CAPSTONE TURBINE CORPORATION

CAPSTONE GAS PACK

USER'S MANUAL

Publisher

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ABOUT THIS DOCUMENT

This document provides user instructions to operate and maintain the Capstone Gas Pack fuel gas booster.

This document is intended for user personnel who may not have specific training on the Gas Pack system. Any required maintenance must be performed by Capstone Authorized Service Providers (ASPs), who have received rigorous training and have been certified to perform commissioning, troubleshooting, and repair of the MicroTurbine and the related systems.

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.

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 clarifies instructions or highlights information that might be overlooked.

SAFETY INFORMATION

The user must read and understand the Safety Information section of the Capstone MicroTurbine™ User's Manual (400001 for C30/C60 or 400017 for C65) before operation of the Gas Pack and related equipment. Failure to obey all safety precautions and general instructions may cause personal injury and/or damage to the equipment.

The user must also read and understand this manual before operation of the Gas Pack and related 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.

Only Capstone Authorized Service Providers (ASPs) should open the MicroTurbine enclosure or the Gas Pack enclosure (including panel removal or control console door opening) due to the inherent danger of multiple power sources, pressurized fuel gas and oil.

PRODUCT DESCRIPTION

The Gas Pack (see Figure 1) is a variable-speed drive device that serves to boost the inlet supply pressure of low pressure natural gas. The Gas Pack compresses pipe line quality natural gas from a low-pressure source and delivers pressurized fuel gas to the fuel system of a Capstone Model C60/C65 Natural Gas MicroTurbine, also referred to as C60/C65, MicroTurbine or MT in this document.

The Gas Pack can provide high-pressure fuel gas for up to two MicroTurbines using separate outlet Fuel Train assemblies which include 75 psig regulators with pressure gauges. The Gas Pack, MT(s) and interface kit(s) can be configured for either a single or dual MT set. The optional Gas Pack Inlet Kit interfaces the low pressure natural gas supply to the Gas Pack inlet. If the user chooses to use their own plumbing for inlet and high-pressure outlet, care must taken to ensure the high-pressure fuel delivered to the MicroTurbines is a steady 75 to 80 psig.

The Gas Pack operates external to the C60/C65 enclosure, but is integrated by physical attachment to the rear of the C60/C65 enclosure. The Gas Pack performs its intended functions through electrical power, start/stop, and general fault communication connections.

Two versions of the Gas Pack are offered: the AC version, fed by local utility 480 V, three-phase AC; and the DC version, fed by the MT 760 Volt DC power connection located at the back of the MicroTurbine. This DC power is fed from the Gas Pack-attached MT High Voltage DC Bus Bay via weathertight conduit directly to the Gas Pack.

Several Gas Pack configurations are available from Capstone to meet different application requirements. Both external AC and internal DC power versions are offered. The Gas Packs are provided as "kits" that include the required mounting hardware and a fuel outlet kit to connect to the MicroTurbine (MT) that the Gas Pack is mounted on. For some applications, a "skirt" is provided as part of the kit to protect the gas lines under the Gas Pack and to provide mounting space for a natural gas detector when local building regulations require it (these Gas Packs are designed for use with MTs having an internal gas pressure regulator – consult factory or your authorized Capstone distributor, if needed, to confirm which type of MTs are installed at a specific site).

Several optional accessories are also offered to simplify gas connections. These include two fuel inlet kits; one using a gas flame arrestor manufactured by Lisk, and a second one using a Protego brand flame arrestor. The Protego brand flame arrestor is certified to meet CE (European Conformity) requirements. A fuel outlet kit for a second MT is also offered, and allows one Gas Pack to provide fuel to two MTs. This second MT fuel outlet kit option is not useable with MTs having an internal gas pressure regulator. Installers can provide their own fuel inlet connections to the Gas Pack, and also can provide their own fuel connections to a second MT. However, they must ensure that the second MT has fuel inlet pressure between 75 and 80 psig by providing a suitable regulator and pressure gauge in their plumbing.

NOTE	The Gas Pack Assembly (without the optional inlet and outlet fuel kits) weighs about 420 pounds. Use appropriate equipment when positioning or moving the Gas Pack.

