

NEW STANDARD FOR MOBILE GAS TURBINE POWER PACKAGES

Introduction

There has been an increased need for large-scale transportable power to meet emergency, outage and climate driven requirements around the world. To address this need, engineers at Pratt & Whitney Power Systems created an environmentally compliant 25MW Mobile Power Plant readily transportable by air, sea, or land, and easily set up within a small footprint in potentially challenging environments.

Design

The primary design goal was to provide a transportable power plant that required minimum setup time and high reliability. A total of four trailers are required to transport all of the equipment needed to set up a MOBILEPAC plant. One of two operational trailers contains the FT8 gas turbine engine pre-coupled and aligned to the generator. In addition to the gas turbine and generator, this power trailer includes the inlet plenum, exhaust collector/diffuser, and the engine and generator lube oil systems. Figure 1 is a 3D model of the structure and assembly used for design and structural analysis. The second operational trailer contains the generator circuit breaker, MCCs, and all control/monitoring equipment. Two additional trailers carry the remainder of the package including filters, silencers, piping, and quick disconnect cables.

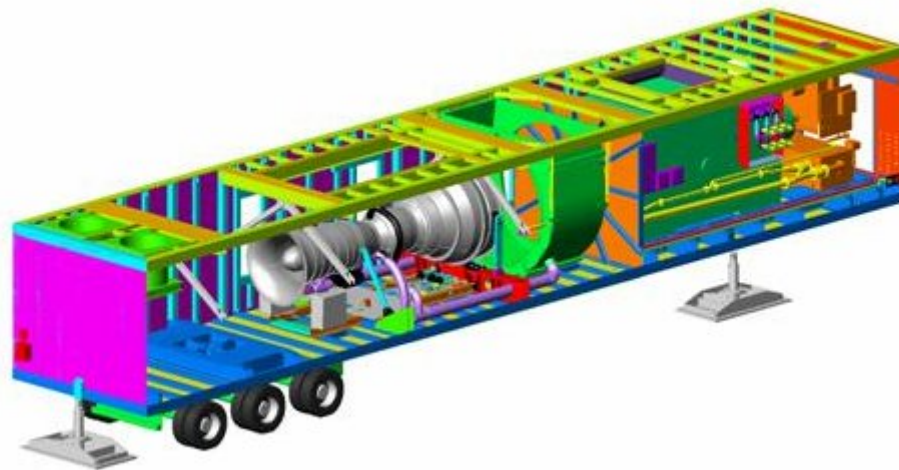


Figure 1: 3D Model of the Mobile PAC

In order to keep weight to a minimum, PWPS engineers designed a riveted aluminum monocoque structure for the power trailer. The structure is similar in construction to an aircraft in which aluminum skin is riveted to stringers to form a strong yet lightweight container which reacts much like a reinforced cylinder to resist torsional, buckling and deflection loads. Basically, the skin of the trailer supports all of the static and dynamic loading of the gas turbine generator installation as opposed to reinforcing a conventional trailer with heavy channel and beam structures for strength.

The trailer utilizes a 3-point support commonly used when installing gas turbine generator packages on offshore platforms and aboard ships. One outboard jacking/leveling plate is located towards the rear of the trailer and two are centered under the generator. In the field each of these leveling plates sits on engineered fill compacted to 4000 lbs per square foot or concrete pads at the option of the owner-operator. The 3-point support allows the monocoque structure of the trailer to act as a solid plane transferring its weight to the plates. Should one leveling plate sink, everything remains in plane so the generator and turbine coupling alignment is not affected. Thanks to a lower weight shell, the trailer could be acoustically treated to attenuate noise from the engine and generator without exceeding axle-loading limits.

Figure 2 shows a power trailer under construction. The picture is taken through the inlet with the plenum not installed. A few items of note in this figure: Interior walls are perforated aluminum sheet covering acoustic insulation; Quick disconnect cable connectors can be seen on both walls of the trailer; Roof openings for engine removal, exhaust and generator exhaust; Piping in foreground is engine lubrication oil.

The control trailer is built on a custom fabricated trailer. This trailer includes: 15-kV generator circuit breaker, engine and station control and monitoring system, protective relays and synch panel, batteries and charger, motor control center, package auxiliary transformer, hydraulic engine starter, and CO2 fire suppression system. To maintain a benign environment for the electronics, the control enclosure is heated and air-conditioned.

