



# Assembly of Western European Union

DOCUMENT 1547

13 November 1996

## FORTY-SECOND SESSION

---

### **Airborne surveillance**

### **REPORT**

submitted on behalf of the Technological and Aerospace Committee  
by Mr Lenzer, Rapporteur



*Airborne surveillance*

---

REPORT<sup>1</sup>

*submitted on behalf of the Technological and Aerospace Committee<sup>2</sup>  
by Mr Lenzer, Rapporteur*

---

TABLE OF CONTENTS

DRAFT RECOMMENDATION

on airborne surveillance

EXPLANATORY MEMORANDUM

submitted by Mr Lenzer, Rapporteur

- I. Introduction
- II. Ground surveillance from space
- III. Requirements still to be met
  - (i) Observation continuity
  - (ii) Observation precision
  - (iii) Flexibility of use

Other surveillance systems

- (i) The high-altitude flying platform
  - (ii) Helicopter systems
  - (iii) Drones
- IV. Capabilities of airborne observation systems

---

1. Adopted unanimously by the Committee.

2 *Members of the Committee:* Mr *López Henares* (Chairman), MM *Lenzer*, *Marshall* (Vice-Chairmen); Mrs *Aguiar* (Alternate: *Coelho*), MM *Arnau*, *Atkinson*, Mrs *Blunck*, Mrs *Bribosia-Picard*, Mr *Cherribi*, Sir *John Cope*, Mr *Diana*, Mrs *Durrieu*, Mr *Feldmann*, Mrs *Gelderblom-Lankhout*, MM *Jeambrun*, *Le Grand*, *Litherland* (Alternate: Sir *Dudley Smith*), MM *Lorenzi*, *Luis*, *Magginas*, *Martelli*, *Olivo*, *Probst*, *Ramírez Pery*, *Sofoulis*, *Staes*, *Theis*, *Valleix*.

*Associate member:* Mr *Dincer*.

N.B. *The names of those taking part in the vote are printed in italics.*

V. Operational requirements

- at WEU level
- at national levels

VI. Airborne solutions envisaged

- Fixed wing systems
- Rotary-wing systems
- Drones

VII Conclusions

APPENDIX

Airborne surveillance systems – Global Express, Gulfstream V and Airbus A319

*Draft Recommendation*  
*on airborne surveillance*

The Assembly,

- (i) Considering that space-based systems, owing to certain intrinsic features, do not meet all the requirements involved in monitoring the earth's surface, particularly where continuity of observation, data precision and flexibility of use are concerned;
- (ii) Taking the view therefore that satellite systems, which are designed to meet certain strategic needs, must be supplemented by airborne systems capable of meeting tactical requirements;
- (iii) Bearing in mind that the new geopolitical situation, characterised by a large number of local conflicts that may be far apart, confirms how important are the requirements described above;
- (iv) Noting that the recent conflict in Bosnia and Herzegovina has served to highlight deficiencies in ground surveillance, thereby confirming that airborne facilities supplementing a satellite option would be a more effective way of meeting operational needs;
- (v) Regretting that the Council has not yet tasked the Planning Cell to analyse areas in which the airborne surveillance needs of the various European armies converge;
- (vi) Considering that such an analysis should lead to the standardisation of headquarters requirements, so that WEU's needs in this respect can be defined.
- (vii) Pointing also to the fact that the Planning Cell could draw up draft military specifications and thus guide the work of WEAG Panel I, which would have the specific advantage of improving Europe's industrial capacity and competitiveness in this area;
- (viii) Noting the existence within NATO of a study group tasked with assessing Alliance needs in terms of airborne surveillance,
- (ix) Taking account of the fact that this assessment should be the basis for determining the number of systems necessary and procuring the system or systems selected;
- (x) Considering that such decisions are of major importance, especially from an industrial point of view,
- (xi) Noting furthermore that various European countries have made substantial investments in airborne surveillance in recent years, without a single study being undertaken in the framework of European cooperation;
- (xii) Observing, however, that the work of various kinds done so far shows many similarities, suggesting a high degree of convergence with regard to needs;
- (xiii) Recognising that, at a time when defence budgets in the WEU countries are subject to severe restrictions, it is absolutely essential to achieve a definition of European requirements reflecting virtually all national needs and which might also include some items intended to meet highly specific requirements;
- (xiv) Noting finally that the WEU Council is making only very limited use of the Satellite Centre, particularly in view of the new operational capabilities the Helios 1 satellite brings to it and that the Satellite Centre's original terms of reference include analysis of imagery obtained by means other than by satellite,