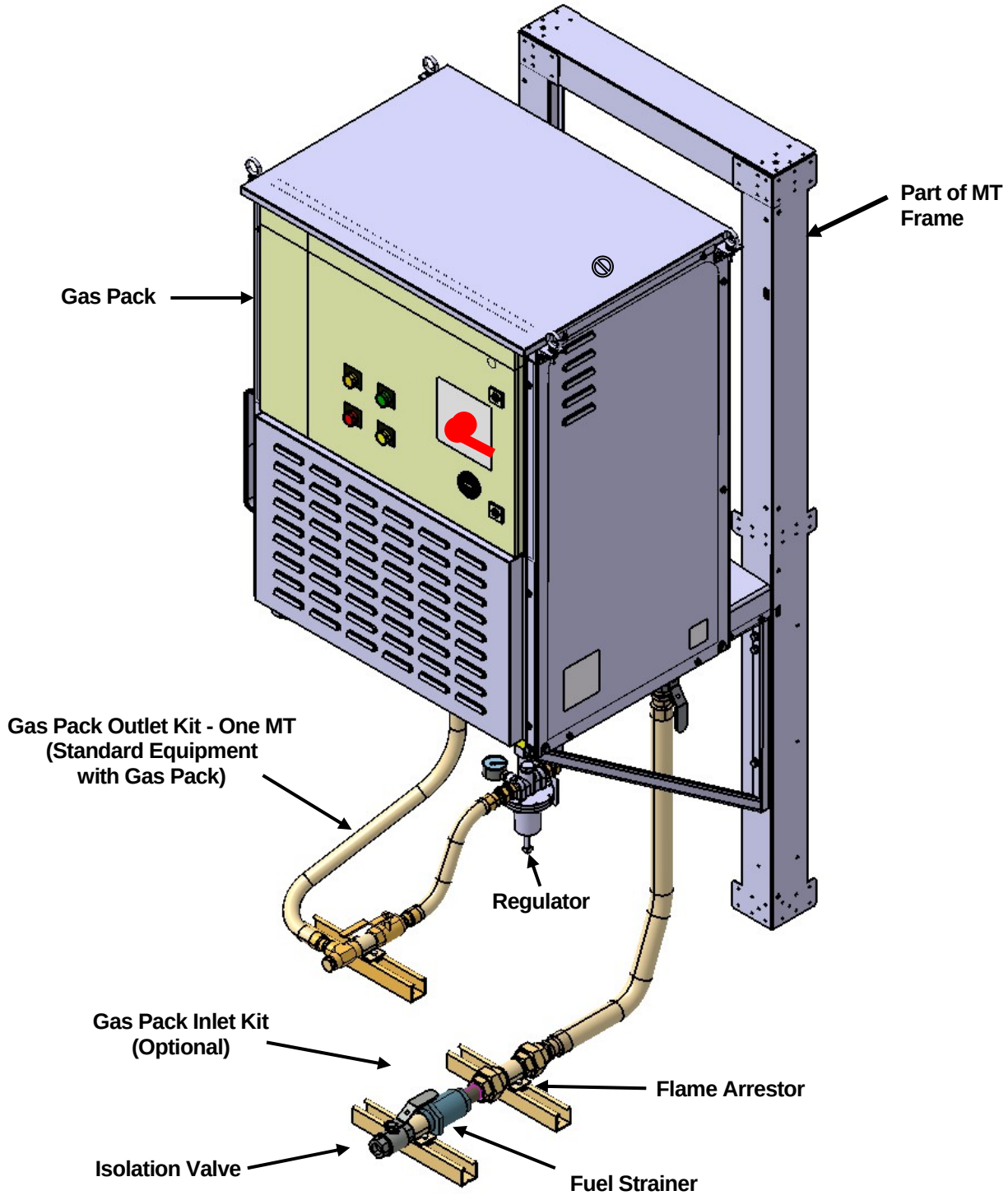

Figure 1. Gas Pack Fuel Gas Booster and Inlet/Outlet Fuel Kits

Gas Pack Block Diagram

Figure 2 shows a block diagram and flow schematic of the Gas Pack system.

