

# Space Launch Report: Ariane 5 Data Sheet

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## Ariane 5

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*Ariane 5G+ (L518/V158) Orbited Rosetta in 2004 (Click for Larger Image)*

Ariane 5 was developed by the European Space Agency to replace Arianespace's Ariane 4 commercial satellite launcher. The big rocket was originally sized to launch a pair of satellites each weighing 2 to 3 metric tons (tonnes) to geosynchronous transfer orbit (GTO). It was subsequently upgraded to handle dual 4 to 5 tonne payloads.

Ariane 5 uses 2.5 stages and four propulsion units. At liftoff, its twin segmented solid motors provide more than 500 tonnes thrust each to augment the single core stage Vulcain LOX/LH2 engine's 110 tonnes of thrust. The original Ariane 5 G ("Generic") version used a hypergolic EPS second stage with a 2.6 tonne thrust Aestus engine.

Ariane 5 ECA uses an "E" ("Evolution") core stage, powered by an upgraded Vulcain 2 of 138 tonnes thrust, and an ESC-A upper stage.

ESC-A is an upgraded Ariane 4 LOX/LH2 third stage with a 6.4 tonne thrust HM7B engine. Slightly upgraded solid motors were also developed to power the "E" vehicles. Ariane 5 ECA can boost about 10 tonnes to GTO, including satellite adapter hardware. It stands nearly 58 meters tall with a long payload fairing.

Future plans call for development of a new 15 tonne thrust, restartable Vinci engine to replace the HM7B engine. The reengined stage, named ESC-B, will create an upgraded Ariane 5 ECB capable of lifting 12 tons to GTO. Ariane 5 ECB may enter service in 2017 or 2018.

A fourth Ariane 5 variant, named Ariane 5 ES(V) (also called Ariane 5 "Versatile"), flew for the first time in March 2008. This version uses the "E" core stage and the same solid rocket boosters as the Ariane 5 ECA. Ariane 5 ES(V) uses an Aestus-powered storable propellant (EPS-V) stage that can carry as much as 10 tons of propellant, 0.3 tons more than the initial model, although smaller propellant loads are used for low earth orbit missions. Unlike earlier "G" model EPS stages, the "ES(V)" EPS-V stage can be restarted. Ariane 5 ES(V) was developed to launch Europe's 20 ton ATV automated cargo carrier to the International Space Station (ISS).

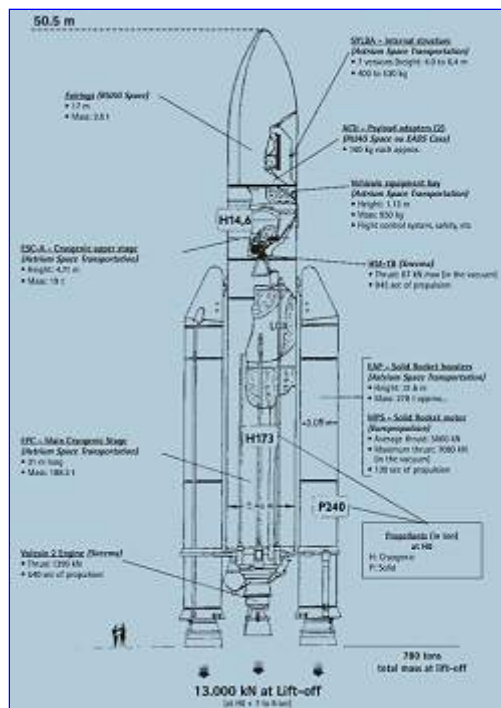
Two interim G-series models appeared during the G to E transition period. Ariane 5G+ was a standard Generic model topped by the 10-ton propellant EPS upper stage that flew during 2004. Ariane 5GS added the improved E-class solid motors to the G+ configuration.

*Ariane 5 ECA Drawing (Click to Enlarge). 50.5 meter height assumes*

*13.8 meter fairing.*

Ariane 5's solid boosters are produced adjacent to the new ELA-3 launch site at Kourou Space Center, stacked in a dedicated building on a launcher platform, then rolled to the launcher integration building. There, the first and second stages are mated. Although the site is designed to support 6-8 Ariane 5s per year, only 3 were launched each year during the 2002 to 2004 period.

