

ARCHIVED REPORT

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Mitsubishi SpaceJet

Outlook

- Mitsubishi has temporarily paused most SpaceJet activities
- Type certification documentation is proceeding
- Mitsubishi is reviewing the future of the program

Orientation

Description. Twin-turbofan-powered regional transport aircraft.

Sponsor. Mitsubishi Aircraft Corp, a subsidiary of Mitsubishi Heavy Industries Ltd.

Status. Most SpaceJet development activities were temporarily paused in October 2020.

Total Produced. Six SpaceJet M90 (MRJ90) aircraft were produced by the end of 2020.

Application. Scheduled and non-scheduled regional passenger transportation.

Price Range. SpaceJet M100, \$46.3 million; SpaceJet M90, \$47.3 million. Both are estimates in 2020 U.S. dollars.



SpaceJet M90

Source: Mitsubishi Aircraft Corp

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Contractors

Prime

Mitsubishi Aircraft Corp	http://www.mitsubishiaircraft.com , Nagoya Airport, Toyoyama-cho, Nishikasugai-Gun, Aichi, Japan, Tel: + 81 568 39 2100, Fax: + 81 568 39 2217, Prime
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Subcontractor

AcousticFab LLC	http://www.ittaerospace.com , 28150 Industry Dr, Valencia, CA 91355 United States, Tel: + 1 (661) 295-4000 (APU Inlet; Exhaust Components)
Adams Rite Aerospace Inc	http://www.ar-aero.com , 4141 N Palm St, Fullerton, CA 92835 United States, Tel: + 1 (714) 278-6500, Fax: + 1 (714) 278-6510 (Cockpit Door Module; Ballistic Bulkhead)
Aerospace Industrial Development Corp (AIDC)	http://www.aidc.com.tw , No 111-X60, Lane 68, Fu-Hsing N Rd, Taichung, Taiwan, Tel: + 886 4 270 70001, Fax: + 886 4 228 42849 (Slats; Flaps; Belly Fairing; Rudder; Elevator)
Airbus Helicopters Deutschland GmbH	http://www.airbus.com/helicopters.html , Industriestrasse 4, Postfach 1353, Donauwörth, Germany, Tel: + 49 906 71 0, Fax: + 49 906 71 40 11 (Cargo Doors; Passenger Doors; Service Doors)
Collins Aerospace Systems, Electric Systems	http://www.collinsaerospace.com , 4747 Harrison Ave, Rockford, IL 61108-7929 United States, Tel: + 1 (815) 226-6000 (Electrical Power System; Flap/Slat Actuation System)
Collins Aerospace Systems, Sensors & Integrated Systems	http://www.collinsaerospace.com , 14300 Judicial Rd, Burnsville, MN 55306-4898 United States, Tel: + 1 (952) 892-4000, Fax: + 1 (952) 892-4800 (Windshield Heat Controllers; Ice Detector; Air Data Sensor)
Collins Aerospace Systems, Aerostructures	http://www.collinsaerospace.com , 850 Lagoon Dr, Chula Vista, CA 91910-2098 United States, Tel: + 1 (619) 691-4111, Fax: + 1 (619) 691-3030 (Nacelle & Thrust Reverser System)
Collins Aerospace Systems, Avionics & Mission Systems	http://www.collinsaerospace.com , 400 Collins Rd NE, Cedar Rapids, IA 52498 United States, Tel: + 1 (319) 295-1000, Fax: + 1 (319) 295-5429 (Pro Line Fusion Avionics System; Primary Flight Control Computers; Pilot Controls; Horizontal Stabilizer Trim System)
Collins Aerospace Systems, Wheels & Brakes	http://www.collinsaerospace.com , 101 Waco St, PO Box 340, Troy, OH 45373-3872 United States, Tel: + 1 (937) 339-3811, Fax: + 1 (937) 440-3286 (Integrated Brake System)
Collins Aerospace Systems, Interiors	http://www.collinsaerospace.com , 3420 S 7th St, Suite 100, Phoenix, AZ 85040-1169 United States, Tel: + 1 (602) 243-2200, Fax: + 1 (602) 243-2300 (Evacuation Systems)
Collins Aerospace Systems, Interiors, Lighting Systems	http://www.collinsaerospace.com , 3445 S 5th St, Suite 180, Phoenix, AZ 85040 United States, Tel: + 1 (602) 735-7900, Fax: + 1 (602) 735-7989 (Lighting Systems)
Collins Aerospace Systems, Power & Controls	http://www.collinsaerospace.com , One Hamilton Rd, Windsor Locks, CT 06096-1000 United States, Tel: + 1 (860) 654-6000, Fax: + 1 (860) 353-5805 (Fire Detection and Suppression System; Air Management System; Auxiliary Power Unit; Engine Control System and Accessories)
Delta Kogyo Company Ltd	http://www.deltakogyo.co.jp , 1-14, Shinchi, Fuchu-cho, Aki-gun, Hiroshima-ken, Japan, Tel: + 81 082 282 8211, Fax: + 81 082 282 8221 (Passenger Seats)
LMI Aerospace Inc	http://www.lmiaerospace.com , 411 Fountain Lakes Blvd, St. Charles, MO 63301-4352 United States, Tel: + 1 (636) 946-6525, Fax: + 1 (636) 916-2198, Email: LMInfo@lmiaerospace.com (Tailcone)
LMI Everett - Merrill Creek	http://www.lmiaerospace.com , 1910 Merrill Creek Pkwy, Everett, WA 98203-5859 United States, Tel: + 1 (425) 293-0340, Fax: + 1 (425) 293-0341, Email: LMInfo@lmiaerospace.com (Thermoset Components)
Leach International North America	http://leachcorp.com , 6900 Orangethorpe Ave, Buena Park, CA 90620 United States, Tel: + 1 (714) 736-7598, Fax: + 1 (714) 739-1713, Email: leach.info@esterline.com (Primary Electrical Power Distribution System)

