Capstone MicroTurbine
User's Manual

This document presents information and instructions for use of the CAPSTONE® MicroTurbine™.

Capstone Turbine Corporation
21211 Nordhoff Street, Chatsworth, California 91311 USA

Copyright © 2002 Capstone Turbine Corporation. All rights reserved.

CAPSTONE and the turbine blade logo are Registered Trademarks of Capstone Turbine Corporation.
MicroTurbine™ is a Trademark of Capstone Turbine Corporation.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Welcome to the world of Capstone Power Generation!

We are pleased that you have chosen the Capstone MicroTurbine product for your application.

Front View

Model C30 (rear) **Model C60 (rear)**

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Table of Contents

About This Document 6
Safety Information 6
Introduction 6
Symbols 6
General Precautions 7
Electrical Precautions 8
Fuel Precautions 8
Exhaust Precautions 9
Acoustic Emissions Precautions 9
Certifications, Permits, and Codes 10
Document Overview 10
MicroTurbine Introduction 10
Key Mechanical Components 11
Main Features 11
MicroTurbine Engine 12
Controller 12
Air Bearings 12
Fuel System 12
Emissions 12
Enclosure 13
Stand Alone Option 13
Distributed Generation 13
Integrated Combined Heating and Power (iCHP) Option 13
Offshore Option 14
Operational Features 14
Peak Shaving 14
Combined Peak Shaving and Standby 14
MultiPac Power 14
Resource Recovery 14
iCHP Electrical and Thermal Recovery 14
OEM Applications 15
Output Measurements 15
ISO Conditions 15
Pressure 15
Volume 15
Heating Values 15
MicroTurbine Performance 15
Grid Connect Output 15
Stand Alone Output 16

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Power Quality 16
Heat Output 16
Operating the MicroTurbine 16
Basic MicroTurbine Operation 16
Routine Operation 16
Communications 17
Routine Operation Data 17
Control Device Authority and Priority 17
Start-up 18
Shutdown 18
Emergency Stop (E-Stop) 18
Restart 18
Using the Display Panel 19
Display Panel Areas 19
Menu Navigation 20
Display Panel Data Entry 20
Logging On with a Password 21
Changing the Password 21
Display Panel Menu Hierarchy 22
Display Panel Menu Screens 23
Incident Log Menu 25
System Settings Menu 26
Time of Use Menu 27
Grid Connect Menu 27
Load Management Menu 28
Stand Alone Menu 29
Battery Management Menu 29
CHP Config Menu 30
UCB Analog Inputs 30
UCB Output Relays Menu 30
Unit Data Menu 30
Using the User Interface Port 32
Capstone Remote Monitoring Software 33
MicroTurbine Operating Modes 33
Grid Connect Operation 33
Stand Alone Operation 34
Dual Mode Operation 37
MultiPac Operation 38
iCHP Operation 40
MicroTurbine Preventive Maintenance 41
Scheduled Maintenance 41
Preventive Maintenance 42
MicroTurbine Inlet Air Filter 44

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

External Fuel Filter 45
Battery Pack 45
Battery Charge Management 46
Manual Battery Pack Equalization Charge 47
Warranty 47
Troubleshooting 48
Incidents 48
Incident System Severity Levels 48
Incident Names and Codes 48
Internal Incident 49
Fuel Incident 49
Grid Incident 49
Lo-Temp/Hi-Temp/Hi-Alt Incident 49
E-Stop Incident 49
User Connection Incident 49
Viewing Incident Records 50
Basic Troubleshooting Procedures 51
No Lights on Display Panel 51
No Attempt to Start after ON Command 51
Start Attempt Fails 51
Low Power Output 52
Unexpected Shut Down or Warning 52
Rebooting a MicroTurbine 52
Product Support 55

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

About This Document

This document provides user instructions to operate and maintain the Capstone Turbine Corporation MicroTurbine.

This document is intended for user personnel who may not have specific training on the MicroTurbine. Capstone Authorized Service Providers (ASPs) have received rigorous training and have been certified to perform commissioning, troubleshooting, and repair of the MicroTurbine.

User personnel who have not received certification of satisfactory completion of this training should not attempt any procedures other than those specifically described in this document.

Safety Information

This section presents safety information for the user of Capstone Turbine Corporation MicroTurbines. The user must read and understand this manual before operation of the equipment. Failure to obey all safety precautions and general instructions may cause personal injury and/or damage to the equipment.

It is the user's responsibility to read and obey all safety procedures and to become familiar with these procedures and how to safely operate this equipment.

Introduction

The Capstone MicroTurbine is an advanced power generation system with user and material safety foremost in mind. Fail-safe operation includes mechanical systems, electrical systems, and engine control software.

Symbols

There are three very important symbols used in this document: Warnings, Cautions, and Notes. Warnings and Cautions alert you to situations and procedures that can be dangerous to people and/or cause equipment damage. Notes provide additional information relating to a specific operation or task.

WARNING	A Warning means that personal injury or death is possible.

CAUTION	A Caution means that damage to the equipment is possible.

NOTE	A Note is used to clarify instructions or highlight information that might be overlooked.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

General Precautions

The following general precautions must be observed and followed at all times. Failure to do so may result in personal injury and/or equipment damage.

NOTE	Some of the following precautions do not directly apply to users, but it is important for users to be aware of them.

- **Only Capstone Authorized Service Providers are permitted access to the inside of the enclosure.**
- Read and understand the User's Manual before operating the equipment.
- Read and obey all warnings and cautions.
- Make sure all fuel connections are tight, free from leaks, and protected from damage.
- Make sure all electrical connections are tight, clean, dry, and protected from weather and damage.
- The MicroTurbine may be equipped with a heat recovery system. Use caution around relief valves where hot water and steam may be present.
- On offshore oil applications, the pressurized enclosure (Class I, Division 2 option) should not be opened: 1) Unless the area is known to be free of flammable materials; 2) The indicated internal temperature is below 450° C (842° F) degrees; 3) All devices have been de-energized from the utility. Power should not be restored until the enclosure has been purged for three minutes.
- Use hearing protection when you work on or near a MicroTurbine that is in operation.
- The MicroTurbine is heavy. Be careful when you move or lift the MicroTurbine.
- Keep the equipment clean.
- Keep all flammable materials away from the MicroTurbine and its components.
- Do not operate or work on the equipment if mentally or physically impaired, or after consumption of alcohol or drugs.
- Make sure all fasteners are installed and properly tightened.
- Keep an ABC rated fire extinguisher near the MicroTurbine.
- Obey all applicable local, state, and national codes and regulations.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Electrical Precautions

The output voltage and residual capacitor voltage of this equipment is dangerous. High voltage can kill or injure. Use caution when you work on electrical equipment. The MicroTurbine system can include multiple sources of power. Turn off the system and lockout the power supply prior to all work on the equipment.

NOTE	Some of the following precautions do not directly apply to users, but it is important for users to be aware of them.

- Command the MicroTurbine system to OFF.
- Open and lock the dedicated disconnect switch to isolate the MicroTurbine from the electric utility grid or loads.
- If the MicroTurbine is equipped with a battery pack (i.e., if the MicroTurbine includes the Stand-alone Option), open the battery isolation switch and unplug the battery cable.
- Wait five (5) minutes for any capacitive stored voltage to dissipate.
- Always disconnect all power sources.
- Use a voltmeter to make sure that all circuits are de-energized.
- All output connections must be made in accordance with applicable codes.

WARNING	The MicroTurbine system contains and produces high voltage. High voltage can injure or kill. Obey all safety procedures when you work around electrical equipment.

WARNING	Make sure the system is off and the dedicated disconnect switch is in the open position and is locked. This will help prevent injury and damage to the equipment.

Fuel Precautions

The Capstone MicroTurbine operates on approved liquid or gaseous fuels. Keep flames, sparks, pilot lights, equipment that produces electrical arcs, switches or tools, and all other sources of ignition away from areas where fuel and fumes are present. If there is a fire, use a multi-purpose dry chemical or CO_2 fire extinguisher.

Fuel lines must be secure and free of leaks. Fuel lines must also be separated or shielded from electrical wiring. If you smell fuel fumes, immediately stop operation of the equipment, close the fuel isolation valve, and locate and repair the source of the leak or call a qualified professional.

WARNING	MicroTurbine fuel is flammable and explosive. An explosion can cause death or injury to personnel and/or damage to equipment. No open flame or smoking is allowed near the MicroTurbine.

WARNING	Liquid and gaseous fuels can be corrosive. Concentrations of Hydrogen Sulfide (H_2S) can be found in Sour Natural Gas and Sour High Btu Gas. Injury to personnel and/or damage to equipment can occur. Minimize exposure to liquid or gaseous fuels and provide satisfactory fresh airflow when you are around equipment.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Exhaust Precautions

The Capstone MicroTurbine is designed to produce very safe emissions. The exhaust is clean and oxygen rich (approximately 18% O_2), with very low levels of air pollutants. Like all fossil fuel combustion technology, the MicroTurbine can produce dangerous emissions (like nitrogen dioxide and carbon monoxide) from the fuel combustion process. Although the MicroTurbine has ultra low nitrogen dioxide (NO_2), and carbon monoxide (CO) emission levels, make sure precautions are taken to prevent personnel from being exposed to nitrogen dioxide and carbon monoxide while the system is operating. Nitrogen dioxide and carbon monoxide are poisonous at high concentrations.

When installed indoors, the MicroTurbine exhaust must be vented to the outside. Make sure there is a satisfactory fresh air supply. An exhaust system must be added to pull the exhaust away from the system to reduce the risk of exposure to dangerous emissions.

For exhaust connection data, temperatures, pipe requirements, and other related information, contact your Capstone Authorized Service Provider.

When installed outdoors, the MicroTurbine should be located where there is a satisfactory fresh airflow so the exhaust emissions will be dissipated.

WARNING	The MicroTurbine exhaust contains nitrogen dioxide and carbon monoxide, which are poisonous at high concentrations. Make sure there is satisfactory fresh airflow when you work around the equipment.

WARNING	The exhaust airflow and pipes are hot enough to cause personal injury or fire. The exhaust airflow can reach temperatures as high as 371 °C (700 °F). Keep people, equipment, and other items away from the exhaust airflow and pipes. Always vent exhaust away from personnel.

WARNING	Hot surfaces and hot exhaust can be dangerous. Personal injury and/or damage to equipment are possible. Be careful when you work on equipment.

Acoustic Emissions Precautions

The Capstone MicroTurbine is designed to produce safe acoustic emissions. However, when working at a radius of 10 meters (or 33 feet) from an enclosed Capstone MicroTurbine, sound level exposure will average approximately 70 dBA.

Capstone recommends that hearing protection be worn when working on or in the immediate vicinity of operating MicroTurbines for extended time periods.

Other acoustic emissions regulations may apply to your specific installation location. Always check to be certain that your installation complies with all codes required by the local jurisdiction.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Certifications, Permits, and Codes

Your Capstone MicroTurbine is designed and manufactured in accordance with a variety of national and international standards.

The Capstone MicroTurbine operates on approved liquid or gaseous fuels; thus installation frequently requires one or more permits from local regulatory agencies.