Ariane 5 qualification testing began inauspiciously on 4 June 1996, when Ariane 501 exploded 39 seconds after launch from Kourou. A guidance system failure was blamed. Successor Ariane 502 made it to orbit on 30 October 1997, but first stage roll-control problems caused a slight loss of velocity and the test payloads fell just short of their planned geosynchronous transfer orbit (GTO). Ariane 503 finally qualified the vehicle with a successful flight on 21 October 1998. All three of the test flights carried dummy or experimental payloads. Ariane 504 inaugurated commercial service on 1999 December 10 when it orbited ESA's 3,764 kg X-Ray Multi-Mirror spacecraft. The Ariane 5 G/G+/GS series ended its run in 2009 after achieving 22 successes in 25 attempts and ending with 15 consecutive successes.



A failed Vulcain-2 engine doomed the inaugural Ariane 5 ECA flight (Ariane 517) on December 11, 2002, destroying the Hotbird 7 communications satellite. After an extensive Vulcain-2 redesign and testing effort, Ariane 5 ECA finally flew successfully on February 12, 2005 when Ariane 521 boosted XTAR-EUR and MaqSatB2 into GTO. By early 2014, the Ariane 5 ECA series had achieved 41 consecutive successes after the single, inaugural failure, establishing itself as one of the world's most reliable launch vehicles.

The first Ariane 5 ES flight, the March 9, 2008 V-181 mission, successfully orbited 19.012 tonne ATV-1 "Jules Verne" into a 51.6 deg low earth orbit.

## Vehicle Configurations

|                | LEO Payload<br>(metric tons)<br>(800 km SSO)<br>(500 km ISS) | GTO Payload<br>1500 m/s<br>to GEO*<br>(metric tons) | Configuration             | Liftoff Height<br>(meters)<br>Short/Medium/Long<br>Fairing | Liftoff Mass<br>(metric tons) |
|----------------|--------------------------------------------------------------|-----------------------------------------------------|---------------------------|------------------------------------------------------------|-------------------------------|
| Ariane 5G      | 9.5 t (SSO)                                                  | 6.64 t                                              | G Core +<br>2 SRB + EPS   | 46.1/47.2/50.4 m                                           | 720 t                         |
| Ariane 5 ES(V) | 15.7 t (SSO)<br>19.3 t (ISS)                                 | 7.575 t                                             | E Core +<br>2 SRB + EPS-V | 46.1/47.2/50.4 m                                           | 760 t                         |
| Ariane 5 ECA   |                                                              | 10.05 t                                             | E Core +<br>2 SRB + ESC-A | 49.5/50.55/54.7 m                                          | 780 t                         |
| Ariane 5 ECB   |                                                              | 12 t                                                | E Core +<br>2 SRB + ESC-B | 49.5/50.55/54.7 m                                          | ~800 t                        |

\* GEO: Geosynchronous Earth Orbit

## Vehicle Components

|                        | SRBs<br>EAP-G<br>(EAP-E) | Cryo Core<br>(EPC)<br>Generic ("G") | Cryo Core<br>(EPC)<br>Evolution ("E") | EPS<br>(EPS-V)       | ESC-A   | ESC-B  |
|------------------------|--------------------------|-------------------------------------|---------------------------------------|----------------------|---------|--------|
| Diameter (m)           | 3 m                      | 5.4 m                               | 5.4 m                                 | 5.4 m                | 5.4 m   | 5.4 m  |
| Length (m)             | 31.6 m                   | 30.5 m                              | 30.5 m                                |                      | 4.711 m |        |
| Propellant Mass (tons) | 237 t<br>(240 t)         | 158 t                               | 175 t                                 | 9.7 t<br>10 t (V)    | 14.9 t  | 25 t   |
| Total Mass (tons)      | 268 t<br>(278 t)         | 170 t                               | 189 t                                 | 10.9 t<br>11.3 t (V) | 19.44 t |        |
| Engine                 |                          | Vulcain                             | Vulcain 2                             | Aestus               | HM7B    | Vinci  |
| Fuel                   |                          | LH2                                 | LH2                                   | MMH                  | LH2     | LH2    |
| Oxidizer               |                          | LOX                                 | LOX                                   | N2O4                 | LOX     | LOX    |
| Thrust (vac tons)      | 509.9 t                  | 112.167 t                           | 137.662 t                             | 2.957 t              | 6.424 t | 15.3 t |
| ISP (vac sec)          | 274.5 s                  | 431.2 s                             | 431.2 s                               | 321 s                | 446 s   | 466 s  |

|                 |       |       |       |            |       |   |
|-----------------|-------|-------|-------|------------|-------|---|
| Burn Time (sec) | 130 s | 600 s | 540 s | 1000 s (V) | 945 s |   |
| No. Engines     | 1     | 1     | 1     | 1          | 1     | 1 |