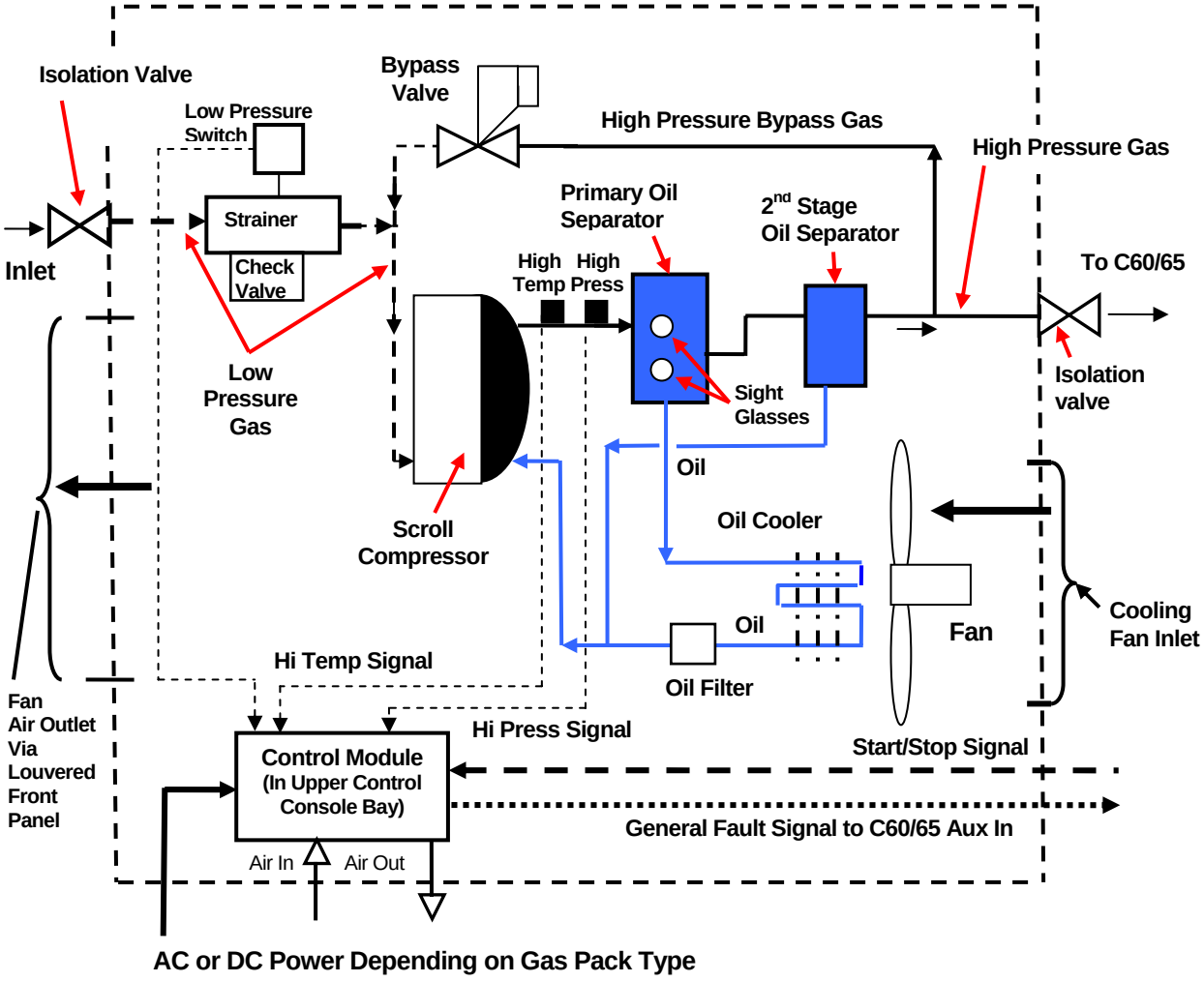

Figure 2. Gas Pack Block Diagram and Flow Schematic

PRODUCT INTERFACE DEFINITION

Figure 3 shows an interface layout of 2 MicroTurbines, Gas Pack, and Fuel Trains.