It is not practical to list in the User's Manual the requirements of each authority having jurisdiction and how the Capstone MicroTurbine meets those requirements. For certification data, such as weights, dimensions, required clearances, noise levels, and the Capstone MicroTurbine Compliance List, please contact your Capstone Authorized Service Provider.

Document Overview

This document provides the data necessary for the user to operate and maintain the Capstone MicroTurbine. Basic troubleshooting is included in this manual, but only Capstone Authorized Service Providers are permitted to perform detailed troubleshooting and repair of the equipment.

For detailed technical data, or for service to the MicroTurbine, contact your Capstone Authorized Service Provider.

MicroTurbine Introduction

The Capstone MicroTurbine is an adaptable, low-emission, and low maintenance power generation system. A turbine-driven high-speed generator is coupled with digital power electronics to produce high quality electrical power.

The Capstone MicroTurbine is a versatile power generation system suitable for a wide range of applications. Capstone's proprietary design allows users to optimize energy costs while operating in parallel with an electric utility grid. The MicroTurbine can provide prime power generation where the electric utility grid is not readily available or where service is unreliable.

Alternating Current (AC) electrical power can be paralleled with an electric utility grid or with another generation source. The MicroTurbine can act as a stand-alone generator for standby, backup, or remote off-grid power. Multiple systems can be combined and controlled as a single larger power source, called a MultiPac.

The MicroTurbine can efficiently use a wide range of approved hydrocarbon-based gaseous and liquid fuels.

The MicroTurbine produces dry, oxygen-rich exhaust with ultra-low emissions. Utilizing both the generated electric power and the exhaust heat can provide even greater energy cost savings.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Key Mechanical Components

The key mechanical components that make up the Capstone MicroTurbine are shown in the following illustration.

Typical Capstone MicroTurbine Engine

Main Features

The various features of the Capstone MicroTurbine are listed below:

- State-of-the-art Digital Power Controller with built-in protective relay functions provides two output choices:
  - Built-in synchronous AC
  - Stand Alone AC output (optional)
- Patented air bearings eliminate the need for oil or other lubricants.
- Air-cooled design of the entire system (turbine and controller) eliminates the need for liquid coolants.
- Only one moving part. No gears, belts, or turbine-driven accessories.
- Advanced combustion control eliminates the need for ceramics or for other costly materials or for catalytic combustion, and provides ultra-low emissions.
- An optional integral annular recuperator (heat exchanger) doubles thermal efficiency.
- Digital control technology facilitates advanced control, monitoring, and diagnostic capabilities, both on-board and remotely (via an RS-232 link).

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

MicroTurbine Engine

The MicroTurbine engine is a combustion turbine that includes a compressor, combustor, turbine, generator, and (except in the Simple Cycle model) a recuperator. The rotating components are mounted on a single shaft supported by patented air bearings and spin at up to 96,000 RPM. The permanent magnet generator is cooled by the airflow into the MicroTurbine. The output of the generator is variable voltage, variable frequency AC. The generator is used as a motor during start-up and cooldown cycles.

Controller

The digital power electronics control the MicroTurbine system operation and all subsystem operations. The digital power electronics change the variable frequency AC power from the generator to DC voltage, and then to constant frequency AC current.

During start up, the digital power electronics operate as a variable frequency drive, and motors the generator until the MicroTurbine has reached ignition and power is available from the MicroTurbine. The digital power electronics again operate as a drive during cooldown to remove heat stored in the recuperator and within the MicroTurbine engine in order to protect the system components.

Air Bearings

The MicroTurbine utilizes gas foil bearings (air bearings) for high-reliability, low maintenance, and safe operation. This allows fewer parts and the absence of any liquid lubrication to support the rotating group. When the MicroTurbine is in operation, a gas film separates the shaft from the bearings and protects them from wear.

Fuel System

The MicroTurbine can efficiently use a wide range of approved hydrocarbon-based gaseous and liquid fuels. The MicroTurbine includes an integral fuel delivery and control system. The standard system is designed for pressurized hydrocarbon-based gaseous fuels. Other models are available for low-pressure gaseous fuels, gaseous fuels with lower heat content, gaseous fuels with corrosive components, biogas (landfill and digester gas), and liquid fuels. Contact your Capstone Authorized Service Provider for data on approved fuels and performance specifications.

Emissions

The Capstone MicroTurbine is designed to produce very safe emissions. The exhaust is clean and oxygen rich (approximately 18% O_2) with very low levels of air pollutants. Like all fossil fuel combustion technology, the MicroTurbine can produce dangerous emissions (like nitrogen dioxide and carbon monoxide) from the fuel combustion process. The MicroTurbine has ultra low nitrogen dioxide (NO_2) and carbon monoxide (CO) emission levels.

Some fuels will have inherently higher emissions levels. Liquid fuel will generally have higher nitrogen dioxide and carbon monoxide levels than natural gas. Landfill and digester gas fuels can have lower nitrogen dioxide levels with higher carbon monoxide levels at full power. Fuels containing significant amounts of carbon monoxide and acetylene (C_2H_2) will also result in higher nitrogen dioxide emissions.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Enclosure

The MicroTurbine standard enclosure is functional design for indoor and outdoor use, and is certified to NEMA 3R - rainproof.

A lighter weight Industrial Enclosure (also NEMA 3R), with a more conventional appearance, is also available.

The Open Package version is suitable for integration into single or multiple system skid-mounted enclosures, which can also include fuel treatment and heat recovery equipment.

Capstone components for Original Equipment Manufacturer (OEM) use can be provided with or without a mounting frame.

Stand Alone Option

A Stand Alone option is available for the MicroTurbine, which includes a large battery pack used for unassisted start and for transient electrical load management. The Stand Alone option includes a power converter and battery management system, which keeps the battery optimally charged. The battery is a lead-acid type and completely sealed.

When equipped with the Stand Alone option, the system can power connected loads at user-selected voltage and frequency setpoints. It can power remote facilities such as construction sites, oil fields, offshore platforms, and other locations where the electric utility grid is not available.

Distributed Generation

The MicroTurbine produces synchronous current when connected to an electric utility grid. It allows electric utilities to expand power generation capacity in small increments, to optimize current infrastructure, and reduce or delay the need to develop, fund, and build new transmission and distribution lines.

Integrated Combined Heating and Power (ICHP) Option

The Integrated Combined Heating and Power (ICHP) option allows the user to realize the benefits of usable electrical and thermal power from a single fuel source. The electricity provides on-site power generation for baseloading, peak shaving and capacity addition, in conjunction with local utility power. The heat offsets or replaces local thermal loads such as space heating, pool heating and industrial process hot water.

The major system components are a Capstone model C60 high-pressure natural gas MicroTurbine, an exhaust heat recovery unit, and an exhaust diverter to allow full or partial recovery of exhaust energy. The system includes microprocessor control with input/output functions to allow application in a wide variety of heat recovery uses. The system allows a user to realize high total system efficiency with respect to incoming fuel energy, providing economical operation and operational flexibility.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Offshore Option

The offshore option contains a stainless steel pressurized enclosure, which houses the MicroTurbine system, and is certified for Class I, Division 2 (C1D2), or Class I, Zone 2 coastal marine environments. The C1D2 option utilizes an integrated blower assembly to reduce the exposure of ocean salt to internal components. These options are available in both dual mode Model C30 and Model C60 product lines.

Operational Features

Operational features of the MicroTurbine are presented in the following paragraphs.

Peak Shaving

The MicroTurbine can augment utility supply during peak load periods, thus increasing power reliability and reducing or eliminating peak demand charges.

Combined Peak Shaving and Standby

The MicroTurbine can be used for both Grid Connect power and Stand Alone power for protected loads, and can be programmed to switch automatically (with the Dual Mode Controller Option) upon loss/restoration of electric utility grid power. The MicroTurbine, with its low emissions, low maintenance requirements, and high reliability is well suited for combination peak-shaving and standby power applications.

MultiPac Power

Capstone MicroTurbines can be installed in groups of up to 20 units (100 units with the optional Capstone PowerServer) and will operate as a single power generation source. This MultiPac capability features a single control point and synchronous voltage and frequency output for all units. Individual MicroTurbines share power, current, and load on both a dynamic and steady state basis.

Resource Recovery

Capstone MicroTurbine models are available that use methane-based oilfield flare casing gas or low-energy (as low as 350 Btu) landfill/digester gas as fuel sources. Versions of these are available that can accept Sour Gas with up to 7% Hydrogen Sulfide (H_2S) content. This application helps eliminate pollution and provides economical power for on-site use as a by-product. Where waste gas incineration is a priority, the non-recuperated Simple Cycle model provides the same electrical output while destroying twice the gas volume.

ICHP Electrical and Thermal Recovery

The dry, oxygen-rich exhaust from the MicroTurbine can also be used for direct heat or as an air pre-heater for downstream burners. The usable electrical and thermal power allows commercial businesses to offset or replace local thermal loads such as domestic hot water, space heating, pool heating, and industrial hot water. In addition, the oxygen-rich exhaust together with ultra-low emissions makes the direct exhaust applicable for some food processing and greenhouse uses, such as heating, cooling (by absorption), dehumidifying, baking, or drying.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

OEM Applications

The MicroTurbine core technology can be integrated into a wide variety of products and systems. Uninterruptible power supplies, all-in-one combined heat and power systems, and welding machines are just a few examples of original equipment manufacturer applications.

Output Measurements

The measurements presented in this document are in metric units (with U.S. standard units in parentheses). Refer to the sections below for more data.

ISO Conditions

Combustion turbine powered devices (including the Capstone MicroTurbine) are typically rated at 15 °C (59 °F) at sea level, or 1 atmosphere (1 atm) which is 760 mm Hg (14.696 psia) and identified as International Standardization Organization (ISO) conditions. For a complete definition of ISO testing conditions, refer to ISO 3977-2.

Pressure

Pressure figures assume gauge pressure, or 1 standard atmosphere (1 atm) 760 mm Hg (14.696 psia) less than absolute pressure, unless otherwise indicated.

Volume

Fuel gas and exhaust gas volumetric measurements are listed in normalized cubic meters (Nm^3) and standard cubic feet (scf). These volumes are defined at 1 atm (760 mm Hg, 14.696 psia) and 15.6 °C (60 °F).

Heating Values

Heat contents and heat rates will be found in either Lower Heating Value (LHV) (dry) or Higher Heating Value (HHV), depending upon the application. Capstone calculates heating values at 1 atmosphere (atm) and 15.6 °C (60 °F), according to ASTM D3588.

MicroTurbine Performance

The MicroTurbine electrical output capability is reduced when operating in higher ambient temperatures or elevations, by intake or exhaust restrictions, and by some options. Contact your Capstone Authorized Service Provider for data on performance specifications.

Grid Connect Output

The MicroTurbine electrical output in Grid Connect mode is 3-phase, 400 to 480 VAC and 45 to 65 Hz (both voltage and frequency are determined by the electric utility grid). Allowable connection types include:

- 4-wire Wye
- 3-wire Wye with neutral grounding resistor

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Stand Alone Output

When equipped with the Stand Alone option, the electrical output is user adjustable from 150 to 480 Volts AC, and from 10 to 60 Hz.