RECOMMENDS THAT THE COUNCIL

1. Task the Planning Cell with an analysis of areas in which the airborne surveillance needs of the various member countries converge,
2. Ensure that such analysis leads to standardisation of the various requirements, making it possible to identify WEU's needs in this respect;
3. Ensure that a study is made of the various European government and industrial projects and programmes in this field, taking maximum cost-effectiveness into account at all times;
4. Ask the Planning Cell to draw up draft military specifications that would guide the work of WEAG Panel I, thereby helping improve European industry's capacities and competitiveness;
5. Ensure that the results of all such work are taken into consideration by member countries in institutions which, like the Atlantic Alliance, are soon to take decisions on operational requirements in respect of airborne surveillance and on the selection and procurement of the necessary systems;
6. Make more use of the facilities of the WEU Satellite Centre and especially of the operational capabilities of Helios 1;
7. Ensure that the Planning Cell and the Intelligence Section are closely involved in the work and use of the Satellite Centre

## *Explanatory Memorandum*

*(submitted by Mr Lenzer, Rapporteur)*

### *I. Introduction*

1. Among the final considerations set out in the recent report on "WEU and Helios 2"<sup>1</sup>, the importance was underlined in air-ground surveillance terms of combining airborne and satellite options. In other words, data gathered through the use of strategic (satellite) systems should be supplemented by information obtained via tactical (airborne) systems.

2. Indeed, as we shall examine in further detail in a subsequent chapter, certain intrinsic features of space-based systems mean they cannot fully meet all requirements, particularly where continuity of observation, data precision and flexibility of use are concerned, hence the need for other information sources such as airborne systems, to supplement data obtained by satellite.

3. This need is becoming increasingly evident in view of the new geopolitical situation, which is characterised by a large number of local conflicts, making it essential for satellite surveillance capabilities to be supplemented by data-gathering facilities available on airborne systems.

4. The need that must be addressed then is how to obtain information on enemy movements directly they occur and ensure virtually instantaneous communication with all forces involved so these can be engaged immediately. The conflict in Bosnia and Herzegovina served to highlight these problems and provided an illustration of how an airborne component was used to supplement satellite facilities in order to resolve them effectively.

5. NATO's involvement, for the first time in its history, in crisis-management operations under United Nations mandate in former Yugoslavia, pinpointed deficiencies in surveillance capabilities, particularly in terms of the detection and monitoring of ground movements in areas of interest. It became clear that such facilities are essential in order to support political decisions taken with a view to specific activities or to planning what defensive action should be taken.

6. Thus in 1994 an initiative was taken in NATO to create a study group tasked with providing the organisation with what was originally referred to as the Alliance ground surveillance (AGS) capability and later became known as air-ground, or airborne, surveillance. This initiative, first set in motion by the United States, initially stemmed from genuine need, but was also undoubtedly influenced by the fact that the United States already had its own system, the Joint Surveillance Target and Attack Radar System (JSTARS), which had been used in operation Desert Shield/Desert Storm in August 1993.

7. Your Rapporteur was told that when an initial assessment of Alliance requirements for an AGS capability was carried out, the number of planes involved proved to be too high (just over 50). Subsequent discussions led to consideration as to whether NATO should have a core fleet covering minimum essential requirements. In the United States' view, these requirements should be met immediately through NATO procurement of existing systems, namely JSTARS (4-5 planes) and Horizon (8 systems).

8. This minimum requirement represents what is essential for dealing with local conflicts such as, for example, that in former Yugoslavia. In the event of a conflict of larger proportions, those nations having their own facilities would make them available to the Alliance.

9. This proposal raises various problems, the first being to define the size of the core or minimum fleet; secondly, it raises both major industrial issues and the matter of the degree of goodwill it can be assumed nations will show in making their respective assets available to NATO when the occasion arises.

10. These minimum needs therefore have to be defined and an agreement reached on organising a system for assigning national assets which at the same time addresses the concerns of the smaller nations that have no such systems but wish to draw on NATO's for their own national ends.

11. However the main problem is undoubtedly of an industrial order, in view of the fact that four

<sup>1</sup> Document 1525

countries have air ground surveillance (AGS) systems, which are either already operational or at varying stages of development. These are the US JSTARS system, the United Kingdom's Astor system, France's Mosta and Horizon systems and Italy's Creso system. A chapter of the report will be devoted to examining them further.

12. At present, an embryonic project office and a steering committee already exist. The office is to become an Agency (similar to that set up for the European Fighter Aircraft (EFA) as soon as a firm decision is taken by the Conference of National Armaments Directors, which could take place around April 1997. Prior to this, NATO's Military Committee should first find that the project is urgent and give its opinion on which system should be chosen.

13. According to *Defense News*<sup>2</sup>, SHAPE (Supreme Headquarters Allied Powers Europe) officials are in no doubt as to its urgency and have said as much to NATO's Military Committee. *Defense News* adds that the fact that the project is urgent gives JSTARS, built by Northrop Grumman Corporation, the edge over its rivals that are still under development, although their constructors say they could bring their systems up to operational level immediately and claim they would be cheaper.

