The Development of H2A204 Type and its Successful Maiden Flight

TAKASHI MAEMURA*1
TAKESHI MORI*1
KOKI NIMURA*1
TOKIO NARA*1
JUNICHI HORIKAWA*1

1. Introduction

As a Japan's flagship launch vehicle, H-IIA has a capability to carry a four ton class satellite into geostationary transfer orbit (GTO). In order to make the H-IIA launch vehicle meet the demands for larger satellites, the H2A204 type, which is an additional H-IIA version and has four solid rocket boosters (SRB-A) instead of the two in the current configuration, has been developed. This new H-IIA version extends the launch capability into GTO of the H-IIA launch vehicle family to 6 ton class satellites. (See **Fig. 1**)

The development of H2A204 started in late 2001. Though the accident to flight No.6 forced this development program to slow down, it was carried on. The integrated system test for the first flight vehicle on Tanegashima launch site was conducted in October 2006, followed by the successful maiden flight of H2A204 on December 18, 2006.

This paper describes the H2A204 launch vehicle development and reports the results of its maiden flight.

2. Development of H2A204

As stated above, the H2A204 has increased the number of SRB-A boosters from two to four to carry a 6 ton class satellite into GTO. So the H2A204 configuration has been modified to hold the additional two SRB-A boosters, which are described below.

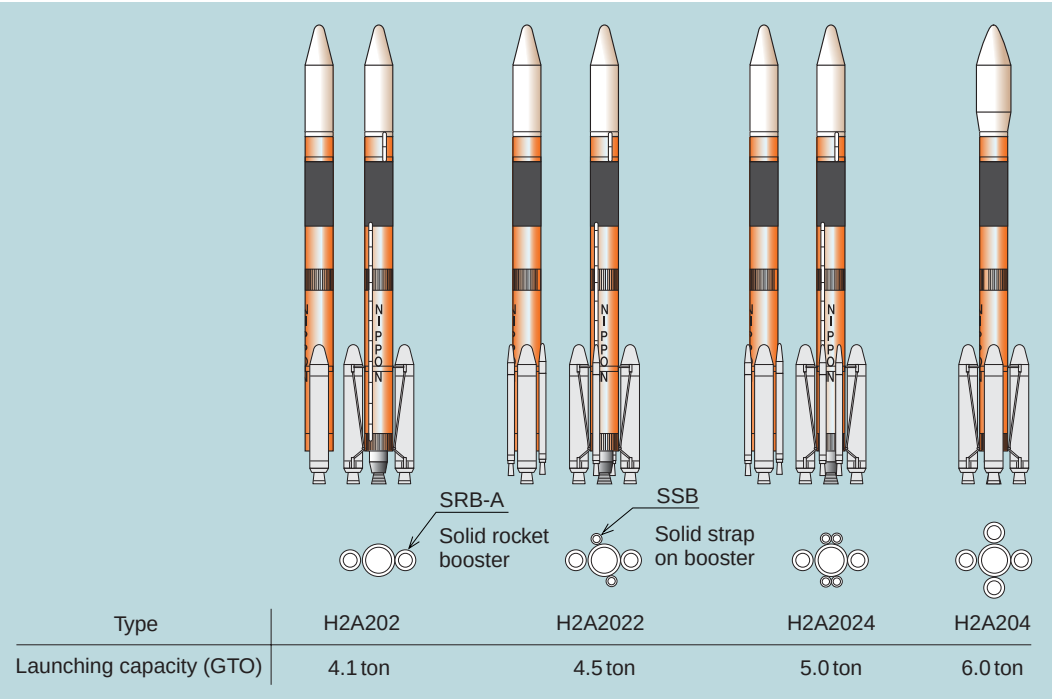

Fig. 1 H-IIA launch vehicle family This figure shows the types of vehicles composing H-IIA family.

*1 Nagoya Aerospace Systems Works

(1) Modification of the structure of the first-stage core vehicle that carries the four SRB-A boosters

- Liquid hydrogen tank: SRB-A mounting fittings were added and the tank wall thickness was increased as reinforcement.
- Engine section: SRB-A mounting fittings were added (see **Fig. 2**) and the plate thickness was increased as reinforcement.

(2) Measures against a tougher flight environment because of the four SRB-A boosters

- Plume heating from SRB-A: The plume heating was evaluated by using computational fluid dynamics (CFD). **Figure 3** shows an example of the analysis, with the evaluation method verified through the telemetry data of flight No. 8 and 9. Thermal protection for the bottom of the vehicle was taken against the thermal environment predicted by this evaluation.
- Acoustic environment at lift-off: In order to reduce the sound pressure level at lift-off which will be increased by the addition of the boosters, a water injection system (see **Fig. 4**) was installed to inject additional water into the jet blast.