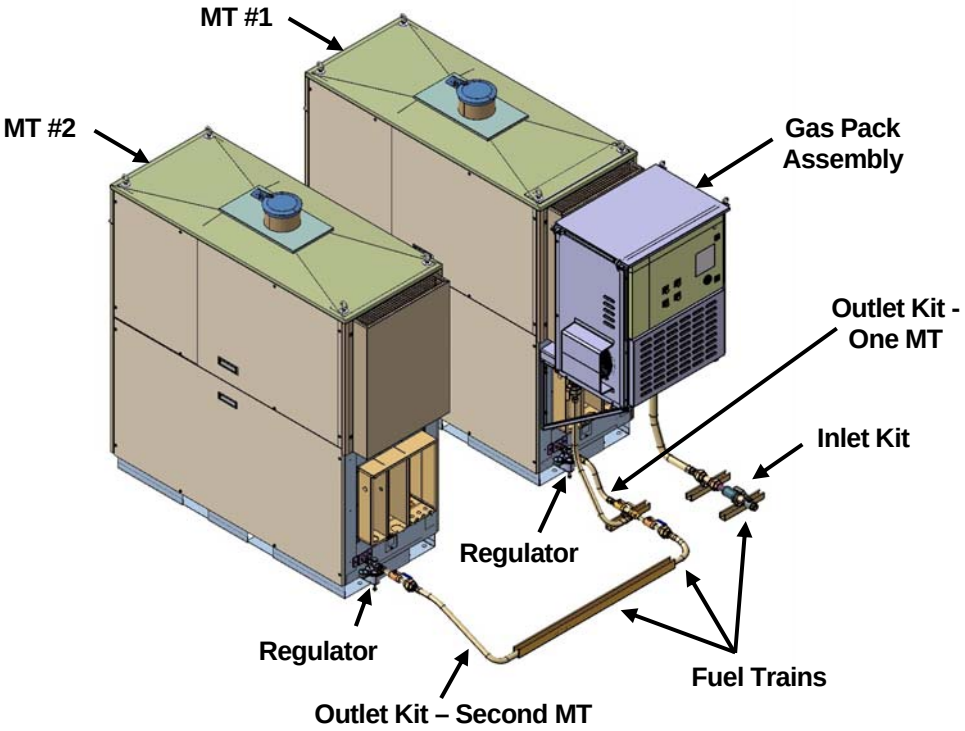

Figure 3. Installation Overview of 2 MicroTurbines, Gas Pack & Fuel Trains

Figure 4 shows the location and type of C60/C65 MicroTurbine inlet connector that interfaces with the Gas Pack fuel outlet plumbing (Fuel Train).

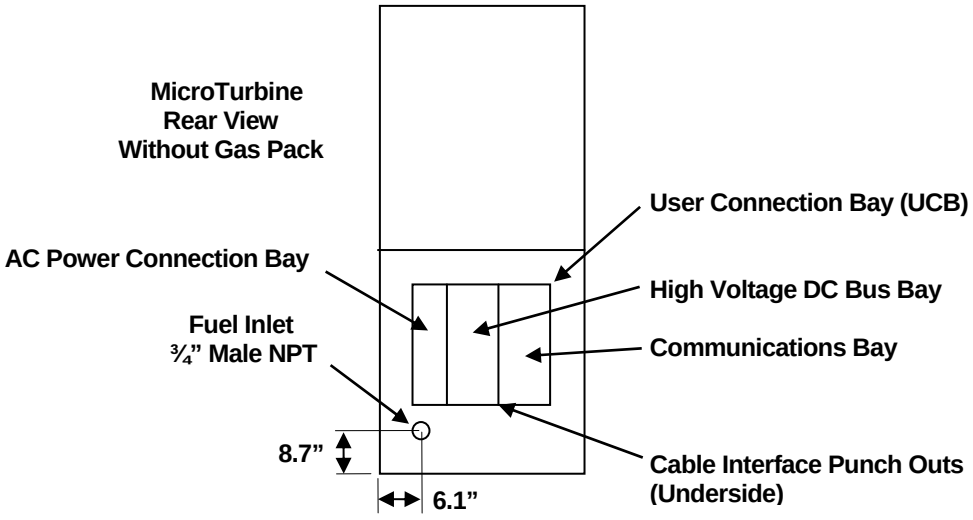

Figure 4. Rear View of MT Showing High Pressure Fuel Inlet Fitting

Figures 5 and 6 show the closer views of the installed Fuel trains for single and dual MTs equipped with the pressure regulator(s) near the MT inlet.

