New engines add Marquise performance

David M. North/Washington
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Mitsubishi Aircraft International's new turboprop Marquise has increased performance with new 1,000-shp. Garrett AiResearch turboprop engines. The aircraft was flown here recently by this editor. The Dallas-based company recently phased out the MU-2N and MU-2P and replaced them with the Marquise and the Solitaire, respectively (AW&ST Aug. 7, 1978, p. 23).

Mitsubishi's plans call for between 60 and 70 aircraft to be produced in 1979 at its San Angelo, Tex., manufacturing facility. The current production rate is 5.5 aircraft per month, with 60% of them being the higher-priced Marquise. Depending on aircraft orders, the company is considering a production rate of six aircraft per month starting in 1980.

The response to the new aircraft has prompted Mitsubishi to expand its sales force, George H. Scragg, Jr., Mitsubishi's vice president of marketing, said, from 16 to 19 salesmen, operating from its three

Mitsubishi Aircraft International's new model Marquise incorporates two 1,000-shp. Garrett AiResearch TPE331-10-501M turboprop engines flat-rated to 715 shp. The Marquise can be distinguished from its predecessor, the MU-2N, by a smaller diameter tailpipe exhaust, and from the smaller Solitaire by the lower side bulges housing the main landing gear.

major sales offices in Denver, Houston and Hartford, Conn. The company also uses its five demonstrator pilots and technical advisers in its sales presentations to prospective operators.

Mitsubishi has made a decision to place the Marquise and the Solitaire in the quality end of the turboprop market and not to sell price, Scragg said. The first 10 Marquises are being sold at $1.095 million, with the price being raised to $1.185 million for later aircraft. The price of the first 10 Solitaires is $935,000, increasing to $980,000 for following aircraft.

Brand loyalty for the Mitsubishi aircraft is high, with nine out of 10 new aircraft bought by previous Mitsubishi owners, Scragg noted. "The new series is the first quantum step up in performance we have had in years," he added.

The evaluation of the Marquise was flown from Washington's Dulles Airport with Bruce H. Boehm, a demonstration pilot based at Bradley International Airport in Windsor Locks, Conn. During the preflight, Boehm described some of the changes that have been incorporated in the new aircraft. The aircraft to be flown was N907MA, the first production Marquise.

The biggest change to the new Marquise and Solitaire has been the incorporation of the Garrett AiResearch TPE331-10-501M 1,000-shp. engine. These engines have been flat-rated to 715 shp. and yield 778 eshp. in the Marquise. The Solitaire's two engines are rated at 724 eshp. each.

The two-stage centrifugal compressor and three-stage axial turbine on the Marquise has a larger turbine with a smaller tailpipe diameter than the TPE331-5-252M, which powers the MU-2N. The prime advantages of the new engines on the Marquise, according to Boehm, are the improved rate of climb at higher altitudes and the increased cruise speeds at the higher altitudes. The MU-2N has a normal cruise speed of 292 kt. at 12,000 ft., while the Marquise will achieve the same cruise speed at 18,000 ft.

The Marquise, with its wet wing, has a usable fuel capacity of 403 gal. in contrast to the MU-2N's capacity of 364 gal. This additional 39 gal. has contributed to the Marquise's range increase of approximately 200 naut. mi. to a total range of 1,395 naut. mi. with 45-min. reserve, flown at 31,000 ft. with maximum takeoff gross weight. The increased range also is partly attributable to a higher ratio of naut. mi./lb. of fuel achieved with a lower engine profile and the more efficient engines.

During the preflight, the same rugged exterior and attention to detail that marked earlier Mitsubishi aircraft was evident in the Marquise. The airframe of the Marquise has been structure tested for a

service life of 25,000 flight hours. The landing gear is of rugged, military-type construction and electrically operated with a manual backup system. Low-pressure, wide-profile tires allow operation from sod or gravel airfields.

The Marquise continues the use of spoilers for lateral control, rather than an aileron system. The use of spoilers allows space for full-span, double-slotted, Fowler-type flaps on the Marquise and the Solitaire.

Interior space and passenger comfort also were considered by Mitsubishi in its new turboprop. A shelf in the Marquise's baggage space was eliminated, providing the aircraft a 69-cu.-ft. baggage area. The toilet seat, which is located in this area, now is certificated as a passenger seat.

Cabin arrangement

Standard executive cabin arrangement allows for the seating of seven, plus two pilots, or eight with a crew of one. The interior furnishings in the Marquise can be removed to accommodate a high-density passenger capacity of 11, including crew. The interior furnishings include a refreshment center with a heated liquid dispenser. The trash can and insulated ice bucket have been made larger in the new aircraft.

Taking a cue from previous Mitsubishi owners, the company has widened the cabin seats, leaving an aisle width of 10 in. The cabin height is 51 in., and the three passenger seats can be moved away from the cabin side for added headroom. A three-place sofa also is standard in the Marquise.

One item of the interior design that is particularly pleasing to the pilot is the ability to reach the coffee dispenser from the left seat. The optional stereo tape controls also can be reached from the pilot's seat.