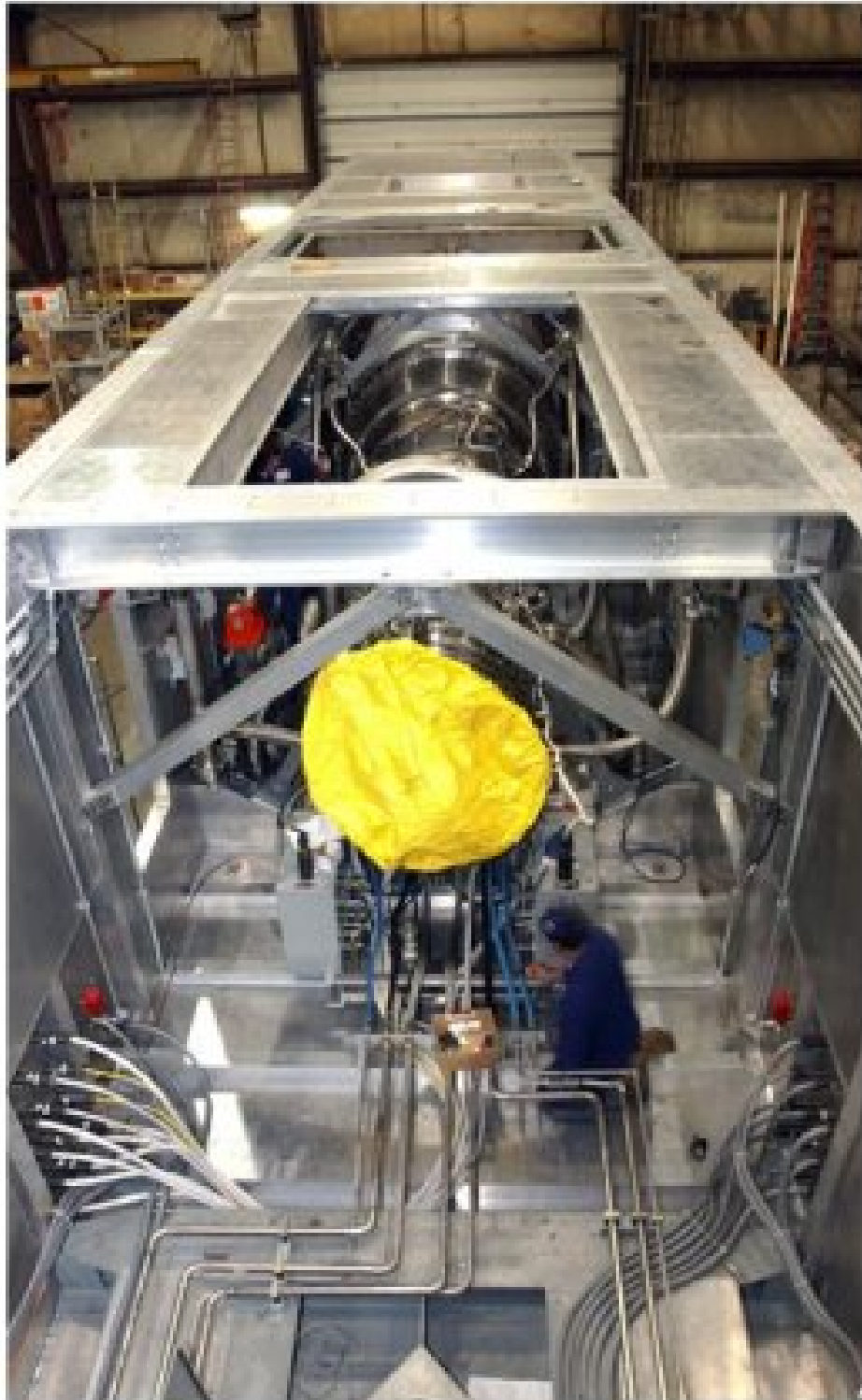


Figure 2: MOBILEPAC Power Trailer under construction

Transportation

The power trailer is transported to its site by a jeep and wheeled tractor that fits to a pivot pin under the front of the trailer. In addition, a hydraulically steered bogey located towards the aft end of the power trailer increases maneuverability on tight roads and simplifies positioning the trailer upon arrival at site. The power trailer suspension is equipped with an air ride system to absorb road shock and pneumatic jacking capability to adjust for road clearance. This trailer is approximately 65 ft long by 12 ft wide and 13.5 ft high. Significant clearance was design on the underside of the trailer to accommodate highly crowned or undulating roads.