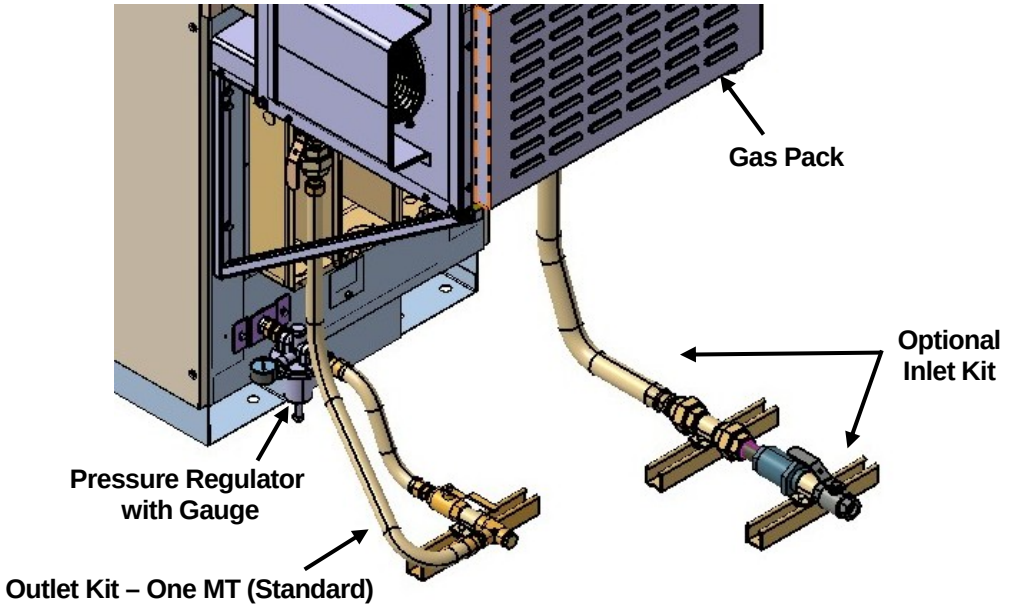

Figure 5. Single MT Installation Showing Gas Pack and Fuel Trains

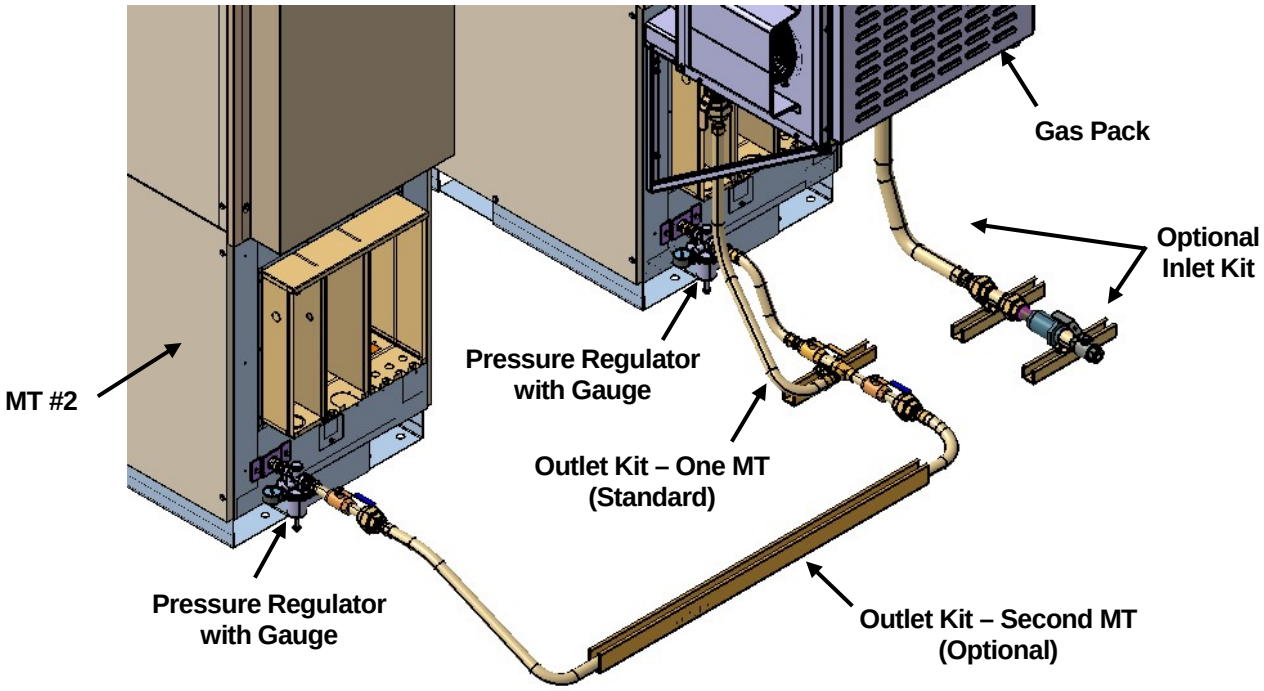

Figure 6. Dual MT Installation Showing Gas Pack and Fuel Trains

Control Panel Lights and Controls

Figure 7 shows the Gas Pack front panel control console with the associated functions described below.

ON/OFF Switch: The red handle rotating disconnect, called the "On/Off Switch," rotates counterclockwise to the Off position, interrupting the main power to the Gas Pack. The "On/Off Switch" may be a circuit breaker or fused disconnect (depending on the Gas Pack model) and functions as both a manual disconnect as well as automatic circuit protection for the Gas Pack.

POWER ON Light: An illuminated orange Power On light indicates the Gas Pack is energized. However, it does not indicate that the compressor is running.