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Nabtesco Corp	http://www.nabtesco.com , 9-18, Kaigan 1-chome, Minato-ku, Tokyo, Japan, Tel: + 81 3 3578 7070, Fax: + 81 3 3578 7237 (Flight Control Actuators)
PPG Aerospace - Transparencies	http://www.ppgaerospace.com , 1719 US Hwy 72 E, Huntsville, AL 35811 United States, Tel: + 1 (256) 851-7001, Fax: + 1 (256) 851-8821 (Flight Deck Windows)
Parker Aerospace, Hydraulic Systems Division	http://www.parker.com , 2220 Palmer Ave, Kalamazoo, MI 49001-4165 United States, Tel: + 1 (269) 384-3400, Fax: + 1 (269) 384-3862 (Hydraulic System)
Pratt & Whitney	http://www.pratt-whitney.com , 400 Main St, East Hartford, CT 06108 United States, Tel: + 1 (860) 565-4321, Email: info@pw.utc.com (PW1200G Geared Turbofan)
Safran Cabin, Bellingham	http://www.safran-cabin.com , 3225 Woburn St, Bellingham, WA 98226 United States, Tel: + 1 (360) 738-2005, Fax: + 1 (360) 715-3999 (Interior Components)
Spirit AeroSystems	http://www.spiritaero.com , 3801 S Oliver St, PO Box 780008, Wichita, KS 67278 United States, Tel: + 1 (316) 526-9000, Fax: + 1 (316) 526-1845, Email: communications@spiritaero.com (Engine Pylons)
Sumitomo Precision Products Co Ltd	http://www.spp.co.jp , 1-10, Fuso-cho, Amagasaki, Hyogo, Japan, Tel: + 81 6 6489 5936, Fax: + 81 6 6489 5889 (Landing Gear)

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data**(SpaceJet M100/SpaceJet M90)**

Design Features. Low-wing design with twin geared turbofan engines mounted under the wing. The wing is swept back and is fitted with winglets. The tail section includes a sweptback fin and horizontal stabilizer. The fuselage has a circular design. Landing gear are retractable tricycle type, with twin wheels on each unit.

Compared to the earlier Mitsubishi Regional Jet (MRJ) design, the SpaceJet features increased use of aluminum-lithium alloys and carbon composites. On the MRJ, carbon composites accounted for 10-15

percent of the aircraft structure, primarily in the tail section.

The SpaceJet is fitted with a fly-by-wire flight control system. The Collins Pro Line Fusion avionics suite is the aircraft's core avionics system.

Mitsubishi has claimed that the SpaceJet will provide double-digit reductions in fuel consumption and operating costs per trip compared to comparable commercial jets.