The maximum power need not be balanced. Loads can be connected 3 phases or single phase and phase-to-phase or phase-to-neutral, so long as the current limits are respected. A Ramp Start feature can assist in starting loads with large in-rush currents.

Power Quality

The MicroTurbine output conforms to IEEE 519-1992, IEEE Recommended Practices, and Requirements for Harmonic Control in Electrical Power Systems.

Heat Output

The recuperated MicroTurbine can produce up to 571,000 kJ (541,000 Btu) per hour of clean, usable exhaust heat in the range of 261 to 315° C (500 to 600° F).

The non-recuperated MicroTurbine Simple Cycle system can produce up to 720,000 kilojoules (680,000 Btu) per hour in the range of 518 to 574° C (965 to 1065° F).

The MicroTurbine exhaust stream is 127 to 203 mm (5 to 8 in.) in diameter, flowing up to 17 to 28 Nm^3 (550 to 900 scf).

Contact your Capstone Authorized Service Provider for data on heat output performance for specific system variations and/or ambient conditions.

Operating the MicroTurbine

Typical operation of the MicroTurbine is presented in the following paragraphs.

Basic MicroTurbine Operation

This section details basic system operation and explains how to use the MicroTurbine.

Routine Operation

Most MicroTurbine applications require no regular interaction with an operator during normal operation. Built-in dispatch features include peak shaving with local or remote control, external switch control, programmable scheduling, automatic restart, and automatic loading.

Offshore applications with the pressurized enclosure (Class I, Division 2 option) utilize a Programmable Logic Controller (PLC) unit to monitor external inputs such as gas detection and pressure sensing and intelligently control normal operation. All built-in MicroTurbine dispatch modes remain the same, except for auto restart functionality, which is unavailable.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Communications

There are two ways for the user to communicate with the MicroTurbine, (1) either via the Display Panel, or (2) via the User Interface Port (UIP).

The user may communicate directly through the display panel mounted on the MicroTurbine or through a personal computer connected to the User Interface Port. The PC may be connected to the User Interface Port directly (with an RS-232 null modem cable) or via a phone line and optional modem. Communication is then possible by use of the optional Capstone Remote Monitoring Software (CRMS) on the PC, or other program that uses Capstone's open communication protocol.

The set-up, control, and basic performance of the MicroTurbine can be monitored and adjusted through the display panel and the User Interface Port.

Primary user communications include:

- Start and stop functions
- Adjustment of power output
- Storage and display of operation history
- The configuration of operational parameters
- Battery management functions

Routine Operation Data

The Display Panel (or a computer connected directly or via modem) can be used to monitor many operational parameters during system operation. Some of the routine operation and performance data items available for monitoring are listed below:

- Power Output (in kilowatts, or kW)
- Turbine Speed (in revolutions per minute, or RPM)
- Turbine Exit Temperature (in °C or °F)
- Phase Voltages (in Volts) and Currents (in Amperes)

Control Device Authority and Priority

The display panel or a PC connected to the User or Maintenance interface ports can function as a control device for the MicroTurbine. Either device can view system data at any time, but only one device can control the MicroTurbine operation (that is, providing start / stop command or changes to power demand).

The display panel has default control authority to issue operational commands to the MicroTurbine. The user can start and stop the MicroTurbine without logging on to the system (that is, no password is required). All other system adjustments require the user to log on to the system with the user password.

The User Interface Port will take control when a password is entered either from the Capstone Remote Monitoring Software or other software using the Capstone open communication protocol.

All system commands via the User Interface Port, such as start, stop, and adjustment of Power Demands, require entry of a user password. When the User Interface Port has control, the display panel does not have control and can only be used to view information. The system automatically cancels a log on after five minutes of inactivity.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Start-up

A Start command can be issued from the display panel or remotely via the optional Capstone Remote Monitoring Software. When the command has been issued, the generator operates as a motor to bring the MicroTurbine up to ignition speed, at which point fuel is introduced into the combustion chamber and ignited. When the Turbine Exit Temperature (TET) sensors detect an increase in temperature, the system is declared lit, and the MicroTurbine accelerates to full load.

The start-up process from a cold start to full load requires up to two minutes. For offshore applications with the pressurized enclosure (Class I, Division 2 option), this process may increase to five minutes, due to an air purge cycle. Also, the MicroTurbine system can only be started via the PLC controlling the pressurization system.

Shutdown

When the MicroTurbine is issued a Stop command, power output is reduced, followed by a period that the MicroTurbine is motored at nominal speed to remove heat stored in the recuperator and MicroTurbine engine in order to protect the system components.

The overall cooldown period is up to ten minutes, but is affected by MicroTurbine model and temperature at shutdown. A restart may be attempted at any time, and a start will occur after completion of the initial cooldown period. Auto Restart is not available for offshore systems with Class I, Division 2 operation.

If the Stand Alone battery requires a recharge (after a stop command is issued), the MicroTurbine will continue to operate with fuel in order to recharge the battery. The MicroTurbine will enter the cool down period after the battery has reached a 90 to 95% state of charge. The battery can require as long as 20 minutes to recharge after a stop command has been issued before entering cooldown.

Emergency Stop (E-Stop)

The optional Emergency Stop (E-Stop) kit is designed to allow for the safe and immediate shut down of the MicroTurbine in the event of an emergency. Activation of the E-Stop immediately shuts off fuel and electrical output. This will cause the compressor bypass valve to open, vent the compressed air out of the MicroTurbine, and the turbine will coast to a stop.

After an emergency stop, the power to the MicroTurbine must be turned off for 30 seconds before a restart can be attempted. Emergency stops should **NEVER** be used for routine shutdowns. Emergency stops increase stress on the system components and will result in reduced service life of the MicroTurbine.

CAUTION	Repeated use of the optional Emergency Stop switch will result in damage to the MicroTurbine. Use only in emergency situations.

Also, after an emergency stop, you may want to close the external fuel isolation valve to shut off any additional fuel flow into the MicroTurbine. The external fuel isolation valve must be returned to the open position before a restart of the MicroTurbine is attempted.

Restart

The MicroTurbine system can normally be restarted after a shutdown, while the battery recharges, or during the cool down period before the speed of the MicroTurbine reaches zero. This allows for faster power output and helps to eliminate wear on the bearings.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Using the Display Panel

Use of the Display Panel is described in the following paragraphs.

The MicroTurbine may be configured and commanded from the display panel. The display panel is located on the front of the package above the engine air inlet, and is used to control MicroTurbine operation and access data stored within the system. The display panel includes a keypad, a display window, navigation buttons, and system control buttons. The paragraphs below describe display panel operation.

For offshore applications with the pressurized enclosure (Class I, Division 2 option), display panel screen information is visible through a see-thru plastic window. However, access to the panel navigation buttons and numeric keypad should only be attempted during maintenance operations, and only if the area has been tested to be free of flammable gases.

Display Panel Areas

The **BATT START** button, at the far left of the display panel, is used to wake a Stand Alone system from sleep mode (see Waking a Stand Alone MicroTurbine on page 34).

The **Numeric Keypad**, located to the left of the display window, is for data input. The system accepts data input only on specific screens, and the input line must be selected, indicated by the flashing line. Data input from the Numeric Keypad requires logging-on with a password (see Logging On with a Password on page 21).

The **Display Window** is in the center of the display panel. The display window can display four lines of twenty characters, each which indicate menu hierarchy position, data display, and data input.

The **Navigation Buttons** are located to the right of the display window, and consist of four buttons arranged vertically, each with a line to its left indicating a line of data in the display window. These four buttons, plus the buttons just to their right labeled (**-**), (**+**), and ACCEPT, are the navigation buttons; they are used for selecting various display screens or data items.

The **Control Buttons** are to the right of the Navigation Buttons. The command buttons start and stop the MicroTurbine, and enable and disable power output in Stand Alone mode.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Menu Navigation

Movement around the top-level menu screens can be accomplished by use of the Navigation Buttons. The top line of the display always shows the name of the current top-level menu.

To move around the top-level menus, press the topmost of the four line Navigation Buttons. The menu position indicator numbers at the right end of the top line will flash. When the numbers are flashing, press the (**-**) or (**+**) buttons to move around the menus.

Each of the top-level menu screens has a number of submenus. The second line on the display panel shows the current submenu. Movement around the submenus is similar to the top-level menus except you must press the second line Navigation Button to select line two of the display. When the numbers are flashing, press the (**-**) or (**+**) buttons to move around the submenus.

When you reach the desired menu, press the ACCEPT button to choose the menu, or wait 20 seconds for the system to automatically accept the menu selected.

The third and fourth levels display the selected performance data or allow input, like passwords or adjustment of power settings. The descriptions of each screen or submenu are grouped according to the top-level menu.

Display Panel Data Entry

Data input requires selection of the appropriate level with the Navigation Buttons, causing the display line to flash. Enter data using the Numeric Keypad, or scroll through available data entry options with the (**-**) or (**+**) buttons and press the ACCEPT button when finished. To make changes to any system set-up or operational mode requires the entry of a user password. Numeric entries can be cancelled by use of the (**-**) button.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Logging On with a Password

To enter commands from some of the display panel menus, the user must log on with a valid password (the description of the various menus on the following pages includes whether logging on with a password is required).

NOTE	The default user password (at the display panel) is set to **87712370**. In the event of a lost user password, your Capstone Authorized Service Provider can reset the user password to this default.

To log on with a password, follow these steps:

1. At the top-level System Data Menu, push the second level Navigation Button and the (**-**) or (**+**) buttons until you come to the Enter Password submenu.
2. Select the third level Navigation Button (the display indicates "**********"). Enter the current password (see the above notes).
   - Note that the display of ********* becomes **--------** as you enter the password.
3. Press the ACCEPT Button. The display will indicate "PROTECTED LEVEL SET".
4. You are now logged into the system.

Not all data items can be modified at the user password level.

Changing the Password

A user can change the user password at any time using the following steps:

1. The user must be logged-in (with a password) to change the password.
2. Go to the top-level **System Settings** menu, push the second level Navigation Button and the (**-**) or (**+**) buttons until you come to the User Password submenu.
3. Select third level Navigation Button (**********Change**) and enter new password.
4. Press the ACCEPT button. A confirmation message will be posted that states the password needs to be verified.
5. Press the fourth level Navigation Button. Verify the Password on the fourth level (**********Verify**); re-enter the "new" password to verify.
6. Press the ACCEPT button. A confirmation message will be displayed that states the password has been verified.

If the new password is not verified in this manner, the old password will remain in effect.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Display Panel Menu Hierarchy

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Display Panel Menu Screens

The Display Panel Menu Hierarchy on the previous page shows the typical structure of all the menus and submenus. There are several Display Panel menu screens that are important to the User. These screens are detailed below.

System Data Menu

NOTE	The user will be able to view the data on various screens of the System Data Menu without logging on; to change some of the settings requires logging on with a user password.