14. From another angle, WEU has not yet discussed airborne surveillance and has no plans to do so. The Armaments Secretariat has not considered the matter, nor has the Planning Cell been tasked by the Council in that connection. However this should not, in your Rapporteur's view, prevent the Assembly's Technological and Aerospace Committee reaching its own conclusions and endeavouring to secure the adoption by member countries, acting as WEU alone or within NATO, of a firm stance in defence of Europe's political, military and industrial interests.

## II. Ground surveillance from space

15. Over the last six years the Committee has produced eight reports on the subject of military observation satellites and the development of a European space-based observation system for security and defence purposes. Two colloquies on these issues have also been organised, which gives

an idea of their importance and our concern that Europe should have its own independent surveillance system which, in our view, is essential to the security and defence of our continent.

16. In 1986, France launched its Helios programme for a military observation system by satellite. While France's decision to seek the cooperation of other countries was influenced by high programme costs, political considerations also steered it in that direction. Italy and Spain joined the Helios 1 programme, taking funding shares of 14% and 7% respectively.

17. The Helios 1 programme, whose final cost is assessed as being in the region of ten billion francs, consists of two satellites, Helios 1A and 1B. Helios 1A was launched on 7 July 1995 by an Ariane 4 rocket from the Kourou base in Guiana while construction of Helios 1B began in mid-1995 and is due for completion at the end of the current year. Helios 1B's launch date will depend on Helios 1A's performance and on launch forecasts for the Helios 2 satellite, to which we shall return later.

18. The theoretical lifetime of Helios 1 satellites is between four and five years and they weigh some 2.5 tonnes. They are designed for high-resolution (circa 1 metre) optical observation, which restricts their observation capability to daylight hours in good visibility. Helios 1 is stationed in a sun-synchronous polar orbit at an altitude of 677 km and has a repeat flyover time of 24 hours, given its speed of roughly 7.8 km per second.

19. As your Rapporteur noted in Document 1525<sup>3</sup> the satellite's orbit and manoeuvring capabilities guarantee that a given location can be observed every day and that 15 or so scenes can be taken daily from orbits corresponding to priority interest zones such as Europe, Africa and the Middle East.

20. The Helios 1 programme is based on the same platform as the Spot 4 civilian satellite and the general architecture of both satellites is very similar, showing that optimum synergy can be obtained between the civilian and military sectors. Moreover Helios 1 has shown that a military space-based observation system can be shared quite satisfactorily and that the organisational set-up

2. 9-15 September, 1996

3. "WEU and Helios 2", Document 1525, report submitted on behalf of the Technological and Aerospace Committee by Mr Lenzer, Rapporteur



required for construction and operation of the satellite can be small, flexible and functional.

21 The first Helios images reached the WEU Satellite Centre at Torrejón (Madrid), on 1 May 1996 and were immediately analysed, in accordance with instructions concerning Sarajevo received from the Planning Cell.

22. The need both to replace the Helios 1 satellites and to upgrade the programme has led to a new system, Helios 2, being built. This draws on the experience gained with its predecessor, incorporates new technologies and improves the programme by introducing infrared components for night-time observation, thus allowing more data to be gathered.

23. Like Helios 1 and Spot 4, Helios 2 is geared to synergy between the civilian and military sectors through compatibility with the civilian satellite Spot 5. Bearing this in mind, the lessons learnt and experience gained from Helios 1 should make it possible with Helios 2 to cut the time required for collecting images by a half or a third and obtain a detection capability far greater than that of its predecessor, owing to its ability to take scenes simultaneously and its higher resolution (of the order of 50 cm).

24 On 7 December 1995, France and Germany agreed to cooperate on earth observation using military satellites. The agreement covers the French Helios 2 programme and the German Horus radar satellite project. Since then, talks between the two countries, mainly intended to clarify the financial and industrial aspects of cooperation, have run up against Germany's budget problems, with the German defence minister insisting repeatedly that he did not have the necessary resources for this type of project.

25 However, all the signs now are that the project will go ahead, thanks to the intervention of the German Foreign Affairs and Research Ministers<sup>4</sup>, but it is clear that the longer it takes for the agreements to be firmed up, the more difficult it will be to keep to the schedule envisaged for the start of the project.

26. In principle, the launch of Helios 2 is scheduled for 2001. Project definition studies on

Horus are to begin in 1998, construction will follow in the year 2000 and its launch should take place in 2005. Spain and Italy are also waiting for the agreements between the French and the Germans to take their final shape before possibly joining the project alongside these two countries.