	<u>Metric</u>	<u>U.S.</u>
Dimensions		
Length	34.50/35.80 m	113.20/117.44 ft
Height	10.30/10.40 m	33.81/34.14 ft
Wingspan	27.80/29.20 m	91.22/95.82 ft
Weight		
Maximum takeoff weight (MTOW)	42,000/42,800 kg	92,594/94,358 lb
Maximum landing weight (MLW)	36,200/38,000 kg	79,807/83,776 lb
Performance		
Maximum operating speed	Mach 0.78	Mach 0.78
Takeoff field length (MTOW, SL, ISA)	1,760/1,740 m	5,770/5,710 ft
Landing field length (MLW, dry)	1,550/1,480 m	5,090/4,860 ft
Range		
M100 with 84 pax	3,540 km	1,910 nm
M90 with 88 pax	3,770 km	2,040 nm

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Propulsion

M100/M90 (2) Pratt & Whitney PurePower PW1200G geared turbofan engines rated 78.2 kN (17,600 lbst) each.

Seating

Crew of two. The M100 accommodates 84 passengers in a typical single-class, four-abreast configuration; maximum capacity is 88 passengers. It can be configured for 76 seats in a three-class seating layout. The M90 accommodates 88 passengers in a typical single-class, four-abreast layout; maximum capacity is 92 passengers.

Variants/Upgrades

MRJ70. Canceled in June 2019, the MRJ70 was redesigned into the SpaceJet M100. The MRJ70 was a short-fuselage model seating 76 passengers in a typical single-class layout. It was marketed in three versions. The standard MRJ70STD variant provided a range of 1,020 nautical miles with 76 passengers. Maximum takeoff weight was 36,850 kilograms (81,240 lb).

The MRJ70ER extended-range version was able to fly 1,670 nautical miles with 76 passengers. Its maximum takeoff weight was 38,995 kilograms (85,969 lb).

The MRJ70LR long-range version had a range with 76 passengers of 2,020 nautical miles. Maximum takeoff weight was 40,200 kilograms (88,626 lb).

All three versions of the MRJ70 were powered by two Pratt & Whitney PW1215G geared turbofan engines rated 69.3 kN (15,600 lbst) each.

SpaceJet M100. Compared to the MRJ70, the SpaceJet M100 is 1.1 meters (3.6 ft) longer, and has smaller winglets (resulting in a shorter wingspan), increased seating capacity, and greater overhead bin storage. The M100 can accommodate 84-88 passengers in a single-class configuration. Range with 84 passengers is 1,910 nautical miles. Maximum takeoff weight is 42,000 kilograms (92,594 lb). The M100 is powered by two Pratt & Whitney PW1200G geared turbofan engines rated 78.2 kN (17,600 lbst) each.

In order to meet scope clause restrictions in the U.S. market, the M100 can be configured in a 76-seat, three-

class layout. In this configuration, its maximum takeoff weight is 39,008 kilograms (86,000 lb).

In May 2020, Mitsubishi suspended development of the M100 until further notice.

SpaceJet M90. Formerly called the MRJ90, the SpaceJet M90 seats 88 passengers in a typical single-class configuration.

The M90 has a range with 88 passengers of 2,040 nautical miles. Maximum takeoff weight is 42,800 kilograms (94,358 lb). It is powered by the same 78.2-kN (17,600-lbst) PW1200G engines that power the SpaceJet M100.

Prior to the rebranding of the MRJ series as the SpaceJet family, Mitsubishi had been marketing the MRJ90 in three versions: standard, extended-range, and long-range. It is presently uncertain whether the rebranded SpaceJet M90 would continue to be available in three such versions.

SpaceJet M200. Proposed stretched variant accommodating up to 100 passengers. Not formally launched as of early 2021.

Service entry of the M200 had been tentatively planned for 2026. Should Mitsubishi decide to pursue development of the M200, the new model could replace the M90 in the company's product line.

Program Review

Background. Then known as the Mitsubishi Regional Jet (MRJ), the SpaceJet had its beginnings in 2003 as a technology development project conducted by Mitsubishi Heavy Industries (MHI) for Japan's New Energy and Industrial Technology Development Organization (NEDO). At the time, the effort was focused on the design of a small commercial aircraft seating 30-50 passengers. By 2006, however, the program's concentration had shifted to an aircraft aimed at the 70-90 seat market.