On power-up of the MicroTurbine, the Display Panel defaults to the top-level System Data menu. The System Data menu displays the total output for a system of 1 to 20 MicroTurbines (up to 100 MicroTurbines with the optional Capstone PowerServer) and other adjustable measurements and system states. With the System Data Menu you can control up to 20 MicroTurbines as one system (or up to 100 MicroTurbines with the optional Capstone PowerServer). This is called a MultiPac. The System Data submenus are detailed below.

Turbine Number

KW

High Incident

The **Turbine Number** submenu displays the MicroTurbine number and whether it is currently configured for GC (Grid Connect) or SA (Stand Alone), and whether it is a Single unit or a MultiPac (MP) unit or the Master of a MultiPac system. This data is displayed on the second line of the display panel. This submenu also gives the Total Output of the system in kilowatts (kW) on the third line. The fourth line displays the High Incident data, which is the highest system severity level (SSL) fault code and the highest fault type currently reported by the system. This is information that must be forwarded to your Capstone Authorized Service Provider.

Clear Incident

High Incident

<Yes/No>

The **Clear Incident** submenu attempts to clear the highest-level fault and to return the system to standby. The third line displays the system severity level (SSL) fault code and displays the highest fault type and the highest identification number of the faults currently reported by the system. If the fault can be cleared, the fault # line will be updated with the new highest SSL fault or System OK if all faults were cleared. If the same fault remains, the fault cannot be cleared.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

System Configuration

The **System Config** submenu contains system settings and allows the user to adjust the third level data, as detailed below:

- The **Power Connect** option allows the user to change the operating mode of the MicroTurbine.

  0 = Invalid State, factory default

  1 = Stand Alone

  2 = Grid Connect

  3 = Dual Mode

Refer to the sections on Grid Connect, Stand Alone, and Dual Mode for details.

- The **MultiPac** <ENABLE/DISABLE> option allows the user to remove or add a MicroTurbine to a MultiPac. This allows maintenance of a MicroTurbine unit in a MultiPac without having to shut down all MicroTurbines in the system.
- The **Auto Load** <Yes/No> option allows the user to enable or disable the MicroTurbine to automatically meet the load demand when running in Stand Alone mode:
  - A Yes setting automatically makes power available to match the output with the load demand.
  - With a No setting, the user must manually use the display panel Interlock + Enable button to allow power to be output when in Stand Alone mode before the turbine will produce power to meet the load demand.
- The **Auto Restart** <Yes/No> option enables or disables the system's ability to automatically attempt to restart after an incident driven shutdown.

Control Access

<Device>

The **Control Access** submenu displays which communication device currently has control for changing settings of the MicroTurbine.

- Display Panel
- User Port
- Maintenance Port

Enter Password

<Password>

The **Enter Password** submenu allows the user to logon and access the MicroTurbine controls.

The factory default User-level password is **87712370**. Refer to the previous section on passwords for more data.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

System Components Menu

NOTE	The user will be able to view or change the data on the various screens of the System Components Menu without logging on with a password.

The top-level **System Components** menu displays the hardware and software components that are installed on the MicroTurbine. This menu lists Capstone serial numbers and part numbers for the MicroTurbine, control board, power board, display panel, fuel device(s), and battery device contained within the system. Serial numbers are six digits, all numeric. Part numbers are six digits followed by a dash and three additional digits.

This menu also displays information regarding the software used to run the power electronics, the display panel and fuel device(s), battery device and UCB (User Connection Board) contained within the system. The System Components submenus that are important to the User are detailed below. This information should be provided to the Authorized Service Provider for any service call.

System

The **System** submenu displays the serial and part number of the MicroTurbine system.

DPC Main Code

The **DPC Main Code** submenu displays the software version number and the serial and part number of the main code set, the overall version of software for the MicroTurbine.

Incident Log Menu

NOTE	The user will be able to view the data on the various screens of the Incident Log Menu without logging on with a password.

The top-level **Incident Log** menu records the last 20 faults and warnings. When the log is full, the oldest fault or warning is deleted and the newest one goes to the top as number one. The **Incident Rec** (incident record) submenu on line two displays the current incident number as 1/20, 2/20, 3/20 thru 20/20. The two Incident Record submenus that are important to the User are detailed below.

Sts [Starts]

Incident Text

The **Sts** (starts) submenu on line three displays the number of starts at the time of the incident. The **Incident Text** displayed on the fourth line is a description of the fault or warning; report this information to your Capstone Authorized Service Provider. Refer to the basic troubleshooting section for more data.

Date

Time

The **Date and Time** submenu on lines three and four, displays the system date in MM/DD/YYYY and the time in 24:00:00 for the current incident. This data can be used to identify if more than one incident occurred at the same time to assist in troubleshooting.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

System Settings Menu

NOTE	The user will be able to view the data on the various screens of the System Settings Menu without logging on with a password; to change any settings requires logging on with a user password.

The top-level **System Settings** menu allows the user to change some of the global operating parameters that apply regardless of application or operating mode. Usually these parameters are established at installation and not changed thereafter. The System Settings submenus that are important to the User are detailed below.

Display Format

<Metric/English>

The **Display Format** submenu on line two allows for the display of Metric or English measurement units to be used for all screens on the Display Panel.

Set Date/Time

<Date>

<Time>

The **Set Date/Time** submenu on line two allows the User to change the date and time. This is stored in the controller for incident logging and time-based dispatch modes. The system date is in MM/DD/YYYY format and the time is in 24:00:00.

Reboot

<No/Yes>

The **Reboot** submenu on line two allows the User to reset the system when the system is in a standby or fault state. Reboot does NOT revert user-entered settings to the factory default settings.

User Password

<New Pswd> [New Password]

<Ver Pswd> [Verify Password]

The **User Password** submenu on line two allows the User to change the user level password. Refer to the previous section on how to change a password for more data.

Logoff

<No/Yes>

The **Logoff** submenu on line two reverts the system to base password mode, disabling all password protected parameter adjustments. The user should manually log off using this menu after making any required changes.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Time of Use Menu

NOTE	The user will be able to view the data on the various screens of the Time of Use Menu without logging on with a password; to change any settings requires logging on with a user password.

The top-level **Time of Use** menu is used to program the on/off and power demand schedules for the MicroTurbine based on time and day of week. When Time of Use Grid Connect Dispatching mode is activated, up to 20 events may be programmed. An event consists of an ON or OFF command, a power level demand adjustment, and the time that the event executes.

LMTOU Event [Load Management Time Of Use]

The **LMTOU Event** submenu on line two displays the event number as 1/20, 2/20, through 20/20, and allows the selection of an event to be configured. The LMTOU Event submenus are detailed below.

- The **Day of Week** <Active/Inactive> on line three identifies the day of the week for the event execution. 1 = Sunday, through 7 = Saturday. Entering 0 disables the event without changing its time or other parameters.
- The **Time** submenu on line three identifies the time of day for the event execution. Enter in 24:00:00 format.
- The **Command** <Stop/Start>submenu on line three allows the start (On) or stop (Off) for the MicroTurbine of an event.
- The **Power Demand** <kW> submenu on line three identifies the power output demand level for the event. This is adjustable from 0.0 kW to the power capability of the system.

Grid Connect Menu

The top-level **Grid Connect** menu establishes operation parameters for the Grid Connect mode. This menu is applicable only when the MicroTurbine operates in Grid Connect mode. The Grid Connect Protective Relay settings are established here. The one Grid Connect submenu that is important to the User is detailed below.

Set Demand

<kW>

Allows entry of power output demand level in kilowatts. A password is not required to adjust this parameter from the display panel. Power output is adjustable from 0.0 to 2,000,000.0 kW to allow for the use of the MultiPac configuration.

WARNING	Do not attempt to change any Grid Connect Protective Relay functions other than Set Demand. Injury to personnel and/or damage to equipment can occur. Contact your Capstone Authorized Service Provider for additional information.

NOTE	The primary Grid Connect Protective Relay function is to ensure that the MicroTurbine does not energize utility wires de-energized by the utility.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Load Management Menu

NOTE	The user will be able to view the data on the various screens of the Load Management Menu without logging on with a password; to change any settings requires logging on with a user password.

The top-level **Load Mgmt** (load management) menu allows the user to put into operation the load management and reverse power flow protection dispatch scheme when the MicroTurbine is in Grid Connect mode. The Load Mgmt submenus are detailed below.

NOTE	Load Management requires an External Power Meter. The External Power Meter is not supplied with the MicroTurbine and must be connected between the MicroTurbine and electric service entrance by a Capstone Authorized Service Provider.

Rev Pwr Protect [Reverse Power Protection]

<Disable/Enable>

<Sec>

Enables the ability of the system to automatically shut down if the External Power Meter registers negative power flow. Line four displays the number of seconds allowed to output negative power flow before this shutdown occurs.

Utility Pwr [Utility Power]

<kW>

Input the number of kilowatts that the system will try to control utility usage with the External Power Meter for load management dispatch mode. This value is adjustable from -1000.0 to 1000.0 kW.

Response Time

<Sec>

Specifies the time period required before the system responds with a new output command based on External Power Meter signals. This is adjustable from 1 to 120 seconds and acts as a filter on power meter inputs.

Min TPwr Shutoff [Minimum Time Power Shutoff]

<kW>

<Min>

Indicates the minimum power value in kilowatts and time in minutes at which the MicroTurbine will shutdown. If your load is drawing less that a predetermined amount of power for the programmed time, then the MicroTurbine will shut down. The time value is adjustable from 1 to 15 minutes.

Meter Const [Meter Constant]

<Wh/Pulse>

Specifies the number of watt-hours represented by a single pulse signal from the External Power Meter. This is adjustable from 0.00 to 500.00 watt-hours/pulse. These parameters are usually established at installation of the External Power Meter and not changed once set. Contact your Capstone Authorized Service Provider for more data.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Stand Alone Menu

NOTE	The user will be able to view the data on the various screens of the Stand Alone Menu without logging on with a password; to change any settings requires logging on with a user password.

The top-level **Stand Alone** menu establishes voltage and frequency output and is applicable only when the MicroTurbine operates in Stand Alone mode. It also establishes the operational limits for voltage and frequency, and the rates at which voltage and frequency are increased to nominal on start up (RampStart). These limits are usually set when the MicroTurbine is commissioned and are not changed once set. Contact your Capstone Authorized Service Provider for more data on the Stand Alone menu.

Battery Management Menu

NOTE	The user can view the data on the various screens of the Battery Management Menu without logging on; to change any settings requires logging on with a password.

The top-level **Battery Mgmt** (battery management) Menu provides for adjustment of the battery charge management. Refer to the Battery Maintenance section for more data. The Battery Mgmt submenus are detailed below.

Auto Sleep Time

<Hrs>

Specifies the time that an inactive MicroTurbine will remain in the Standby state, before it automatically enters the Sleep state. This is adjustable from 0.1 to 23.9 hours and sustains minimal power draw to maintain battery life.

Manual Charge

<Disable/Enable>

Controls whether the system begins to recharge the battery when the system is in Grid Connect mode and in the Standby state or in the Stand Alone mode Load state.