### Vehicle Components, Cont'd

|                   | VEB    | Sylda 5     | Speltra       | Short Fairing | Medium Fairing | Long Fairing |  |
|-------------------|--------|-------------|---------------|---------------|----------------|--------------|--|
| Diameter (meters) | 5.4 m  |             | 5.4 m         | 5.4 m         | 5.4 m          | 5.4 m        |  |
| Length (meters)   | 1.56 m |             | 7 m           | 12.7 m        | 13.8 m         | 17 m         |  |
| Mass (tons)       | 1.9 t  | 0.425-0.5 t | 0.716-0.822 t | 2.00 t        | 2.13 t         | 2.5 t        |  |

### Ariane 5 Launch History

| DATE     | VEHICLE      | ID   | PAYLOAD                     | MASS (t) | SITE* | ORBIT**   |
|----------|--------------|------|-----------------------------|----------|-------|-----------|
| 04/06/96 | Ariane 5G    | L501 | V89/Cluster FM1-4           | 4.80     | KO 3  | [FTO] [1] |
| 10/30/97 | Ariane 5G    | L502 | V101/MaqSat H/B/Teamsat     | 4.98     | KO 3  | [EEO] [2] |
| 10/21/98 | Ariane 5G    | L503 | V112/Maqsat 3/ARD           | 5.40     | KO 3  | GTO [3]   |
| 12/10/99 | Ariane 5G    | L504 | V119/XRMM                   | 3.80     | KO 3  | HTO       |
| 03/21/00 | Ariane 5G    | L505 | V128/Insat 3B/Asiastar      | 4.836    | KO 3  | GTO       |
| 09/14/00 | Ariane 5G    | L506 | V130/Astra-2B/GE-7          | 5.30     | KO 3  | GTO       |
| 11/16/00 | Ariane 5G    | L507 | V135/PAS-1R/AmSat-3D        | 5.608    | KO 3  | GTO       |
| 12/20/00 | Ariane 5G    | L508 | V138/Astra 2D/GE-8          | 3.701    | KO 3  | GTO       |
| 03/08/01 | Ariane 5G    | L509 | V140/Eurobird/Bsat-2a       | 4.368    | KO 3  | GTO       |
| 07/12/01 | Ariane 5G    | L510 | V142/Artemis/BSat2B         | 4.403    | KO 3  | [EEO] [4] |
| 03/01/02 | Ariane 5G    | L511 | V145/Envisat                | 8.111    | KO 3  | LEO/S     |
| 07/05/02 | Ariane 5G    | L512 | V153/Stellat 5/NStar C      | 5.72     | KO 3  | GTO       |
| 08/28/02 | Ariane 5G    | L513 | V155/Atlantic Bird 1/MSG 1  | 4.72     | KO 3  | GTO       |
| 12/11/02 | Ariane 5 ECA | L517 | V157/HotBird 7/Stentor      | 5.547    | KO 3  | [FTO] [5] |
| 04/09/03 | Ariane 5G    | L514 | V160/Insat 3A/Galaxy 12     | 4.708    | KO 3  | GTO       |
| 06/11/03 | Ariane 5G    | L515 | V161/Optus C1/BSat 2C       | 6.023    | KO 3  | GTO       |
| 09/27/03 | Ariane 5G    | L516 | V162/Insat 3E/eBird/SMART 1 | 4.635    | KO 3  | GTO       |
| 03/02/04 | Ariane 5G+   | L518 | V158/Rosetta                | 3.011    | KO 3  | HCO       |
| 07/18/04 | Ariane 5G+   | L519 | V163/Anik F2                | 5.950    | KO 3  | GTO       |
| 12/18/04 | Ariane 5G+   | L520 | V165/Helios 2A              | 4.2      | KO 3  | LEO/S     |
| 02/12/05 | Ariane 5 ECA | L521 | V164/XTAR-EUR/MaqSat B2     | 7.379    | KO 3  | GTO       |
| 08/11/05 | Ariane 5 GS  | L523 | V166/iPStar 1               | 6.485    | KO 3  | GTO       |
| 10/13/05 | Ariane 5 GS  | L524 | V168/Syracuse3A/Galaxy15    | 5.758    | KO 3  | GTO       |
| 11/16/05 | Ariane 5 ECA | L522 | V167/Spaceway2/Telkom2      | 8.095    | KO 3  | GTO       |
| 12/21/05 | Ariane 5 GS  | L525 | V169/MSG-2/Insat-4A         | 5.115    | KO 3  | GTO       |
| 03/11/06 | Ariane 5 ECA | L527 | V170/Hotbird 7A/SpainSat    | 7.78     | KO 3  | GTO       |
| 05/27/06 | Ariane 5 ECA | L529 | V171/Satmex 6/Thiacom 5     | 8.23     | KO 3  | GTO       |
| 08/11/06 | Ariane 5 ECA | L531 | V172/Syracuse 3B/JCSAT 10   | 7.80     | KO 3  | GTO       |
| 10/13/06 | Ariane 5 ECA | L533 | V173/DirectB9S/OptusD1      | 8.18     | KO 3  | GTO       |
| 12/08/06 | Ariane 5 ECA | L534 | V174/Wildblue 1/AMC-18      | 6.82     | KO 3  | GTO       |
| 03/11/07 | Ariane 5 ECA | A535 | V175 Skynet 5A/Insat 4B     | 7.67     | KO 3  | GTO       |
| 05/04/07 | Ariane 5 ECA | A536 | V176 Astra 1L/Galaxy 17     | 8.60     | KO 3  | GTO       |
| 08/14/07 | Ariane 5 ECA | A537 | V177 Spaceway 3/BSAT 3A     | 8.06     | KO 3  | GTO       |
| 10/05/07 | Ariane 5 GS  | A526 | V178 Intelsat 11/Optus D2   | 4.85     | KO 3  | GTO       |
| 11/14/07 | Ariane 5 ECA | A538 | Skynet5B/StarOne (V179)     | 8.735    | KO 3  | GTO       |
| 12/21/07 | Ariane 5 GS  | A530 | V180/RAScom 1/Horizons 2    | 5.464    | KO 3  | GTO       |