RUN Light: An illuminated green Run light indicates that the compressor is running and able to supply compressed fuel to the MicroTurbine. Both the Run light and the Power On light should be on to indicate proper operation. If the compressor is running and either light is off, it means that indicator light is not operating properly.

FAULT Light: An illuminated red Fault light indicates a fault has occurred which has caused the Gas Pack to shut down.

RESET Button: The yellow Reset button resets the fault which has occurred so a Gas Pack/MT restart may be implemented by the user.

RUN TIMER: This indicator displays the accumulated Gas Pack run time in hours.

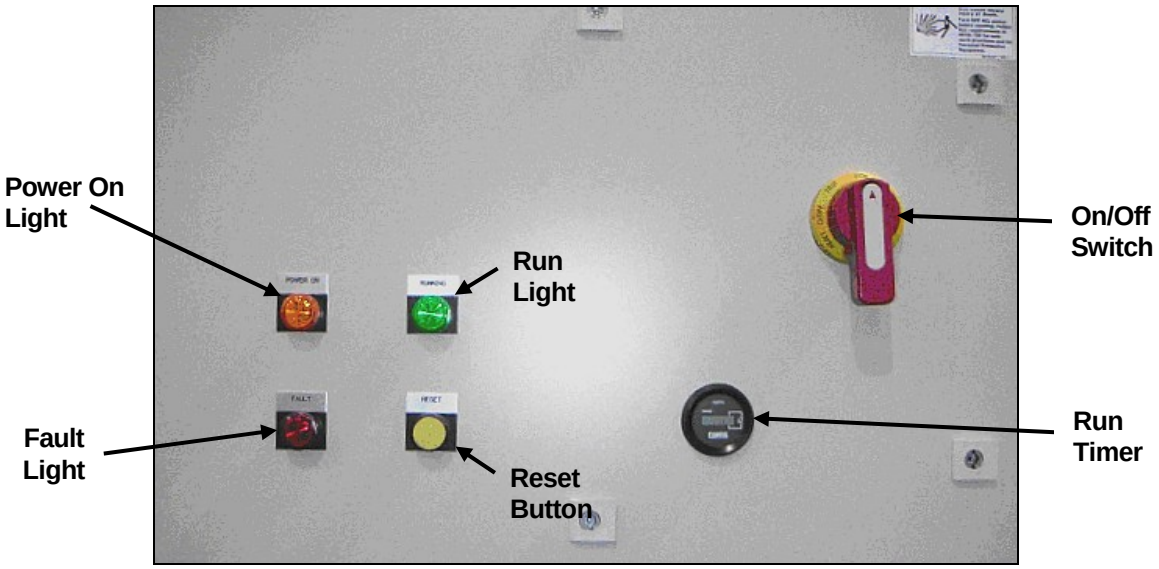

Figure 7. Gas Pack Control Console Panel

PRODUCT OPERATION

Normal Operating Procedures

The Gas Pack should already be installed and commissioned by a Capstone Authorized Service Provider. Therefore, the user operation need only follow the instructions below for normal startup and shutdown of the system.