<Day of Week> [for Equalization Charge]

Mon–Sun Eq Charge

Charge Allowed

<Disable/Enable>

Used to configure allowable times for a battery equalization charge cycle to occur. There is an **Eq Charge** submenu for each day of the week. Three equalization charge parameters apply. Selecting Disable disallows the entire day. Default equates to all days active. If a charge is allowed to occur, the **First OK Hour** and **Last OK Hour** are programmed using a 24-hour clock. Times should be configured to allow for a 4-hour equalization charge to occur.

Notice that once an equalization charge has started, it will complete regardless of the day and hour of the permission set-up.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

CHP Config Menu

The top-level **CHP Config** menu sets various parameters that direct the functionality of the CHP integrated package. These limits are usually set when the MicroTurbine is commissioned and are not changed once set. Contact your Capstone Authorized Service Provider for more data on the CHP Config menu.

UCB Analog Inputs

The top-level **UCB Analog Inputs** menu sets functionality for up to three analog inputs that may be selectively mapped on the user connection board. Each of these inputs may be utilized to control a variety of software functions of the iCHP package (i.e., external water temperature reference, water flow reference, or electric power demand) and is configured for either current (4-20 mA) or voltage (0-5 Vdc). Analog input functionality is usually established at installation and not changed.

UCB Output Relays Menu

The top-level **UCB Out Relays** menu allows setting the logic functions for the output relays on the user connection board. There are six output relays and each can be defined with a number of software functions. This functionality is usually established at installation and not changed.

Unit Data Menu

Notice that the user will be able to view the data on the various screens of the Unit Data Menu without needing to log on with a password. The top-level **Unit Data** menu displays real-time data for each MicroTurbine in a MultiPac system. The second line displays the unit number (1 thru 20; up to 100 with the optional Capstone Power Server), and the third and fourth lines displays data for that specific unit.

Data can be accessed from the master MicroTurbine unit in a MultiPac system or from an individual MicroTurbine using the display panel.

Turbine

<Number>

Selects one of 20 turbines (1-20).

Option

Allows the user to view the following parameters:

- System State Fault Status
- kW Output
- kW Demand
- Output Frequency
- Voltage Phases A, B and C
- Current Phases A, B and C
- Turbine Exit Temperature (TET)
- Engine Speed (RPM)

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

- Fuel Pressure/Fuel Percentage
- Battery Voltage/Current
- State of Charge (SOC)/Base State of Charge (SOC)
- Last Battery Equalization Charge Date/ Number of Equalization Charges
- Aborted Battery Charges/Battery State
- Battery Charge State/Charge Stage
- Battery Temperature/Battery kW
- Ambient Temperature/ Ambient Pressure
- Inverter Temperature/Generator Temperature
- iCHP Water In/Water Out Temperature
- iCHP Temp Feedback
- Diverter State
- Emergency Stop
- RFC Low Pressure Operating Time
- MicroTurbine Hours/Starts

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Using the User Interface Port

The User Interface Port is a DB9 RS-232 serial communications port located on the User Connection Board in the Communications Bay on the back of the MicroTurbine, and is available for remote operation of the MicroTurbine. Depending upon the MicroTurbine model, the User Interface Port location will be one of the following.

WARNING	The User should NOT open bays other than the Communications Bay within the User Connection Bay. Potentially lethal voltages exist inside the other bays.

You can communicate with the MicroTurbine via the User Interface Port by using a Windows 98/2000/NT or later computer with an RS-232 null modem cable and Capstone Remote Monitoring Software. Optionally, a modem may be connected to the User Interface Port for remote operation via a phone line at a baud rate of up to 56k bps.

NOTE	The default User Interface Port user password is set to **USR123P**; the user can change it by using the Capstone Remote Monitoring Software on a computer connected either directly to the User Interface Port or remotely via a modem. In the event of a lost user password, your Capstone Authorized Service Provider can reset the user password to this default.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Capstone Remote Monitoring Software

Capstone Remote Monitoring Software (CRMS) is the optional Capstone proprietary software that can operate and control the MicroTurbine from the RS-232 User Interface Port. This allows communication interface devices (a laptop plugged in with a null-modem cable or a remote computer via a modem) to communicate via the RS-232 port.

CRMS is an easy to use, menu driven Windows-based software for a remote computer to monitor and control the Capstone MicroTurbine. The software can control from 1 to 100 MicroTurbine systems, by direct connection or remotely via a modem. Copies of and licenses for this software are available for purchase from Capstone.

MicroTurbine Operating Modes

This section explains the different operating modes of the Capstone MicroTurbine and how to issue the applicable commands for each mode.

Grid Connect Operation

The MicroTurbine in Grid Connect operation allows electric utilities to expand generating capacity in small increments. This optimizes current infrastructure and reduces the need to upgrade specific site capacity and lowers overall costs.

Grid Connect Dispatch

Operation of the Capstone MicroTurbine in parallel with an electric utility grid consists only of commanding the system on or off, and commanding an output power level. In most configurations these commands are mostly or entirely automated in various ways termed dispatch modes.

NOTE	If Grid Power is removed for any reason, the auto restart dispatch mode can automatically command the system ON when Grid Power is restored.

Configuring Grid Connect

To configure the MicroTurbine for Grid Connect operation it is necessary to enable the Grid Connect Interlock and then command the system to Grid Connect mode either through the display panel or RS-232 commands over the remote communications interface, the User Interface Port.

Grid Connect Interlock

The Grid Connect Interlock consists of a pair of 5-volt dry circuit contact terminals located on the User Connection Board. A low resistance closed circuit between these terminals permits Grid Connect operation, opening the circuit disallows Grid Connect operation. The terminals are found in the Communications Bay at the rear of the MicroTurbine enclosure. **Your Capstone Authorized Service Provider should make this electrical connection.**

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Grid Connect Mode Enable

To enable the Grid Connect mode, the MicroTurbine must be correctly connected to a suitable live electric utility grid and the Grid Connect Interlock must be closed. **Your Capstone Authorized Service Provider should make this electrical connection.**

To enable the Grid Connect mode from the display panel, the user navigates to the System Data menu, then to the System Configuration submenu, and then to the Power Connect submenu. Select Grid Connect mode and then press the **ACCEPT** button. If the Grid Connect Interlock is open, the system will accept the command but post a GC Interlock fault, prohibiting a start.

Starting a Grid Connect System

The MicroTurbine system in Grid Connect mode must be commanded to start. Even if the system is configured for automatic operation, the initial **START** command is required to enable the automatic mode. If the Auto Restart feature is enabled, the **ON** command is stored by the system even through a loss of Grid Power.

To start the system from the display panel, press and hold the **INTERLOCK** button, and then press the **START** button. (If your MicroTurbine has been configured with a remote start/stop switch, simply set the switch to Start or On to start the system.)

Stopping a Grid Connect System

The MicroTurbine system can be stopped at any time. In Grid Connect operation, an **OFF** command will override any dispatch mode settings, and is stored by the system.

The shutdown process includes a cool down period, which can last up to 10 minutes, depending on the operating temperature at shutdown. During the cool down cycle, the power output is reduced and fuel supply is off but the MicroTurbine continues to rotate to dissipate excess heat.

A restart can be attempted at any time during a cool down period.

To stop the system from the display panel, press and hold the **INTERLOCK** button, and then press the **STOP** button. (If your MicroTurbine has been configured with a remote start/stop switch, simply set the switch to Stop or Off to stop the system.)

Grid Connect Power Demand

In Grid Connect operation, the MicroTurbine system must be commanded to a specific output power level. Each dispatch mode includes a power level setting. Some dispatch modes include automatic output power level changes.

Stand Alone Operation

Stand Alone operation provides power to remote facilities such as construction sites, oilrigs, or other locations where the electric utility grid is not available.

If the Capstone MicroTurbine is equipped with the Stand Alone option, operation consists of commanding the system on or off, and then enabling or disabling the power output. These commands can be automated.

Configuring Stand Alone

To configure the MicroTurbine for Stand Alone operation it is necessary to enable the Stand Alone Interlock and then command the system to Stand Alone mode either through the display panel or RS-232 commands over the remote communications interface, the User Interface Port.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Stand Alone Interlock

The Stand Alone Interlock consists of a pair of 5-volt dry circuit contact terminals. A low resistance closed circuit between these terminals permits Stand Alone operation. An opened circuit prevents Stand Alone operation. The terminals are found in the Communications Bay at the rear of the MicroTurbine enclosure. **Your Capstone Authorized Service Provider should make this electrical connection.**

Stand Alone Mode Enable

To enable Stand Alone mode, the MicroTurbine must be powered on (set the Battery Switch to **ON**) and the Stand Alone Interlock closed. To enable Stand Alone mode from the display panel requires logging on with a password; then navigate to the System Data Menu, System Configuration submenu, and the Power Connect submenu. Select Stand Alone mode, then press the **ACCEPT** button. If the Stand Alone Interlock is open, the system will accept the command but post an SA Interlock fault. If no battery is detected, an internal No Battery fault will be reported.

Stand Alone Battery

The Stand Alone MicroTurbine includes a large battery pack which stores energy for starting the MicroTurbine when disconnected from the electric utility grid, and which provides an electrical buffer for sudden increases or decreases in load during Stand Alone operation. Management of the battery and its state of charge is automatic within the MicroTurbine. An awareness of these battery management functions will promote an understanding of why the system may appear to behave autonomously. For example, the MicroTurbine will always attempt to fully recharge the battery after a user commanded shut down and before the MicroTurbine enters the cool down state.

Stand Alone Battery Isolation Switch

The Stand Alone MicroTurbine includes a battery isolation switch to disable the MicroTurbine for service or transport. The switch is found behind the kick panel at the bottom front of the enclosure. Set the switch to **ON** for system operation. Be sure to switch the breaker to **OFF** when not operating the system to maximize battery life.

System Sleep in Stand Alone Mode

Reducing battery draw to near zero during prolonged periods of non-use can extend the MicroTurbine battery charge significantly. This is called Sleep Mode. Sleep Mode is automatic, but the time of inactivity can be adjusted. Refer to the Display Panel section on Auto Sleep mode to adjust this timer. If the battery isolation switch is set to **ON**, and the display panel is dark, the system is most likely in Sleep Mode. In Sleep Mode, the battery pack needs to be recharged periodically. Refer to the section on Battery Maintenance for more data on recharging the Battery.

Waking a Stand Alone MicroTurbine

If the Stand Alone system is in Sleep Mode, pressing the **BATT START** button at the far left of the Display Panel (for less than or equal to 2 seconds) will wake it up. If communicating with the MicroTurbine remotely using a modem connected to the User Interface Port, the modem ring indicator will wake up a sleeping Stand Alone system.

CAUTION	Permanent closure of the battery start contacts (in the following paragraph) will completely discharge the battery. Therefore, the battery start contacts may only be closed for a period of 0.1 to 2.0 seconds.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Alternately, momentarily closing the battery start contacts in the communication bay will wake up the system. This must be a momentary closure of 0.1 to 2.0 seconds only, as permanent closure of these contacts will completely discharge the battery. **Your Capstone Authorized Service Provider should make this electrical connection.**

Starting a Stand Alone System

The MicroTurbine system in Stand Alone operation must be commanded to start. Even if the system is configured for automatic operation, an initial start command is required to enable the automatic mode. If the Auto Restart feature is enabled, the **ON** command is stored by the system even through a loss of system power.