|          |              |      |                              |        |      |         |
|----------|--------------|------|------------------------------|--------|------|---------|
| 03/09/08 | Ariane 5 ES  | L528 | V181/ATV-1 Jules Verne       | 19.01  | KO 3 | LEO/ISS |
| 04/18/08 | Ariane 5 ECA | L529 | V182/VINASAT 1/StarOne C2    | 6.74   | KO 3 | GTO     |
| 06/12/08 | Ariane 5 ECA | L540 | V183/Skynet5C/Turksat3A      | 7.75   | KO 3 | GTO     |
| 07/07/08 | Ariane 5 ECA | L541 | V184/ProtoStar 1/BADR 6      | 7.537  | KO 3 | GTO     |
| 08/14/08 | Ariane 5 ECA | L542 | V185/Superbird 7/AMC 21      | 7.27   | KO 3 | GTO     |
| 12/20/08 | Ariane 5 ECA | L543 | V186/Hotbird9/W2M            | 8.34   | KO 3 | GTO     |
| 02/12/09 | Ariane 5 ECA | L545 | V187/Hotbird 10/NSS 9        | 7.422  | KO 3 | GTO     |
| 05/14/09 | Ariane 5 ECA | L546 | V188/Herschel/Plank          | 5.32   | KO 3 | HTO     |
| 07/01/09 | Ariane 5 ECA | L547 | V189/TerreStar 1             | 6.91   | KO 3 | GTO     |
| 08/21/09 | Ariane 5 ECA | L548 | V190/JCSAT 12/Optus D3       | 4.5    | KO 3 | GTO     |
| 10/01/09 | Ariane 5 ECA | L549 | V191/Amazonas 2/GMS          | 8.0    | KO 3 | GTO     |
| 10/29/09 | Ariane 5 ECA | L550 | V192/NSS 12/Thor 6           | 8.675  | KO 3 | GTO     |
| 12/18/09 | Ariane 5 GS  | L551 | V193/Helios 2B               | 4.2    | KO 3 | LEO/S   |
| 05/21/10 | Ariane 5 ECA | L551 | V194/Astra3B/COMSATBw2       | 7.97   | KO 3 | GTO     |
| 06/26/10 | Ariane 5 ECA | L552 | V195/Arabsat5A/COMS1         | 7.4    | KO 3 | GTO     |
| 08/04/10 | Ariane 5 ECA | L554 | V196/RascomQAF1R/COMS        | 6.25   | KO 3 | GTOS    |
| 10/28/10 | Ariane 5 ECA | L555 | V197/W3B/BSAT 3b             | 7.43   | KO 3 | GTO     |
| 11/26/10 | Ariane 5 ECA | L556 | V198/Intelsat17/Hylas1       | 8.08   | KO 3 | GTO     |
| 12/29/10 | Ariane 5 ECA | L557 | V199/Hispasat1E/KoreaSat6    | 8.17   | KO 3 | GTO     |
| 02/16/11 | Ariane 5 ES  | L544 | V200/ATV-2 Johannes Kepler   | 19.7   | KO 3 | LEO/ISS |
| 04/22/11 | Ariane 5 ECA | L558 | VA201/Yahsat1A/IntelsatND    | 8.97   | KO 3 | GTO     |
| 05/20/11 | Ariane 5 ECA | L559 | VA202/ST2/GSAT 8             | 8.19   | KO 3 | GTO     |
| 08/06/11 | Ariane 5 ECA | L560 | VA203/Astra 1N/BSat 3c       | 8.26   | KO 3 | GTO     |
| 09/21/11 | Ariane 5 ECA | L561 | VA204/Arabsat 5C/SES-2       | 7.85   | KO 3 | GTO     |
| 03/23/12 | Ariane 5 ES  | L553 | VA205/ATV-3 Edoardo Amaldi   | 19.714 | KO 3 | LEO/ISS |
| 05/15/12 | Ariane 5 ECA | L562 | VA206/JCSAT13/VINASAT2       | 7.5    | KO 3 | GTO     |
| 07/06/12 | Ariane 5 ECA | L563 | VA207/Echostar 17/MSG 3      | 8.13   | KO 3 | GTO     |