On the outside, the new Marquise is barely distinguishable from its predecessor. The larger Marquise can be differentiated from the eight-seat Solitaire by its side bulges, which house the landing gear. This year, for the first time, Mitsubishi is offering the De Vore Aviation Tel-Tail aircraft tail floodlighting system as optional equipment.

Autopilot storage

Once in the left seat, Boehm swung the autopilot console from its stored position below the center console to its operating location behind it. The autopilot is stored below the center console for easier access to the cockpit.

The Collins Pro Line avionics package is standard on the Marquise. This package includes the Collins FD-112V flight director with radar altitude scale, VOIR-30 AGM automatic omnis with dual glideslopes and

two VHF-20A transceivers. The Bendix M4D autopilot also is standard on the aircraft.

Of the few avionics options available, N907MA was equipped with an RCA Primus 300WXD digital color radar, rather than the RCA Primus 30A digital radar that is standard on the Marquise. Other options include the choice of a second transponder, King KNC-610 and Bendix RNS-3500 area navigation systems and a radar altimeter on the copilot's panel. A King Gold Crown avionics package is available to replace the Collins, if requested.

The Mitsubishi aircraft incorporate a Single-Radline/Auto Start system, consisting of an electronic computer that receives electrical input signals representing airspeed and ambient pressure, engine inlet temperature, engine rotor speed and exhaust gas temperature, and calculates a single exhaust gas temperature output signal. In the case of the Marquise, the exhaust gas temperature limit is 650C for maximum takeoff, continuous and cruise power settings.

Another change from earlier versions, and one that was requested by operators, was the calibration of fuel flow and quantity in pounds rather than gallons as on earlier aircraft. The Marquise uses a simple fuel system for its usable fuel capacity of 403 U.S. gal. There are four integral fuel tanks in the wings, with a fifth in the wing carry-through above the fuselage. This center tank feeds both engines, so with one engine out there are no fuel management problems. Tip tank fuel is transferred to the center tank by bleed air pressure, while the outer wing tank fuel is transferred by the use of electrically driven transfer pumps.

The Marquise's flight deck is well organized, and this pilot with no previous experience in Mitsubishi aircraft was able to find most of the items on the prestart checklist without difficulty. For single-pilot operation, all controls and instruments were reached easily. The anti-icing switches and gauges, plus lighting controls, are on the overhead panel.

N907MA had 1,500 lb. of fuel on board, and with three persons in the aircraft plus some baggage, the ramp weight of the demonstration Marquise was calculated to be 9,800 lb. This was 84.3% of the aircraft's maximum ramp weight of 11,625 lb.

Following the engine starts, which had a maximum temperature of 700C, both engines settled down to 430C, 150-lb./hr. fuel consumption each and 73% rpm at idle power. During the start, the electronic computer had been engaged and was monitoring the exhaust gas temperature.

During the long taxi from the Page Airways ramp to Runway 30, directional and speed control were accomplished with differential

and reverse blade angles using the power levers. The rudder pedal steering also was used, with no evidence of shimmy. The Marquise gives the impression of a sturdy and heavy aircraft during taxi. The lack of noise in the aircraft cockpit was evident, although the propeller arcs are less than 5 ft. behind the cockpit windows.

A running takeoff was made from midfield on Runway 30, with a takeoff roll of approximately 1,500 ft. for the 18C day and a 10-kt. headwind component. A 20-deg. flap setting was used for takeoff. An accelerate and stop distance for the same conditions that existed that day and on the demonstration Marquise was calculated from the performance data to be 2,300 ft.

Following the takeoff and a late raising of the gear and flaps by this editor, who was responding slowly to the aircraft's performance, a 200-kt. climb was started. Passing through 4,000 ft., the rate of climb was 1,800 fpm, while the fuel flow showed 410 lb./hr. on each engine. Passing through 15,000 ft. at 180 kt. using 650C exhaust gas temperature as the limiting factor, the rate of climb was 2,000 fpm with a 360 lb./hr. fuel flow on each engine.

The left engine showed 88% rpm, while the right engine's rpm gauge indicated 82. Boehm said that the rpm difference was attributable to running the pressurization from one engine. The Marquise uses an AiResearch pressurization system capable of 6 psi. differential. This system will give a cabin pressure altitude of 9,850 ft. when the airplane altitude is 31,000 ft.

A final altitude of 22,000 ft. was picked to give representative figures for cruise conditions in the Marquise. Because of altitude limitations imposed by Washington air traffic center, a time to climb could not be calculated. However, it took N907MA slightly less than 14 min. to reach 22,000 ft. The performance charts list the time to climb at 11 min., which Boehm said is conservative and can usually be beaten by 30 sec. or more. The performance charts also list 30 naut. mi. and 130 lb. of fuel to reach 22,000 ft.

With 100% rpm set at 650C exhaust gas temperature, the Marquise was indicating 205 kt. with a fuel flow of 280 lb./hr./engine. True airspeed was calculated to be 292 kt. at the high-speed cruise conditions.