To start the system from the display panel, press and hold the **INTERLOCK** button, and then press the **START** button. (If your MicroTurbine has been configured with a remote start/stop switch, simply set the switch to Start or On to start the system.)

Enabling Stand Alone Power Output

To enable power output, first start the MicroTurbine, and wait for the engine to warm up and for the base battery state of charge to reach at least 60%. A Not Ready to Load message is displayed. Press and hold the **INTERLOCK** button, and then press the **ENABLE** button.

NOTE	The Enable command can be issued at any time. The system will transition to power output when battery voltage and state of charge are ready.

The Auto Load dispatch mode will automatically issue the Enable command when the system is ready to support the connected loads.

Stand Alone System Power Level

In Stand Alone mode, the MicroTurbine system will produce (up to its capacity) whatever current is necessary to maintain the commanded voltage and frequency. The output power is determined by the connected load(s).

Disabling Stand Alone Power Output

To disable power output, press and hold the **INTERLOCK** button, and then press the **DISABLE** button. All power output will immediately cease, but the system will continue operating with fuel.

Stopping a Stand Alone System

The MicroTurbine system can be stopped at any time.

To stop the system from the display panel, press and hold the **INTERLOCK** button, and then press the **STOP** button. (If your MicroTurbine has been configured with a remote start/stop switch, simply set the switch to Stop or Off to stop the system.)

A system **OFF** command first disables power output. The system then charges the battery, which can take up to 20 minutes. Finally, the turbine shutdown process includes a cool down period, which can last up to 10 minutes.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Dual Mode Operation

If the MicroTurbine is equipped with the Stand Alone option and the optional Dual Mode Controller is installed, a setting in the MicroTurbine system software enables the system to reconfigure itself to either Grid Connect or Stand Alone operation mode. This is called Dual Mode.

In the case of grid loss/recovery, the operation of the MicroTurbine in Dual Mode is identical to the operation in Grid Connect mode or Stand Alone mode. Operation of the Dual Mode feature consists of switching the MicroTurbine (and protected loads) from Grid Connect operation to Stand Alone operation, or back.

NOTE	Note that both the Grid Connect and Stand Alone interlock terminals must be closed for Dual Mode operation.

Capstone Automatic Dual Mode Controller

The Capstone Automatic Dual Mode Controller is an optional accessory that enables the MicroTurbine to automatically transition from Grid Connect operation to Stand Alone operation when a utility power outage occurs. During a utility power outage, the MicroTurbine normally operates in Stand Alone mode to provide power to Protected Loads. The Automatic Dual Mode Controller isolates the MicroTurbine and the Protected Loads during Stand Alone operation. When utility power is restored, the Automatic Dual Mode Controller automatically returns the MicroTurbine and the Protected Loads to Grid Connect operation. The Automatic Dual Mode Controller also allows the MicroTurbine to be used as an automatically dispatched standby generator for Protected Loads.

The Automatic Dual Mode Controller can:

- Sense the loss of electric utility grid voltage, and then disconnect the MicroTurbine and its connected (protected) loads from the electric utility grid.
- Start the system and supply Stand Alone power.
- Sense the return of electric utility grid voltage, and then shut down the MicroTurbine.
- Reconnect the MicroTurbine and protected loads to the electric utility grid.
- Start the system and supply electric utility grid parallel power.

The MicroTurbine can be configured to automatically start and load itself in either mode.

Configuring Dual Mode

The MicroTurbine system settings must be established for both Grid Connect parameters and Stand Alone parameters, since the system will be operating in both modes at different times. Contact your Capstone Authorized Service Provider for data on establishment of these parameters.

Setting the System for Dual Mode Operation

To set the system to Dual Mode, use either the Display Panel or the User Interface Port. If using the display panel, you must log on with a password. Navigate to the top-level System Data menu, then the System Configuration submenu, and then the Power Connect submenu, and then select **DUAL MODE** and press the **ACCEPT** button.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Switching Times for Dual Mode

When a utility outage occurs, protected loads will be without power for up to seven minutes as the system transitions from Grid Connect to Stand Alone mode. When utility power is restored, the protected loads return to grid power within ten seconds, but the MicroTurbine will be offline for up to 32 minutes as it reconfigures to Grid Connect Mode.

MultiPac Operation

Capstone MicroTurbines may be configured into an array of up to 20 MicroTurbines (up to 100 with the optional Capstone PowerServer). Such an array will operate as a single power generation source. This MultiPac capability features a single control point (the master unit) and the combined synchronous output of the units in the MultiPac. Individual MicroTurbines share power, current, and load on both a dynamic and steady state basis.

MultiPac operation allows controlling the individual MicroTurbines through the master unit. Observation and control of each MicroTurbine in a MultiPac can be accomplished by the connection of a communications interface device through the master unit or Capstone PowerServer. Any MicroTurbine unit can be designated as the master unit. This unit then becomes the physical and logical control connection point for the entire MultiPac system.

Contact your Capstone Authorized Service Provider for additional information on establishment of a MultiPac system.

MultiPac Grid Connect Operation

In Grid Connect operation, each MicroTurbine independently synchronizes to the grid. MultiPac functionality provides a single interface point for Start, Stop, and Power Demand control. It is not necessary to connect a modem or external power meter to each individual MicroTurbine in a MultiPac, only to the master unit.

MultiPac Stand Alone Operation

In Stand Alone operation, MultiPac functionality provides the capability to synchronize the voltage source outputs of the individual MicroTurbines such that they share power and current on both a dynamic and steady state basis. The master MicroTurbine unit broadcasts synchronization data to the other units over a dedicated Capstone-proprietary digital communications bus.

MultiPac Redundancy

In MultiPac operation, if an individual MicroTurbine fails (shuts down due to a fault), the remaining units will continue to operate. If the master unit fails and communication is not possible, the entire MultiPac system will shut down. If the master unit fails, another unit in the MultiPac system can be manually programmed to be the new master unit (the MultiPac system must not be operating while this re-configuration is performed).

MultiPac Enable/Disable

Individual MicroTurbines must be disabled from a MultiPac system for service and maintenance. When service or maintenance is completed, the individual MicroTurbines must be added back into the MultiPac system (i.e., re-enabled). For data on the steps to Enable/Disable a MicroTurbine unit in a MultiPac system, refer to the Display Panel Menu Screens section on the top-level System Data Menu and the System Configuration Submenu, or contact your Capstone Authorized Service Provider.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Changing the Master Unit in a MultiPac

In a MultiPac system, one MicroTurbine is the master unit. To assign a different MicroTurbine to be the master unit, perform the following steps. The steps are presented in functional groups of steps for clarity.

NOTE	The following steps are performed on the Display Panel of the MicroTurbine that was the old master unit in the MultiPac. Alternatively, comparable steps can be performed using CRMS software on a computer connected to the MicroTurbine User Interface Port.

- *Disable the old Master from the MultiPac*
  1. Log on with the User Password (see Logging On with a Password on page 22).
  2. Go to the **System Data** top-level menu.
  3. Navigate to the **System Configuration** second-level menu.
  4. Navigate to the **MultiPac <Enable/Disable>** third-level menu.
  5. Use the (**+**) or (**-**) buttons to select Disable; then press the ACCEPT button.

NOTE	The following steps are performed on the Display Panel of the MicroTurbine that will be the new master unit in the MultiPac.

- *Set the MicroTurbine that will be the new master unit to number 1*
  6. On the new master unit, log on with the User Password (see Logging On with a Password on page 22).
  7. Go to the **System Data** top-level menu.
  8. Navigate to the **System Configuration** second-level menu.
  9. Navigate to the **Turbine Number <Number>** third-level menu.
  10. Press the "1" Numeric Keypad button to set the Turbine Number to 1; then press the ACCEPT button.

- *Enable MultiPac*
  11. Go to the **System Data** top-level menu.
  12. Navigate to the **System Configuration** second-level menu.
  13. Navigate to the **MultiPac <Enable/Disable>** third-level menu.
  14. Use the (**+**) or (**-**) buttons to select Enable, then press the ACCEPT button.

- *Reboot the new master unit*
  15. Go to the **System Settings** top-level menu.
  16. Navigate to the **Reboot <No/Yes>** second-level menu. Use the (+) or (-) buttons to select Yes, then press the ACCEPT button.
  17. If there had been a telephone line connected to the modem in the "old" master unit, move the telephone line connection to the modem in the "new" master unit.

At this point, the MicroTurbine that had been the original master unit is not part of the MultiPac. To include it in the MultiPac, continue with these steps on its Display Panel.

18. Go to the **System Data** top-level menu.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

19. Navigate to the **System Configuration** second-level menu.
20. Navigate to the **Turbine Number <Number>** third-level menu.
21. Use the Numeric Keypad to set the Turbine Number to a unique value; then press the ACCEPT button.
22. Navigate to the **MultiPac <Enable/Disable>** third-level menu. Use the (**+**) or (**-**) buttons to select Enable, then press the ACCEPT button.

iCHP Operation

The iCHP system has three modes of operation. These are:

- Thermal Bypass (default)
- Electrical Priority
- Thermal Priority

Thermal Bypass – In this mode, the exhaust diverter is locked in the fully bypass position, and the MicroTurbine can operate with a minimum water supply flow. The water flow must be able to absorb 3kW of thermal energy transferred from exhaust. This mode may be used when thermal demand is extremely low compared with the electrical load. All normal MicroTurbine control modes are supported.

Electrical Priority – In this mode, electrical power output is set to the desired level, and water temperature is set to a fixed temperature setpoint – allowing independent electrical and thermal operation. Efficiency will vary depending on both electrical and heat load requirements. Electrical Priority can be used in either Grid Connect or Stand Alone modes of operation.

In Grid Connect, the MicroTurbine is set to a fixed electrical output (in most cases, the maximum output), and water temperature is set to a fixed setpoint. During operation, the diverter adjusts exhaust flow through the heat exchanger to maintain water temperature. System efficiency will drop as exhaust is bypassed to maintain water temperature. This mode is typically used when either a fixed or maximum electrical output is required and usually sets a higher value, hence a higher priority on the electrical output rather than the heat output.

In Stand Alone, the MicroTurbine is programmed to follow the electrical load. As in Grid Connect, the water temperature is fixed. The diverter attempts to maintain a constant water temperature, despite the varying electrical output.

Thermal Priority – In this mode, the water temperature setpoint is fixed and is maintained by automatically varying the MicroTurbine electrical output. During this time, the diverter is fully closed, routing all the exhaust heat through the heat exchanger. If the MicroTurbine is operating at its minimum speed and power (idle), the diverter will begin to open if the water temperature begins to rise above its setpoint. At no time, will the heat exchanger be allowed to operate at an unsafe temperature.

This mode is typically used when maximum fuel efficiency is desired and electrical output is secondary. However, maximum efficiency can be maintained as long as minimum heat load can be achieved without opening the bypass. Thermal Priority can be used <u>only</u> in Grid Connect mode, and cannot be used in Stand Alone operation.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

MicroTurbine Preventive Maintenance

This section details the preventive maintenance procedures that must be performed on the Capstone MicroTurbine.