System Start Up

Perform a startup as follows:

1. Confirm that the Inlet and Outlet valves on the Gas Pack are open, and that the main gas line connection is also open.
2. Make sure that the main circuit breaker or fused disconnect to the MicroTurbine(s) is on, and that the On/Off Switch on the Gas Pack is on. If the Gas Pack is an AC version, switch on the external circuit protective device providing power to the Gas Pack (the orange Power On light on the Gas Pack should now be illuminated). If the Gas Pack is a DC version, the power will be provided from the MicroTurbine's DC bus.
3. Perform a MicroTurbine startup according to your specific system setup. For example, using the Display Panel shown in Figure 8 – press the Interlock and the Start buttons simultaneously on the MT connected to the Gas Pack (or on the Master MT if configured in a MultiPac). Both the orange Power On and green Run lights on the Gas Pack will illuminate, indicating gas compression has started. The MT will automatically start according to its configured setup. Consult the MicroTurbine User's Manual (40001 or 40017) for additional information on MicroTurbine startup.

Figure 8. MT Display Panel and Applicable Functions

System Shut Down

Perform the following sequential steps to shut down the system:

1. Perform a normal MicroTurbine system shutdown according to your specific system setup. For example, using the MT Display Panel – press the Interlock Button and the Stop simultaneously to perform a normal system shutdown (see Figure 8). The MT and Gas Pack will both shut down in a normal sequence.

2. If shutdown is for an extended period of time, the user may also:
    a. Turn the main circuit breaker or fused disconnect to the MicroTurbine(s) off. If the Gas Pack is an AC version, switch off the external circuit protective device providing power to the Gas Pack (there is no need to turn the Gas Pack's On/Off Switch off).
    b. Close the gas Inlet valve on the Gas Pack.

CAUTION	The red handle On/Off switch should not be used to immediately stop a running compressor in a normal shutdown situation. This action stresses the compressor and should not be done unless absolutely necessary. Under normal operating conditions, a Gas Pack fault causes a normal Gas Pack shutdown which also shuts down the MicroTurbine.

Emergency Shutdown (Emergency Off)

In the event of an emergency situation with the Gas Pack:

1. Turn the red handle On/Off switch on the Gas Pack console panel counterclockwise to the Off position.
2. Close the Gas Pack Inlet gas isolation valve, and then close the Gas Pack outlet gas isolation valve.

CAUTION	This action stresses the compressor and should not be done unless absolutely necessary.

Simple Troubleshooting Scenarios

If the system does not start:

1. Verify that the inlet and outlet Isolation valves (under the Gas Pack) are open, and that the red handle On/Off Switch on the Gas Pack is on.
2. If the MicroTurbines are operating in grid connect mode, verify the correct utility power is available at the incoming circuit breaker or fused disconnect to the MicroTurbine(s) and that this main circuit protection device is turned on.
3. Check the status of the Power On and Run lights on the Gas Pack. If the Gas Pack is an AC version, the orange Power On light on the Gas Pack should be illuminated as soon as external power is provided to it. If the Gas Pack is a DC version, the Power On light should illuminate as soon as DC power is available from the MicroTurbine. In either case, the Run light should illuminate as soon as the MT initiates a start sequence.
4. Any fault may shut down both the Gas Pack and MicroTurbine(s). If the red Fault light in the Gas Pack is illuminated, try clearing the fault by pressing the yellow Reset button on the Gas Pack console. If the Gas Pack red Fault light extinguishes, a normal MT restart will also bring up the Gas Pack. If the MicroTurbine initiated the fault, it must be cleared before attempting a system restart. Refer to MicroTurbine User's Manual (400001 or 400017) for fault codes.

