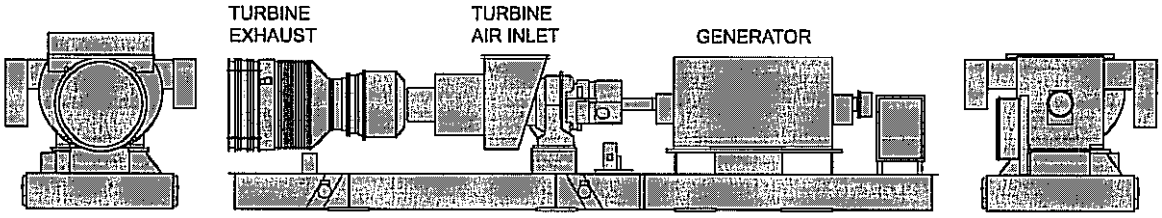
Engine efficiency: 35.2% (measured at generator terminals)

Available Power



DS130GSPG-002M

Typical Service Connections



DS130PG-003M

Package Dimensions

Length: 14.0 m (46' 0")

Width: 3.2 m (10' 7")

Height: 3.3 m (10' 9")

Typical Weight: 86 850 kg (191,465 lb)

Left Side

- Lube Oil: Vent, Drain, Cooler
- Generator Control Box, Power
- Drip Pan Drain
- Package Ground
- DC Power - Electronic Actuator
- Generator Monitor Box
- AC Power - Starter Motor
- Generator Terminal Box (line)
- Turbine Control Box

Right Side

- Combustor and Exhaust Diffuser Drain
- Fuel: Inlet, Filter Drain, Vent
- Package Air Supply
  - Liquid Fuel Atomizing
  - Self-Cleaning Filter
  - Solenoid Actuation
- Turbine Cleaning Fluid Inlet
- AC Power
  - Liquid Fuel Primary Pump
  - Lube Oil Tank Heater
  - Pre/Post Lube Oil Pump
- Air Inlet Duct Drain
- Package Ground

Solar Turbines Incorporated
P.O. Box 85376
San Diego, CA 92186-5376

DS130PG/1109/EO

FOR MORE INFORMATION

Telephone: (+1) 619-544-5352
Telefax: (+1) 858-694-6715
E-mail: powergen@solarturbines.com
Internet: www.solarturbines.com

ISO-9001
DNV
CERTIFICATED FIRM

APPENDIX B
INSPECTION & MAINTENANCE SCHEDULE

WCAA Solar Turbine Model 130

Routine Maintenance Schedule

Annual Inspection (1) Per Year

- Perform all elements of Basic and Semi-Annual Inspections.
- Internally inspect the accessory drive.
- Visually inspect exhaust bellows for cracks and distortion.
- Every three years; disassemble, clean and inspect coupling teeth and sheer bolts for wear or damage; check gearbox-to-generator alignment; realign as necessary.
- Assist site personnel with the visual inspection and cleanliness of generator and make recommendations of corrective maintenance as prescribed by the generator manufacturer.
- Test and calibrate all switches and transmitters.
- Remove and inspect all package lube oil elements; clean or replace, as necessary.
- Test and calibrate speed and temperature topping system.
- Test all safety warning and shutdown devices; adjust as necessary.
- Test fire system for proper operation, reset solenoid operated discharge heads upon satisfactory test performance.

Semi-Annual Inspection (1) Per Year

- Perform all elements of Basic Inspection.
- Inspect fuel control system for security, leaks, and proper operation. Adjust as necessary. Include the following, as applicable.
    - Gas fuel control valves, main and pilot.
    - All linkage and electrical connections.
- Inspect engine air intake and exhaust systems for damage, leaks, and debris.
- Inspect two fuel injectors for clogging, oxidation, cracks, and erosion, per year. Report to customer.
- Perform internal engine bore scope inspection consisting of combustor dome, liners, and first-stage turbine nozzle for cracks, erosion, warping, fret wear, deposits, or unusual hot spots. Report to customer.
- Inspect engine compressor variable vane mechanism for wear. Check for bent arms, loose linkage, and loose bushings. Ensure stop settings are correct. Check for damaged signal wires to actuator, as applicable.
- Insect starter clutch to ensure lock-up in one direction and free rotation in other direction.
- Take lube oil sample for laboratory analysis.
- Check oil cooler for cleanliness; propose regular cleaning maintenance to customer.
- Inspect and test auxiliary and backup equipment, as applicable. Pre/post lube pump.
- Remove and inspect igniter plug and inspect gap, erosion or insulation oxidation. Replace with properly gapped plug as necessary.
- Inspect thermocouple harness for breakage and general condition. Check integrity of support grommets.
- Assist customer in cleaning package.