| 08/02/12 | Ariane 5 ECA | L564 | VA208/Intelsat 20/Hylas2     | 9.4    | KO 3 | GTO     |
| 09/28/12 | Ariane 5 ECA | L565 | VA209/Astra 2F/GSat 10       | 9.4    | KO 3 | GTO     |
| 11/10/12 | Ariane 5 ECA | L566 | VA210/Eutlst21B/Star1-C3     | 8.24   | KO 3 | GTO     |
| 12/19/12 | Ariane 5 ECA | L567 | VA211/Skynet 5D/Mexsat 3     | 7.80   | KO 3 | GTO     |
| 02/07/13 | Ariane 5 ECA | L568 | VA212/Amazonas 3/Azerspace   | 9.265  | KO 3 | GTO     |
| 06/05/13 | Ariane 5 ES  | L592 | VA213/ATV-4 Albert Einstein  | 19.89  | KO 3 | LEO/ISS |
| 07/25/13 | Ariane 5 ECA | L569 | VA214/Alphasat XL/Insat 3D   | 8.77   | KO 3 | GTO     |
| 08/29/13 | Ariane 5 ECA | L570 | VA215/Eutelsat 25B/Gsat 7    | 8.96   | KO 3 | GTO     |
| 02/06/14 | Ariane 5 ECA | L572 | VA217/ABS2/Athena-Fidus      | 9.41   | KO 3 | GTO     |
| 03/22/14 | Ariane 5 ECA | L571 | VA216/Astra 5B/Amaz. 4A      | 8.662  | KO 3 | GTO     |
| 07/29/14 | Ariane 5 ES  | L593 | VA219/ATV 5                  | 19.926 | KO 3 | LEO/ISS |
| 09/11/14 | Ariane 5 ECA | L573 | VA218/Measat 3b/Optus 10     | 9.157  | KO 3 | GTO     |
| 10/16/14 | Ariane 5 ECA | L574 | VA220/Intelsat 30/Arsat 1    | 9.293  | KO 3 | GTO     |
| 12/06/14 | Ariane 5 ECA | L575 | VA221/DirectTV 14/GSAT 16    | 9.48   | KO 3 | GTO     |
| 04/26/15 | Ariane 5 ECA | L576 | VA222/Thor 7/Sircal 2        | 9.00   | KO 3 | GTO     |
| 05/27/15 | Ariane 5 ECA | L577 | VA223/DirectTV 15/SkyMex 1   | 9.20   | KO 3 | GTO     |
| 07/15/15 | Ariane 5 ECA | L578 | VA224/Star One C4/MSG 4      | 7.608  | KO 3 | GTO     |
| 08/20/15 | Ariane 5 ECA | L579 | VA225/Eutlsat 8WB/Intlsat 34 | 9.082  | KO 3 | GTO     |
| 09/30/15 | Ariane 5 ECA | L580 | VA226/SkyMuster/Arsat2       | 9.417  | KO 3 | GTO     |
| 11/10/15 | Ariane 5 ECA | L581 | VA227/Badr 7/GSAT 15         | 8.962  | KO 3 | GTO     |
| 01/27/16 | Ariane 5 ECA | L583 | VA228/Intelsat 29e           | 6.552  | KO 3 | GTO     |
| 03/09/16 | Ariane 5 ECA | L582 | VA229/Eutelsat 65 West A     | 6.564  | KO 3 | GTO     |
| 06/18/16 | Ariane 5 ECA | L584 | VA230/Ecstar 18/BRIsat       | 9.84   | KO 3 | GTO     |
| 08/24/16 | Ariane 5 ECA | L586 | VA232/Intelsat 33e&36        | 9.853  | KO 3 | GTO     |
| 10/05/16 | Ariane 5 ECA | L585 | VA231/SkyMuster 2/GSAT 18    | 9.809  | KO 3 | GTO     |
| 11/17/16 | Ariane 5 ES  | L594 | VA233/Galileo 15-18          | 2.865  | KO 3 | MEO     |
| 12/21/16 | Ariane 5 ECA | L587 | VA234/StarOne D1/JCSAT 15    | 9.841  | KO 3 | GTO     |
| 02/14/17 | Ariane 5 ECA | L588 | VA235/SkyBrasil 1/Telkon 3S  | 9.550  | KO 3 | GTO     |