If the system stops during operation, proceed as follows:

1. Determine if the MicroTurbine(s) have shut down due to an electrical or other fault. Refer to MicroTurbine User's Manual (400001 or 400017) for how to read fault codes. If a MicroTurbine fault is present, take actions to clear the fault condition. The red Fault light in the Gas Pack may also be illuminated in the case of a compressor fault. If so, press the yellow Reset button on the Gas Pack console. If the Gas Pack red Fault light extinguishes and all MicroTurbine faults have been cleared, try restarting the system.
2. Verify that electrical power is available at the Gas Pack and that the MicroTurbine is either connected to suitable grid voltage (if operating in Grid Connect mode) or is able to provide power in Stand Alone mode. If the Gas Pack is an AC version, the orange Power On light on the Gas Pack should be illuminated as soon as external power is provided to it. If the Gas Pack is a DC version, the Power On and light should illuminate as soon as DC power is available from the MicroTurbine. If these conditions are met, try restarting the system.
3. Determine if the heat exchanger fan air inlet and the air vents are restricted in any way. This can cause excessive system temperatures, resulting in an over temperature fault condition. Clean or remove restrictions, if present, and restart the system.
4. Verify that incoming gas pressure is within the system design specification. Inlet gas pressure must remain steady within the range of 0.2 to 10.0 psig during startup and normal load operation. Excessive inlet pressure produces excessive motor current and causes the inverter or circuit breaker to trip. Insufficient pressure trips out the Gas Pack Low Pressure Switch, shutting down the system. Adjust inlet gas pressure to achieve steady operation within the required range, if needed, and restart the system.

NOTE	If the system runs for a short period of time, stops and indicates a fault that can be reset immediately, it is likely that the fuel supply is insufficient for the application. If the system inlet pressure falls below the minimum 0.2 psig, the inlet pressure switch opens and the system stops. When this occurs, the pressure usually increases enough to reset the low pressure switch.

5. If your Gas Pack system includes a regulator with pressure gauge at the inlet to each MicroTurbine, ensure that pressure is between 75 to 80 psig during operation.

Consult your Authorized Service Provider if you are not able to resolve the problem using the steps above.

PRODUCT MAINTENANCE

Maintenance by the user is limited to external cleaning, since only an ASP can open panels and the Gas Pack console door for component checkout, servicing and replacement. A liquid leak detector kit (soap solution/brush) is recommended for general external leak detection purposes around the Gas Pack and associated plumbing. Any line tightening, etc., must only be done by qualified personnel.

WARNING	• Only Capstone-trained persons (ASPs), qualified to work with flammable gases, and associated equipment, plumbing, high voltage electrical components and mechanical systems may perform maintenance, service, and testing on a Gas Pack. • All fuel gases are flammable and some may be toxic. System users are responsible for following proper associated safety and personnel protection measures. • Follow all federal, state, and local regulations regarding energy isolation and maintenance – including use of approved Lockout, Tag, and Try procedures. • Maintain approved clearances from all electrical components.

CAUTION	• Do not operate the system with the inlet gas supply off or allow the unit to operate at a vacuum on the inlet side. • Do not operate this unit in excess of its rated capacity or gas inlet pressure referenced on the nameplate (10 psig).

Scheduled Maintenance

The Table 1 details the preventive maintenance schedules of the Gas Pack under normal environmental conditions. This information is provided for your reference. Only Authorized Service Providers are permitted to access Gas Pack components and perform these maintenance tasks.

Table 1. Gas Pack Scheduled Maintenance – Gaseous Fuels

Maintenance Interval	Component	Maintenance Action	Comments
8,000 hours	Heat Exchanger	Clean	Contact your ASP to schedule service
	Second Stage Oil Separator	Replace	
	Oil	Replenish	
	Oil Filter	Replace	
20,000 hours	Scroll Compressor	Replace	
	Oil	Replenish	
40,000 hours	Heat Exchanger	Replace	

REFERENCE DOCUMENTS

Table 2 lists applicable Capstone reference documents.

Table 2. Reference Documents

Document No.	Document Title
400001	Model C30/C60 User's Manual
400017	Model C65 User's Manual
480028	Gas Pack Commissioning Procedure and Checklist

CAPSTONE CONTACT INFORMATION

If questions arise regarding the Capstone Gas Pack fuel gas booster, please contact Capstone for assistance and information.

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