(3) Optimization of SRB-A thrust profile

- An SRB-A thrust profile with about 70% thrust level of the original SRB-A was developed for H2A204 to keep the flight dynamic pressure and the axial acceleration to levels equivalent to those of the existing H-IIA vehicle that carries two SRB-As. However, an SRB-A with this thrust profile has already been adopted in the improved SRB-A as a countermeasure against the accident of H-IIA flight No. 6, and has been applied in vehicles after flight No. 7 before being used for H2A204 type.

(4) Modification of ground support equipments for four SRB-4 boosters configuration.

- Change to the moving upward type of vehicle support device: The conventional type of vehicle support device that supported the core vehicle at the center body section structure through an umbilical mast was made to move away downward immediately after lift off. However, in order to provide more allowance in clearance with the SRB-A mounted under this support device, it was changed to the moving upward type. (**Figure 5** shows the operation test of this device.)

The validity of these changes was verified through development tests of the sub-systems. Further, an all-stage integrated system test was conducted from October 2006 in the launch site using the first H2A204 flight vehicle, and it was verified that the vehicle and all ground support equipments performed their respective functions for H2A204, ensuring the validity of the results of development.

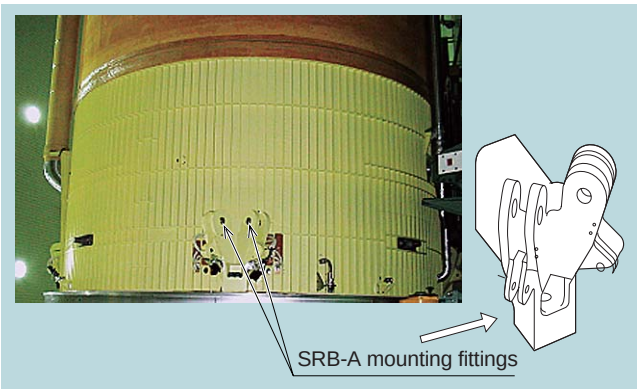

Fig. 2 Appearance of first-stage engine section
This shows the overall appearance of the engine section structure and the SRB-A mounting fittings of the H2A204 type

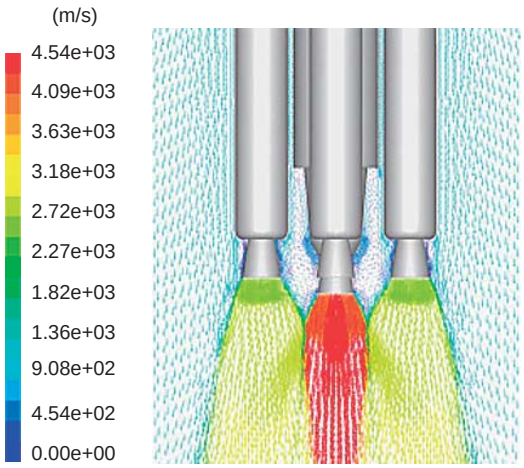

Fig. 3 Example of the result of SRB-A plume analysis
This shows an example of the results by CFD.

Fig. 4 Water injection system for acoustic reduction
This shows the appearance of the operating water injection system.

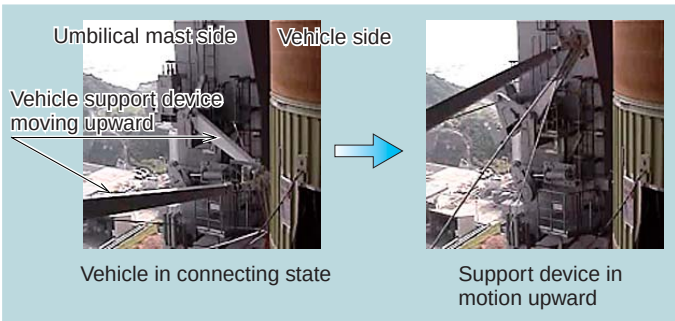

Fig. 5 vehicle support device moving upward type
This shows the vehicle support device in operation.