Still at 22,000 ft., a power setting of 96.5% was selected, giving 200 kt. indicated and a fuel flow of 260 lb./hr. For the -10C air temperature, a true airspeed of 287 kt. was determined, with the book value for the same conditions given at 284 kt. The Mitsubishi figures for the fuel flow at the same conditions was approximately the same as indicated.

The RCA radar had been on standby since takeoff and was now turned on to pick up any weather in the West Virginia area where N907MA was operating. With no weather, the radar was put to mapping the mountainous terrain, which it did with clarity.

A descent to 13,000 ft. was made at the redline speed of the aircraft, 250 kt., and at that speed, conversation with Boehm was easy at a normal voice level. The Mitsubishi aircraft have the reputation of being quiet in the cabin and the cockpit alike.

During the descent, turns using various bank angles were made. The Marquise was found to be stable, and once the aircraft was trimmed for the flight condition, the control wheel could be released with the aircraft continuing on its flight path. The Marquise did not require an excessive amount of trim in transitioning from 250 kt. to 120 kt. prior to accomplishing a series of stalls.

At 90 kt. with the landing gear and flaps extended, the Marquise had instant roll and pitch control response. The stick shaker activated at 75 kt., and the aircraft stalled at 68 kt. The stall was straightforward with no tendency to fall off on a wing. The nose was lowered and power added with less than 100 ft. of altitude loss. The stall had been entered with above idle power.

In the clean configuration, the aircraft's stick shaker activated at 95 kt., and the stall came at 90 kt. The speed loss was gradual, and near the stall speed, elevator control appeared to become less effective in keeping the aircraft in the nose-high position. Roll control was responsive throughout the stall series.

Because of time limitations, one visual landing was made on the return to Dulles Airport. With clear weather conditions, the visibility from the Marquise cockpit was found to be excellent for keeping track of the airport and other aircraft.

Touchdown speed

The base leg was flown at 130 kt., slowing to 120 kt. on final with the gear and flaps down. The aircraft was then slowed to 90 kt. over the threshold of Runway 01. Touchdown should have been close to 80 kt., but this pilot, looking for the runway, kept the speed at 90 kt. and landed fast. Boehm said the aircraft require some familiarity because of the low eye position in the cockpit.

The Marquise was stopped in 1,400 ft. without using full reverse and remained comfortable in the pilot's seat in regard to pull in the seat belt and shoulder straps. The Mitsubishi performance charts indicate that the landing distance over a 50-ft. obstacle for a 9,000-lb. aircraft is 1,500 ft. with the weather conditions at Dulles. This is based on using a short-field landing technique, which was not used in the

demonstration flight. The 1-hr. 18-min. flight in the Marquise used 800 lb. of fuel, with 700 lb. of fuel remaining.

Engine warranty

The engines are warranted for 12 months, or 1,000 hr., with a time between overhaul of 3,000 hr. Included in the standard price of the Marquise and the Solitaire is the training of two pilots and one mechanic at the FlightSafety International facility at Hobby Airport in Houston.

Mitsubishi estimates the total direct operating cost of the Marquise to be $115.37/hr. Including indirect operating costs for hangar rental and insurance, the total operating cost per hour is estimated to be $155.50 for 400 hr. flown annually, and $135.44 for 800 hr. flown annually. This translates to an operating cost per mile at 331 mph of 46 cents for 400 hr. flown annually.

MARQUISE SPECIFICATIONS

POWERPLANT

Two Garrett AiResearch TPE331-10-501M turboprop engines rated at 1,000 shp., flat-rated to 715 shp. Hartzell four-blade, constant-speed propellers.

WEIGHTS

Maximum ramp weight	11,625 lb. (5,270 kg.)
Maximum takeoff weight	11,575 lb. (5,250 kg.)
Maximum landing weight	11,025 lb. (5,000 kg.)
Standard empty weight	7,650 lb. (3,470 kg.)
Total usable fuel	403 U.S. gal. (1,531 liters)

LIMITATIONS

Service ceiling at 10,200 lb.	33,000 ft. (10,069 meters)
Single-engine service ceiling at 10,200 lb.	18,200 ft. (5,550 meters)
Maximum operating speed V_{mo}	250 KCAS (463 km./hr.)
Minimum control speed V_{mo}	99 KCAS (184 km./hr.)

PERFORMANCE

Range at maximum takeoff gross weight, 45-min. reserves	1,395 naut. mi. (2,570 km.)
Takeoff distance over a 50-ft. obstacle	2,170 ft. (660 meters)
Ground roll	1,825 ft. (556 meters)
Landing distance at 11,025 lb. from 50 ft.	2,200 ft. (670 meters)
Ground roll	1,320 ft. (402 meters)
Normal cruise speed, 96% rpm., 20,000 ft., at 10,200 lb.	295 kt. TAS (543 km./hr.)

DIMENSIONS

Length	39.4 ft. (12.03 meters)
Height	13.7 ft. (4.17 meters)
Wing span	39.2 ft. (11.95 meters)
Wing aspect ratio	7.71
Cabin length	21.5 ft. (6.56 meters)
Cabin width	4.9 ft. (1.5 meters)
Cabin height	4.3 ft. (1.3 meters)