In June 2007, MHI displayed a full-size cabin mock-up of the MRJ at the Paris Air Show. In October 2007, the company announced its selection of Pratt & Whitney's new geared turbofan engine (currently known as the PW1200G) to power the aircraft. The Pratt powerplant was chosen for the MRJ over an improved version of the General Electric CF34-10 and a scaled-up variant of the Rolls-Royce RB282. MHI subsidiary Mitsubishi Heavy Industries Aero Engines Ltd (MHIAEL)

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performs final assembly of PW1200G engines in Japan for Mitsubishi aircraft.

Also in October 2007, MHI formally decided to begin marketing the MRJ to potential customers. Two MRJ models were envisioned: the 69-80 seat MRJ70 and the 81-92 seat MRJ90.

MHI officially launched the MRJ program in March 2008. The launch customer for the new aircraft was the Japanese carrier All Nippon Airways (ANA), which placed firm orders for 15 MRJ90s and took options for an additional 10. Besides the ANA orders, MHI said that the launch was also based on positive responses to the MRJ from potential customers. The program schedule at the time of the launch called for first flight in 2011, followed by service entry in 2013.

In April 2008, MHI established a new subsidiary, called Mitsubishi Aircraft Corp, that assumed responsibility for MRJ development, certification, sales, and customer support.

MHI holds an 86.67 percent stake in Mitsubishi Aircraft. Other shareholders include Mitsubishi Corp (3.7 percent), Toyota Motor Corp (3.7 percent), Mitsui & Company Ltd (1.85 percent), Sumitomo Corp (1.85 percent), JGC Corp (0.56 percent), Tokio Marine & Nichido Fire Insurance Company Ltd (0.56 percent), Development Bank of Japan Inc (0.37 percent), Mitsubishi Chemical Corp (0.37 percent), and Mitsubishi Electric Corp (0.37 percent).

Design Revisions

Mitsubishi finalized the MRJ configuration in September 2009. The configuration incorporated a number of changes from the originally envisioned aircraft, however. According to the company, the revisions were the result of feedback from airlines.

The MRJ design now had an aluminum wing box, replacing the composite structure of the earlier MRJ iteration. The new configuration also had a wider cabin with more head clearance. In addition, the aircraft's forward and aft cargo compartments were combined into a single aft cargo compartment.

In conjunction with the changes, Mitsubishi adjusted the MRJ program schedule, sliding the timetable several months to the right. First flight was now scheduled to take place in the second quarter of 2012, with deliveries to begin in the first quarter of 2014.

In December 2011, Mitsubishi's MRJ hydraulic and flight control system test rig, called the "iron bird," simulated airborne flight for the first time. The iron bird consists of flight deck, hydraulic, and flight control

equipment; onboard software; and simulation computers. Testing of the iron bird was conducted at MHI's Oye Plant in Nagoya, Japan.

In April 2012, following an in-depth review, Mitsubishi announced a further delay to the MRJ schedule. First flight was now scheduled for the fourth quarter of 2013, with initial delivery sometime between the summer of 2015 and March 2016. The company said that the delay was due to a need to confirm fabrication processes and to provide sufficient time for technical studies. A company spokesperson added that process validation was taking longer than anticipated.

An additional delay to the MRJ program schedule was announced by Mitsubishi in August 2013. First flight was now planned for the second quarter of 2015, with initial delivery in the second quarter of 2017.

In announcing the delay, Mitsubishi said that, in the course of developing the MRJ, it had simultaneously addressed processes in which the design and development of system and component specifications were aligned with safety certification. It added, however, that design and respective certification had taken greater resources than anticipated, which in turn impacted component deliveries and aircraft fabrication. The company said that, in step with its MRJ program partners, it established the new schedule in order to take into account the fulfillment of safety certification standards.

In May 2014, Mitsubishi completed an MRJ static strength test aircraft. The airframe was used for ground-based static strength testing necessary for the type and airworthiness certification process. Mitsubishi has also built a fatigue test airframe for use in ground-based fatigue tests.

Mitsubishi rolled out the initial flyable MRJ, an MRJ90 model, in October 2014. The following April, the company delayed the initial flight of this aircraft (FTA-1) until September or October of 2015 in order to incorporate verification results from ground tests and related feedback into the aircraft. FTA-1 finally took to the air in November 2015.