|                       |       |                            |       |      |     |
|-----------------------|-------|----------------------------|-------|------|-----|
| 05/04/17 Ariane 5 ECA | L589  | VA236/SGDC, Koreasat 7     | 9.415 | KO 3 | GTO |
| 06/01/17 Ariane 5 ECA | L590  | VA237/ViaSat2/Eutlsat 172B | 9.969 | KO 3 | GTO |
| 06/28/17 Ariane 5 ECA | L591  | VA238/Hellasat 3/GSAT 17   | 9.257 | KO 3 | GTO |
| 09/29/17 Ariane 5 ECA | L5100 | VA239/Intelsat 37e/BSAT 4a | 9.958 | KO 3 | GTO |
| 12/12/17 Ariane 5 ES  | L595  | VA240/Galileo 19-22        | 2.86  | KO 3 | MEO |

|                       |       |                       |       |      |          |
|-----------------------|-------|-----------------------|-------|------|----------|
| 01/25/18 Ariane 5 ECA | L5101 | AV241/SES 14/Al Yah 3 | 8.218 | KO 3 | [EEO][6] |
|-----------------------|-------|-----------------------|-------|------|----------|

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- [1] First Ariane 5 test flight. Control lost 37 seconds after liftoff at 3.7 km altitude, causing vehicle break up and destruction. Inertial Reference System failed due to a software exception resulting from floating point Operand error. Cause was result of specification and design errors in the software of the inertial reference system, due to decision to reuse Ariane 4 flight software.
  - [2] First stage rolled causing Vulcain main engine to shut down 10-20 seconds early. Test flight payloads were left near 535 x 26,631 km x 7.79 deg orbits, lower than planned GTO.
  - [3] Successful test flight put 2.6 tonne Maqsat 3 dummysat into GTO. The 2.8 tonne Advanced Reentry Demonstrator (ARD), released after Stage 1 separation, flew a suborbital reentry test to 830 km apogee, splashed down 1 hour 41 minutes after liftoff in the Pacific Ocean between the Marqueses and Hawaii, and was recovered a few hours later.
  - [4] Storable Propellant Stage (EPS) Stage 2 Aestus engine burned at only 80% thrust and cutoff 80 seconds early, leaving payload in 592 x 17,528 km x 2.9 deg orbit, far from planned 858 x 35,853 km x 2 deg geosynchronous transfer orbit. Cause identified to be combustion instability at Aestus ignition, which led to low thrust and premature depletion of N2O4 or MMH propellant. Water vapor in propellant lines may have caused instability.
  - [5] First Ariane 5 ECA failed when Vulcain 2 core engine suffered cracked cooling tubes. Failure in engine began at T+96 sec. Thrust fluctuations began at T+178 sec. RSO at T+456 sec.
  - [6] Telemetry lost at Stg 2 ignition. Orbits had 20 deg inclination rather than 3 deg, and slightly lower than planned apogee.
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## References

Ariane 5 User's Manual, Arianespace, November 2004  
V-181 Press Kit, Arianespace, March 2008

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