- Restart turbine and record acceleration time. Monitor electric/electronic control system for proper sequencing.
- Note control panel for malfunction indicators. Troubleshoot and record corrective action.

Basic Inspection (2) Per Year

- Review equipment log and unit operation with site personnel.
- Visually inspect control console electrical connections for cleanliness and security.
- Record all panel and package instrument readings. Note any malfunction indications, and check all oil filled gauges.
- Check air inlet system filter elements for obstructions and contaminations. Record differential pressure readings.
- If self-cleaning air filters is used, check supply pressure and manually cycle through cleaning operation.
- Record fuel pressure and have customer adjust, as necessary.
- Record fuel pressure and adjust at off-skid regulator, as necessary.
- Check oil cooler operation.
- Check inlet guide vanes for position. Check linkage.
- Assist customer in checking fire detectors for cleanliness and fire suppression bottles for proper charge.
- Visually inspect unit for fuel, oil, and air leaks.
- Visually inspect mechanical integrity of fasteners, auxiliary motor couplings, and bleed valve, as applicable.
- Inspect engine and package commonest for proper operation condition. Note any unusal noises, vibrations, discolorations, cracks, chaffing lines. Check drain boss of combustor and turbine cases for leaks.
- Check batteries and charger for proper operation.
- Record oil tank vent pressure.
- Review inspection with site personnel and provide copy of inspection report for logbook.
- Conduct and analyze vibration survey.

APPENDIX C
TURBINE LOAD RECORDKEEPING FORM

Turbine Operating Load Form
DTW Powerhouse (Bldg. 611)
EU-Turbine

Date	Turbine Start Time	Turbine Stop Time	Turbine Load (MW)	Initials

APPENDIX D
CORRECTIVE ACTION FORM

WCAA Solar Turbine Titan Model 130

Corrective Action Form

Date Found: _____ Date Corrected: _____

Originator: _____

Condition Found:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Corrective Action Taken:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Startup/Shutdown Plan
Solar Titan 130-20501S Generator Turbine
Detroit Metropolitan Wayne County Airport

Emissions will be minimized during startup and shutdown periods by performing a series of steps based on the recommendations of the turbine manufacturer, Solar Turbines, Inc.

- Startup is defined as the period beginning when fuel is first delivered to the turbine nozzles and ending when the turbine has reached a stable load setpoint. Turbine startup typically lasts approximately 30 minutes.

- Shutdown is defined as the period beginning when the fuel delivery rate begins to decline and ending when fuel delivery to the turbine is stopped. Turbine shutdown typically lasts approximately 20 minutes.

STARTUP SEQUENCE

1. Primary Mode – Fuel is delivered to the primary combustion nozzles within the turbine with flame in the primary zone only. The mode is used to ignite the fuel, accelerate the turbine, synchronize the turbine and generator at a no-load state, and to operate the turbine at low loads. Duration is approximately 15 minutes.

2. Lean-Lean Mode – Fuel is delivered to both the primary and secondary combustion nozzles, with flame in both the primary and secondary zones, for intermediate load conditions. Duration is approximately 5 minutes.

3. Secondary Mode – Fuel is delivered only to the secondary combustion nozzles, with flame in the secondary zone only. The transition mode is necessary to extinguish the flame and purge the primary zone, prior to reintroduction of fuel into what becomes the primary premixing zone. Duration is approximately 2 minutes.

4. Premix Mode – Fuel is delivered to both the primary and secondary combustion nozzles, with flame in the secondary zone only. Approximately 10 minutes is required to reach baseload conditions and for full utilization of the dry, SoLoNOx burner system. Premixing of fuel and combustion air in the SoLoNOx system results in flame cooling and, consequently, lower NOx emissions. Full load operation in premix mode generally results in lower emissions of all constituents.

SHUTDOWN SEQUENCE

During the shutdown sequence, fuel delivery to the primary and secondary combustion nozzles is gradually decreased to minimize thermal shock to the combustion zone equipment. The cooling stage continues for approximately 20 minutes before fuel delivery is discontinued so that combustion, and associated emissions, are halted.