In December 2015, Mitsubishi postponed initial delivery of the MRJ90 to around the middle of 2018. The company said at the time that it had made additions to, and revisions of, test items in order to complete a better-integrated aircraft, and that these changes were incorporated into the revised delivery schedule. Mitsubishi had also conducted an overall review of the program with its partners, and this was reflected in the schedule.

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In January 2017, Mitsubishi postponed initial delivery of the MRJ90 to mid-2020. The company attributed the postponement to revisions of certain systems and electrical configurations on the aircraft needed to meet the latest requirements for certification. The major issues involved the rerouting of wire harnesses and the relocation of certain components in the avionics bay.

Name Change

In June 2019, Mitsubishi rebranded the MRJ series as the SpaceJet family. The MRJ90 was renamed the SpaceJet M90. The MRJ70 was dropped, and was redesigned into the SpaceJet M100. Details regarding the M90 and M100 models can be found in the **Technical Data, Variants/Upgrades, and Forecast Rationale** sections of this report.

Triumph Aerospace Structures provided airframe design and analysis support for development of the M100, particularly in regard to wing optimization and materials technology.

In February 2020, Mitsubishi postponed service entry of the M90, the lead variant in the SpaceJet series. The company did not specify an exact date for entry into service, but indicated that it would not occur until at least its 2021 fiscal year, which runs from April 2021 to March 2022.

In May 2020, development of the M100 variant was suspended until further notice. In October 2020, Mitsubishi paused most SpaceJet development activities, other than type certification documentation.

Contracts/Orders & Options/Inventories

For a complete list of Mitsubishi SpaceJet orders and options and details on inventories, see Appendix VI, Major Civil Transport Orders and Options, and Appendix VII, Major Civil Transport Inventories.

Forecast Rationale

As of early 2021, most activities related to development of the SpaceJet family remained suspended. However, Mitsubishi Heavy Industries has continued work on type certification documentation, with a view to possibly restarting the SpaceJet program at some time in the future.

Mitsubishi had placed a temporary pause on the majority of SpaceJet development activities in October 2020. At the time, the company noted that, given market conditions and the aircraft's development status, it had no choice but to take the action. Mitsubishi also indicated that it intended to review the program, make improvements, and assess a possible restart.

In May 2020, Mitsubishi had suspended development of the M100 variant of the SpaceJet until further notice. During the suspension, the company intends to review and reconsider its plans to develop the 76-84 seat model. Service entry of the M100, which has not flown, had been scheduled for 2023. Work on the 88-92 seat M90, the lead variant in the SpaceJet series, continued.

Mitsubishi had designed the M100 expressly to meet the requirements of U.S. carriers impacted by scope clauses. Scope clause restrictions severely limit sales opportunities for the larger M90 in the U.S. market. Such clauses in pilot contracts at the three U.S. major

carriers prohibit their regional airline partners from operating any aircraft that has a maximum takeoff weight exceeding 86,000 pounds or (with one minor exception) that seats more than 76 passengers. The M90 can be configured with a scope-compliant 76-seat layout, but it would still exceed the 86,000-pound weight limit. Flying the M90 at a weight below that level would entail a significant sacrifice in range.

Thus, the M90 cannot be used by regionals for operations subject to these scope clauses. The M100, on the other hand, can carry 76 passengers in a three-class seating layout. In this configuration, its maximum takeoff weight is 86,000 pounds.

Should the program proceed, the M90 would, at least initially, likely find most of its market outside the U.S. Potential customers for the M90 include regional airlines that are unencumbered by scope restrictions, low-fare airlines, leasing firms, and mainline carriers. Opportunities for relaxation of U.S. scope clause limits will occur periodically as pilot contracts at the major airlines come up for amendment or renewal. As of February 2021, Mitsubishi had 153 firm orders and 114 options and purchase rights for the M90. Included among these totals were 100 orders and 100 options from SkyWest, 32 orders from Japan Airlines, and 15 orders and 10 options from All Nippon Airways.

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However, U.S.-based SkyWest is impacted by scope restrictions, and it seems likely that the carrier would look to convert all or part of its orders to the M100 should development of that model resume.

It is possible that Mitsubishi will ultimately decide to terminate the SpaceJet program. For now, we have withdrawn our SpaceJet forecast pending further developments.

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