NOTE	Failure to provide proper maintenance will void the MicroTurbine warranty. Users do not perform the following MicroTurbine maintenance procedures, but it is important for users to be aware of them.

Only Capstone Authorized Service Providers can access the inside of the MicroTurbine enclosure (except for accessing the User Connection Board in the UCB/JUCB).

Only Capstone Authorized Service Providers can perform maintenance on the MicroTurbine components.

WARNING	The MicroTurbine system generates and uses voltage levels that can injure or kill. Obey all safety precautions when you work with or around electrical equipment.

Scheduled Maintenance

The table listed below details the preventive maintenance schedule of the MicroTurbine under normal environmental conditions. This information is provided for your reference. Only Authorized Service Providers are permitted to access MicroTurbine components and perform these maintenance tasks. Service intervals may differ between specific MicroTurbine models.

Item	Action	Service Interval
Air Filter, MicroTurbine Inlet	Clean / Replace	8,000 hours or as required
Air Filter, Electronics	Clean	8,000 hours or as required
Air Assist Filter, Liquid Fuel System	Inspect	8,000 hours or as required
Fuel Filter, Internal	Inspect / Replace	8,000 hours or as required
Fuel Filter, External	Inspect and/or Replace	8,000 hours or as required
Igniter	Replace	8,000 hours
Injector Assemblies	Replace	8,000 hours (liquid fuel) 20,000 hours (natural gas)
TET Thermocouple	Replace	8,000 hours (liquid fuel) 20,000 hours (natural gas)
Liquid Fuel Pump	Replace	4,000 hours
Boost Pump	Replace	8,000 hours
Battery Pack (included with Stand Alone MicroTurbine)	Refer to the following paragraphs	Refer to the following paragraphs

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Battery	None	Maintain battery charge per recharge intervals listed herein.
Electronics Air Filter	Inspect for cleanliness every six months or 4000 hours *(Note 1)*	Replace every 20,000 hours
Engine Air Filter	Inspect for cleanliness every six months or 4000 hours *(Notes 1, 4)*	Clean/Replace every 8,000 hours
ICHP Linear Actuator	None	Replace every 8,000 hours
Igniter	*(Note 3)*	Replace every 8,000 hours
Injector Assemblies	None	Replace every 20,000 hours
Inlet Fuel Filter	Inspect for cleanliness every six months or 4000 hours *(Notes 1, 2)*	Replace every 20,000 hours
Inlet Fuel Filter, External	Inspect for cleanliness every six months or 4000 hours *(Notes 1, 2)*	Replace every 8,000 hours
TET Thermocouple	None	Replace every 20,000 hours
UCB Battery – C30	None	Replace annually
UCB Battery – C60	*(Note 5)*	Replace every 24 months
Air Assist Filter	Inspect for cleanliness every six months or 4000 hours *(Note 1)*	Replace every 20,000 hours
Battery	None	Maintain battery charge per recharge intervals listed herein. Replace battery per expected cycle life calculations listed in the Battery Performance Technical Reference (410044) manual
Boost Pump, Enhanced Liquid Fuel System	Inspect for leaks every six months	Replace every 8,000 hours
Electronics Air Filter	Inspect for cleanliness every six months or 4000 hours *(Note 1)*	Replace every 20,000 hours
Engine Air Filter	Inspect for cleanliness every six months or 4000 hours *(Notes 1, 4)*	Clean/Replace every 8,000 hours
Igniter	*(Note 3)*	Replace every 8,000 hours
Injector Assemblies	None	Replace every 8,000 hours
Inlet Fuel Filter	Inspect for cleanliness every six months or 4000 hours *(Notes 1, 2)*	Replace every 8,000 hours
Liquid Fuel Pump (operating with Diesel # 2) or Enhanced Liquid Fuel System (operating with Diesel # 2 or Kerosene)	Inspect for leaks every six months	Replace every 4,000 hours
Liquid Fuel Pump (operating with	None	Replace every 2,000 hours

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Kerosene)		
Liquid Fuel System Fittings	Inspect for leaks every six months	Tighten and secure every 8,000 hours
TET Thermocouple	None	Replace every 8,000 hours
UCB Battery - C30	None	Replace annually

NOTES	1. Filters may require more frequent attention based upon environment, installation, and/or air and fuel quality. 2. It is common to find significant amounts of contamination in newly installed fuel lines. A new installation requires inspection of the external fuel filter frequently, until the contamination trapped in the fuel filter falls to a consistent rate. 3. Load profiles with onloads and offloads (non-steady state operation) may require more frequent replacement of the igniters due to usage during injector switching. 4. HEV filters are supplied by the Integrator. Refer to Note 1 for inspection information. 5. C60 Stand Alone, standby only: With the modem connected, the UCB battery will drain in five to seven days. Disconnect modem or turn OFF power to modem to extend the battery life.

Offshore/Coastal Scheduled Maintenance

Maintenance items and intervals for the various components of the offshore/coastal MicroTurbine systems are highlighted in the following table.

NOTE	Inspection and maintenance intervals for offshore/coastal MicroTurbine components are in calendar times as shown in the following table.

Battery	None	Maintain battery charge per recharge intervals listed herein. Replace battery per expected cycle life calculations listed in the Battery Performance Technical Reference (410044) manual
BCM	Inspect annually	Replace every two years
BCT	Inspect annually	Replace every two years
DPC	Inspect annually	Replace every two years
ECM	Inspect annually	Replace every two years

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Electronic Controller Fans (C60 Only)	Inspect annually	Replace annually
Engine Harness	Inspect annually	Replace every two years
Gas Detector Calibration (Optional Equipment)	None	Calibrate every six months. Refer to Detcon MicroSafe™ Model FP-624C Combustible Gas Sensor Operator's Instruction Manual (Document #2246, Rev. 6.6 or later) for details.
Intra-Controller Harness	Inspect annually	Replace every two years
LCM	Inspect annually	Replace every two years
Magnehelic Pressure Gauge (Class I, Div. 2 Systems Only)	None	Calibrate zero setting annually by turning calibration screw at bottom of gauge with blower system turned OFF.
UCB Board	Inspect annually	Replace every two years
Ventilator Blower Air Filter (Class I, Div. 2 Systems Only)	None	Clean/Replace annually

NOTE	For maintenance intervals of all other offshore/coastal MicroTurbine components, refer to the applicable maintenance schedules elsewhere in this document.

Preventive Maintenance

Preventive maintenance activities for the MicroTurbine Inlet Filter, External Fuel Filter, and for the Battery Pack are described in the following paragraphs.

MicroTurbine Inlet Air Filter

The engine air inlet filter should be inspected periodically to ensure unrestricted flow of clean combustion and cooling air to the generator and turbine engine. The recommended interval for this inspection is every 8,000 hours of operation or annually, based on clean environment operation.

Outdoor operation, especially in areas subject to wind and airborne dirt or dust, will require a significant reduction in this interval. If the MicroTurbine is operated under unusual conditions, the filters should be checked more frequently to determine a site-specific service interval. Filters may require more frequent attention based upon environment, installation, and/or air quality.

There are two different types of inlet air filters used on the MicroTurbine. Models using a cotton fiber filter can be cleaned and reused; other models use a disposable paper filter.

Cleaning or replacement of the inlet air filter is only to be performed by a Capstone Authorized Service Provider or other qualified individual.

CAUTION	The MicroTurbine requires clean, dust free air for operation. Do not operate the MicroTurbine without the inlet air filter in place or damage to the equipment can occur.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

External Fuel Filter

The optional external fuel filter element should be replaced periodically to ensure unrestricted flow of clean fuel to the MicroTurbine. This is necessary for MicroTurbine optimal performance. The recommended interval for this replacement is every 8,000 hours of operation, or annually. The service interval is based on typical clean fuel supplies found in the United States. Filters may require more frequent attention based upon environment, installation, and/or fuel quality. Liquid fuels may require more frequent maintenance.

If specifically permitted by the Capstone Authorized Service Provider, the end user can replace the external fuel filter element. The Capstone Authorized Service Provider will provide instruction and oversight.

WARNING	MicroTurbine fuel is flammable and explosive. An explosion can cause death or injury to personnel and/or damage to equipment. No open flame or smoking is allowed near the MicroTurbine.

Battery Pack

The battery pack is a lead acid type, completely sealed, and maintenance free. The battery pack should be fully charged prior to storage and charged again prior to being put back into service. If the MicroTurbine is equipped with a battery, a Battery Isolation Switch is included.

MicroTurbines equipped with the Stand Alone option require maintenance for the battery pack. The battery pack is maintained through software during regular use, however battery packs stored for extended periods will become discharged and require service. Recharge intervals for battery packs in storage with the battery breaker **OPEN** are dependent upon the ambient storage temperatures.

The isolation switch should be set to **OFF** and the battery cable disconnected if the MicroTurbine is to be serviced or transported, or if the MicroTurbine will not be operated for a period of greater than two weeks.

The maximum recharge interval is specified in the following table:

Storage Temperature °C (°F)	Recharge Interval - Days
<20 °C (68 °F)	180
20 °C (68 °F) to 30 °C (86 °F)	90
30 °C (86 °F) to 40 °C (104 °F)	45
40 °C (104 °F) to 50 °C (122 °F)	20
50 °C (122 °F) to 60 °C (140 °F)	5

NOTES	1. The maximum recommended storage temperature for a battery pack is 40°C (104°F). Long-term storage above this temperature may impact battery pack life. 2. Storage over six months without charging or one year with charging is not recommended, as it may contribute to a shortened battery life in the field. 3. The recharge intervals shown in the following table also apply to the Model C60 UCB battery stored unplugged from the UCB Board.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Sleep Mode

During the Sleep mode, the battery pack should be at a higher state of charge since it is called upon to start the MicroTurbine and produce transient power immediately after start-up. This reduces the recharge intervals for Sleep state.

Recharge intervals for battery packs in Sleep mode are dependent upon the ambient temperatures as specified below. Recharge intervals do not apply to the C60 JUCB battery in the following table:

Ambient Temperature °C (°F)	Recharge Interval - Days	
	Model C30	Model C60
<20 °C (68 °F)	15	35
20 °C (68 °F) to 30 °C (86 °F)	15	22
30 °C (86 °F) to 40 °C (104 °F)	8	15
40 °C (104 °F) to 50 °C (122 °F)	4	10
50 °C (122 °F) to 60 °C (140 °F)	2	7

NOTES	1. A Grid Connect Idle Recharge or the Capstone External Battery Charger option may be used to perform the recharge as required. The battery voltage must be greater than 175 VDC on the C30 and greater than 180 VDC on the C60 to perform a Grid Connect Idle Recharge. 2. If the MicroTurbine is in Sleep or Standby mode, there is also a parasitic load that will greatly reduce the allowable storage time.

When the recommended recharge interval is reached, the battery pack voltage should be recorded, and the battery pack must be recharged.

If the MicroTurbine is in operation, a Manual Recharge or a Shutdown Recharge will be sufficient to recharge the battery pack. Refer to the section on Stand Alone operation and the Display Manual Battery Management Menu for more data.