Figure 3: MOBILEPAC Power Trailer in transit on the Interstate.

The control trailer is approximately 50 feet long by 11.5 feet wide and 13.5 feet high.



Figure 4: MOBILEPAC Control Trailer on the Interstate

Two standard flatbed trailers about 48 ft long by 11.8 ft wide by 13.5 ft high are required to deliver accessory equipment. The inlet air filter, inlet silencer, and turbine exhaust stack sections are carried on one trailer. A second trailer carries additional turbine exhaust silencers, a generator exhaust silencer, and field piping and electrical equipment.

MOBILEPAC Installation

Depending upon site preference, the control trailer can be set either in-line with the power trailer or parallel to it. In either case, the switchgear end of the control trailer is positioned near the generator. Little is required in the way of advanced site preparation to support the power and control trailers. There are no pilings or concrete pads required. Basics required are a mobile crane, site electrical power, a relatively flat surface and, for the power trailer, compacted soil areas for supports.



Figure 5: Assembly of Power Trailer

Upon arrival, air suspension at the front and rear of the power trailer are inflated to take up the load and lift the trailer, the jeep is unhitched and removed, and the trailer leveled using the jack plates. After the jacks are set and locked, the air bags are deflated.

Electrical preparations include plugging in quick disconnect cables to mate with the already checked out turbine and plant electrical and control systems. Mechanical preparation includes removing shipping closures, connecting the cold air buffer, fuel and hydraulic start piping and hoses. Given a true emergency, the MOBILEPAC can be operated without installing filtration or silencing equipment. In this situation full power output could be supplied to the grid in as little as 12 hours. A normal timetable allows for installation of the turbine inlet silencer and filter (using crane supplied by operator-owner), turbine exhaust transition and silencers, and a generator exhaust silencer – all of which bolt to the top of the power trailer. Both accessory trailers remains on site just long enough to deliver (or pick up) the accessory equipment. Using an experienced crew, a typical installation requires and additional 12 hours for completion of mechanical and electrical preparations plus pre-operational system checkout by a 4-man crew working two 8-hr shifts.

All that remains for the plant to become operational is a fuel supply and connection to the power grid.



Figure 6: Trailers are designed for Air Shipment

First Site

The first installation of and FT8 MOBILEPAC was in the Canary Islands on the island of La Palma. The airport in La Palma was not capable of accepting such a large transport so the package was flown to an adjacent island and ferried to its final destination. The customer made the entire plant transportable by supplying a mobile sub-station and mobile high-side transformer. The only available site for this package was a terraced lot located on the side of a hill. A temporary access road was constructed to this lot and the trailers had to be located only a meter from the stone terrace wall to make everything fit. The flexibility and relatively small size of the MOBILEPAC made using this site possible.

Maintenance

There is plenty of room around the gas turbine engine to carry out routine inspection and maintenance procedures. Access and working room inside the power trailer is the same as inside a stationary FT8 enclosure. For instance, there is full access around the combustors to inspect and replace fuel nozzles, cans and transition pieces (as required) without first having to remove

other hardware that might be in the way. If necessary, the gas turbine and power turbines can be easily hoisted out of the removable power trailer roof. If it is ever necessary to remove the generator, the generator end wall of the trailer is also easily removable. Maintenance access to both the turbine and generator lube systems is also excellent thanks to a total of 10 full size access doors provided on the power trailer.



Figure 7: Mobile Site in the Canary Islands

Other Features

A MOBILEPAC can generate passive revenue by qualifying as “spinning reserve” or when operated as a synchronous condenser when not needed for emergency back-up or peaking. It does not require a clutch to operate as a synchronous condenser due to its free power turbine design. When in synchronous condenser operation, the plant can switch over to generate a full 25 MW power output within 1 minute. Under normal startup conditions base load power can be reached in less than 10 minutes.

The FT8 Mobile Pac is not taxed as a permanent structure.

Summary

The new Pratt & Whitney MOBILEPAC incorporates several new design concepts resulting in the most flexible and highest performing mobile power plant on the market. Improved design concepts for trailer design, equipment alignment, and leveling technology, create a package that lowers costs to the customer and allows installation in as few as 8 hours at a wider range of sites.