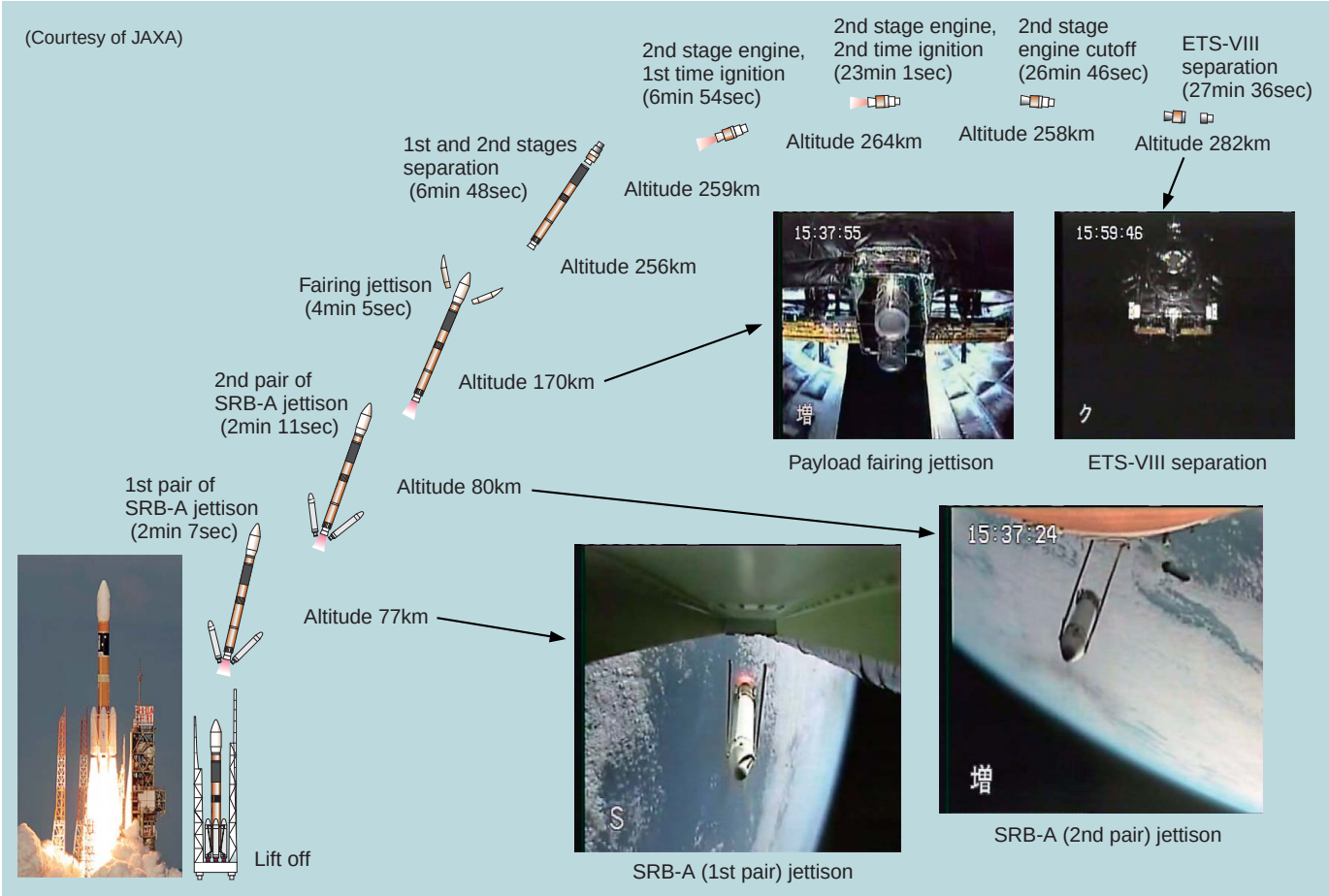

Fig. 6 Flight sequence of H-IIA Flight No.11 This shows the flight sequence and photographs of the main events in flight No.11.

3. Successful maiden flight of the H2A204 type

After two years delay from initial plan caused by the accident to flight No.6 the first vehicle of the H2A204 type was launched on December 18, 2006 from Tanegashima launch site, and successfully injected the satellite (ETS-VIII, named KIKU No. 8) into the target GTO orbit. The flight sequence is shown in **Fig. 6**. The telemetry data and the on-board cameras showed that all flight events including the four SRB-A boosters jettisons performed as planned. The results of the ETS-VIII injected orbit, which was almost as planned in **Table 1**, have proved the high accuracy of the H-IIA launch vehicle family. The ETS-VIII functions normally with the completion of the deployments of its large antenna reflectors and has shifted to the initial functional verification phase.

Table 1 Results of ETS-VIII injection orbit

	Target (allowance)	Actual	Deviation
Apogee (km)	36 156 (±180)	36 177	+21
Perigee (km)	250 (±4)	250	± 0
Inclination (deg)	28.500 (±0.02)	28.500	± 0

4. Conclusion

The development of the H2A204 type, followed by its successful maiden flight, has expanded the capability of the H-IIA launch vehicle family for our satellite customers. Our constant efforts for consecutive successful launches of the H-IIA family, including this new H2A204 type, will enhance our satellite customers' confidence and promote the privatization of the H-IIA launch vehicle.


Takashi Maemura


Takeshi Mori


Koki Nimura


Tokio Nara


Junichi Horikawa