If the MicroTurbine cannot be operated, the optional Capstone External Battery Charger can be used to recharge the battery pack. Contact your Capstone Authorized Service Provider for details on the Capstone External Battery Charger.

Battery Charge Management

The MicroTurbine system is designed to keep the battery approximately 80% charged during operation. This allows for sourcing and sinking of power transients in Stand Alone Mode. After an **OFF** command the system will recharge the battery to 90% before shutting down. This recharge can take up to 20 minutes.

During normal use, battery cells become charged unequally. Periodically, the MicroTurbine will perform an equalization charge cycle to keep the battery in top condition. Allowable times (in 4-hour minimum windows) must be programmed for when this can occur. Refer to the Battery Management menu in the Display Panel section.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Manual Battery Pack Equalization Charge

If the system is not operating or is in storage, a manual equalization charge may be commanded if the system is connected to the electric utility grid (Grid Connect Operation on page 31). Follow these steps to initiate a Battery Pack Equalization charge:

1. Enter your User Password.
2. Go to the **Battery Mgmt** (Battery Management) top-level menu, and then navigate to the **Manual Charge** submenu.
3. Select line three on the display panel and use the (**-**) or (**+**) buttons to **ENABLE** a manual charge.

Notice that battery pack equalization charge can take up to 4 hours.

Warranty

Each MicroTurbine ships with a standard warranty. Extended warranties are available. Contact your Authorized Service Provider for details on Capstone warranty terms and conditions.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Troubleshooting

This section details basic troubleshooting procedures and steps that the user can perform on the Capstone MicroTurbine without accessing the inside of the enclosure. Only Capstone Authorized Service Providers are permitted access to the inside of the enclosure.

WARNING	The MicroTurbine system produces and contains high voltage. High voltage can injure or kill. Obey all safety procedures when you work around electrical equipment. **Only Capstone Authorized Service Providers are permitted access to the inside of the enclosure.**

Incidents

The MicroTurbine continuously monitors a wide variety of parameters both internal and external to the system. An **incident** occurs whenever a measured parameter falls outside prescribed limits. Incidents include (but are not limited to) low fuel pressure, utility interruptions, and utility over voltages.

Incident System Severity Levels

When the system detects an incident, it may take one of several actions, depending on the system severity level (SSL). Actions range from simply noting the occurrence and continuing to operate, to immediate shutdown of the system. The action taken depends upon the severity of the incident. The system will attempt a restart only if the severity of the incident will allow it.

Depending on the parameter and the magnitude of the incident, the event is classified as either a warning or a fault.

A **warning incident** is a condition that is outside normal operating parameters, but which does not require a system shut down.

A **fault incident** is a condition under which the system shuts down to prevent possible damage to the MicroTurbine or unsafe operating conditions.

Incident Names and Codes

When an incident occurs, the **incident name** and **incident code** are displayed on the display panel.

The incident names are:

- Internal Warning or Fault
- Fuel Warning or Fault
- Grid Warning or Fault
- Lo-Temp Warning or Fault
- Hi-Temp Warning or Fault
- Hi-Alt Warning
- E-Stop Fault
- User Connection Fault

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Following the incident name will be a number up to five digits in length, called the incident or fault code. This code aids your Capstone Authorized Service Provider in determining the cause of the incident or fault.

Generally, Lo-Temp, Hi-Temp, and Hi-Alt incidents are due to ambient conditions that are outside the design envelope of the MicroTurbine. Continued operation under these conditions may affect operation and cause damage to the MicroTurbine. Normal MicroTurbine operation may be resumed once the ambient conditions return to the design envelope.

Internal Incident

An Internal Incident is one that is within a major subsystem of the MicroTurbine and is not recoverable by the user. In the case of an Internal Fault, the user should reboot the system. If unsuccessful in restoring normal operation, a Capstone Authorized Service Provider will be required to initiate repair of the MicroTurbine.

Fuel Incident

The user should initially check the fuel supply to the MicroTurbine. Verify that the shut off valve is open. Ensure the line has the correct fuel pressure. Check the optional external filter to ensure that it is not blocked. If the problem persists, call your Capstone Authorized Service Provider.

Grid Incident

This event is likely to be due to an electric utility grid disturbance. Check all breakers and fuses to ensure they are not tripped before troubleshooting. Reboot the system and attempt a start. If the problem persists, call your Capstone Authorized Service Provider.

Lo-Temp/Hi-Temp/Hi-Alt Incident

Generally, these incidents are due to ambient conditions that are outside the design envelope of the MicroTurbine. Possible solutions would be to adjust the room temperature, ensure that adequate ventilation is provided, and verify that the air input and exhaust are not obstructed. Continued operation under these conditions may affect operation and cause damage to the MicroTurbine.

E-Stop Incident

If the event display reads **MANUAL E - STOP**, check the optional emergency stop button and verify that it has been activated. If it has, reset the button, cycle power off to the MicroTurbine for 30 seconds, and turn the power back on. The fault should clear, and the system should resume operation. If it does not, call your Capstone Authorized Service Provider.

User Connection Incident

User Connection incidents can be due to incorrect Grid Connect / Stand Alone settings, mode transition faults when in Dual Mode operation, or to indicate a possible problem with external equipment connected to the MicroTurbine.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Viewing Incident Records

When an incident occurs the system records a snapshot of conditions at that time, called an Incident Record. Several incidents can occur in quick sequence, and the MicroTurbine will continue to operate or shut down depending on the severity of the incident(s).

The following parameters are recorded as part of the **Incident Rec** (Incident Record):

- Incident name
- Incident code
- Cumulative number of starts
- Date and time
- Output power
- Engine speed
- Turbine exit temperature
- Fuel device command
- Ambient temperature
- Voltage and current on each phase
- Frequency
- DC bus and power supply voltage
- Several internal system temperatures

To view an incident record on the display panel, navigate to the top-level **Incident Log** menu. The Incident Log menu records the last 20 faults and warnings. When the log is full, the oldest fault or warning is deleted and the newest one goes to the top as number one. The Incident Record submenu on line two displays the current incident number as 1/20, 2/20, 3/20 thru 20/20.

The two **Incident Rec** submenus that are important to the User are detailed below:

- The **Sts** (starts) submenu on line three displays the number of starts at the time of the incident. The incident text displayed on the fourth line is a description of the fault or warning.
- The **Date and Time** submenu on lines three and four, displays the system date in MM/DD/YYYY and the time in HH:MM:SS (based on a 24-hour clock) for the current incident. This data can be used to identify if more than one incident occurred at the same time to assist in troubleshooting.

NOTE	Having the above Incident Record information at hand when contacting your Capstone Authorized Service Provider will be very helpful.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Basic Troubleshooting Procedures

Basic Troubleshooting procedures are presented in the following paragraphs.

NOTE	Users do not perform some of the following MicroTurbine troubleshooting procedures, but it is important for users to be aware of them. Only Capstone Authorized Service Providers are permitted access to the inside of the enclosure (users are permitted to open the User Connection Bay to access the User Interface Port).

No Lights on Display Panel

If no lights are present on the Display Panel, troubleshoot as follows:

NOTE	Only Capstone Authorized Service Providers can perform the following troubleshooting steps.

1. If Stand Alone equipped, remove the kick plate at the lower front of system. Make sure the Battery Isolation switch, located behind the plate, is set to **ON**. Then press the **BATT START** button on the Display Panel.
2. If Grid Connect, verify electric utility grid voltage is present on the phase terminals in the Power Bay.

No Attempt to Start after ON Command

If no attempt is made to Start, after an **ON** Command, troubleshoot as follows:

1. Verify that the current communication device (Display Panel or User Interface Port) is the control device. See Control Device Authority and Priority on page 17.
2. Verify that **ON** command is consistent with the currently active dispatch mode. Refer to the section on Display Panel Menu Screens for more data.

Start Attempt Fails

If a Start Attempt fails, troubleshoot as follows:

1. If the system attempts but fails to start, an incident code will be registered as described in the previous sections.
2. The troubleshooting procedure is same as for Unexpected Shut Down or Warning in the next section.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Low Power Output

If Low Power Output is perceived, troubleshoot as follows:

1. Check your inlet fuel supply. Verify that the fuel isolation valve is open, and that the inlet fuel line has the correct fuel pressure.
2. Check your external fuel filter. Verify that the external fuel filter (if installed) is not blocked.
3. Check your inlet airflow, ventilation, and exhaust airflow. Verify that the inlet airflow and the exhaust airflow are not obstructed.
4. Check your ambient operating conditions. Verify that ambient conditions are not outside the MicroTurbine design envelope.

Unexpected Shut Down or Warning

When a warning incident occurs, no action is required by the user. When a fault incident occurs, the troubleshooting steps are as follows:

1. Attempt to restart. If unsuccessful, then verify the fuel, air, and electrical supply to the MicroTurbine.
2. Attempt to restart. If unsuccessful, then enter the user password and reboot the system through the Display Panel.
3. Attempt to restart. If unsuccessful, then cycle the power by shutting off power to the system, waiting 30 seconds, and turning the power back on.
4. Attempt to restart. If unsuccessful, then note the event number listed on the display window, and then call your Capstone Authorized Service Provider for assistance.

When required, your Capstone Authorized Service Provider will determine whether the event noted requires a service call or if the user can perform fault correction on site. Generally, the Service Provider will initiate a service call for Internal Fault codes. In most other cases, the Service Provider will recommend a possible course of action to return the MicroTurbine to operational status.

Rebooting a MicroTurbine

In the event you need to reboot a MicroTurbine, follow these steps:

1. At the Control Panel, go to the **System Data** top-level menu.
2. Navigate to the **System Configuration** second-level menu.
3. Navigate to the **Enter Password** third-level menu. Enter the User password. Then press the ACCEPT button. The third line of the display will now indicate "PROTECTED LEVEL SET".
4. Go to the **System Settings** top-level menu.
5. Navigate down to the **Reboot <No/Yes>** second-level menu. Use the (**+**) or (**-**) buttons to select Yes, then press the ACCEPT button.

A reboot of the MicroTurbine is an internal reset of the main processor without removing power from the MicroTurbine system.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

- Notes -

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

- Notes -

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Product Support

Capstone Turbine Corporation is dedicated to the concept of quality to the owners and users of every MicroTurbine. Your MicroTurbine should operate without trouble. If you require maintenance support or other technical assistance, **please contact your Capstone Authorized Service Provider**.

Capstone Technical Support can assist you by providing contact data for your Capstone Authorized Service Provider.

Fill in this record with information about your Capstone Authorized Service Provider to allow easier access.

Capstone Authorized Service Provider Contact Information	
ASP Contact Name	
Address	
Telephone	
Facsimile	
E-mail	

The following information will help your Authorized Service Provider assist you.

System Information	
MicroTurbine Model No.	
System Serial No.	
Fuel Type	
Modem Phone No.	
Options Installed, and any configuration data	

CUSTOMER SATISFACTION

We would love to hear feedback about your experience with our products. Please send email to **comments@capstoneturbine.com**

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

- Maintenance Log -

Event	Date	Hours	Starts
Commissioning			

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.