27. As little information is available on the Horus radar satellite, all that can be said at this stage is that it will make 24-hour observation possible, with a very high yield, irrespective of atmospheric conditions. The platform will be specially adapted to satellites in the three-tonne category and the satellite architecture will be designed around the payload. Lastly, Horus is to have synthetic aperture radar.

28. The Helios 1 programme consists of two segments, the Helios space component – which comprises the satellite and the station-keeping centre – and the user ground component, which consists of the Helios main centres and the image-receiving centres.

29 The duties of the station-keeping centre are to operate and monitor the satellite on a daily basis, through two control rooms, the satellite control centre – which provides an on-line link to the satellite and carries out programmed operations when the satellite flies over the telecommand stations – and the utilities management centre which manages the satellites and their payloads off-line. The utilities management centre prepares the operations, in particular the satellite programming messages, that are drawn up on the basis of work schedules received from the user ground component.

30. As has been said, the user ground component primarily consists of the Helios main centres and image-receiving centres. Each of the three Helios 1 participating countries, namely France, Italy and Spain, has its own main and image-receiving centres. The French Helios main centre at Creil is the hub of the system, centralising image requests from the three countries and relaying them to the station-keeping centre for the purpose of drawing up the satellite's daily work schedule.

31 Thus each national Helios main centre sets objectives, states requirements and lists its priorities on the basis of urgency and the importance of its country's needs. The French main centre is the forum for tripartite dialogue between military representatives of the three countries, at which decisions on the daily programming schedule are

4. *Financial Times*, 8 October 1996.

taken. As has just been explained, the programming schedule is then sent to the station-keeping centre whence it is uploaded to the satellite. Each image-receiving centre has its own images delivered to it in real time or slightly deferred time for onward transmission to its main centre where they are analysed.

32 As a result of agreements WEU has signed with the Helios 1 countries, the WEU Satellite Centre has also started receiving Helios images, as stated earlier.

33 According to Document 1525, to which reference has already been made, a series of measures will need to be adopted for the WEU Satellite Centre to become genuinely operational. To avoid repetition, the Rapporteur refers the reader to the relevant passages of that document.

### *III. Requirements still to be met*

34 Space-based observation is clearly an essential link in the network of ground surveillance systems. Observation satellites also have the advantage of having access to any part of the world without infringing the sovereignty of the states they overfly, as the legislation governing space contains no prohibitions on overflying any country.

35 Notwithstanding, it has to be acknowledged that satellite systems do not meet every observational requirement, mainly because they are not particularly flexible in the way they can be used and because the information they provide is not likely to be sufficient in itself for an accurate assessment to be made of a given situation in times of conflict or crisis.

36 Therefore it would be fair to assume, as the introduction to the present report points out, that satellite systems are essentially suited to collecting information for the creation of documentary databases and for global strategic reconnaissance, rather than for tactical and operational reconnaissance. In this last area, accurate online intelligence is essential and this can only be obtained using a range of different systems that are extremely flexible in their use.

#### *(i) Observation continuity*

37 The concepts of permanent observation and online data relay are increasingly finding application

in situations where armed forces constantly need to have the fullest possible information available to them so as to reach instant decisions on the best course of action to be adopted in the field.

38. Irrespective of altitude, a satellite will only overfly the same point after what is bound to be a fairly long interval. If observation of the entire planet is required, the satellite will have to be placed in sunsynchronous orbit at an altitude of approximately 900 km. It takes it some 102 minutes to travel one such orbit and an interval of several days can elapse before it returns to practically the same orbit.

39 A similar problem arises when delivering observation data to the ground user station as the station has to be "visible" to the satellite. Hence a satellite-based system cannot by itself deliver permanent observation.

#### *(ii) Observation precision*

40. Even a high-yield satellite is limited in the information it can gather. Satellites equipped with sensors operating in the visible and even in the infrared spectrums can prove ineffective if the area of interest is veiled by cloud cover of a given thickness.

41 Although sufficiently high resolution to identify small objects can be obtained by reducing the altitude of the orbiting satellite, this significantly reduces its life-span as the atmosphere applies considerably more drag to its movement in orbits at an altitude of less than 500 km. Furthermore, to operate in this way would mean a large supply of engine-fuel being carried on board, hence the need for a heavier and more expensive satellite.

42. To avoid cloud-cover problems, it is planned, by dint of much effort, to put radar satellites supplying high-resolution images into orbit. These basically have the advantage of operating round-the-clock, regardless of atmospheric conditions, but their high electrical power consumption prevents their being used continuously over a long period.

43 Moreover, radar satellites have to be placed in a high enough orbit to ensure a sufficient life-span – a requirement hardly conducive to high resolution unless recourse is had to a very long integration period which has the disadvantage,

however, of reducing the possibility of observing a wide area.

*(iii) Flexibility of use*

44. Situations may evolve so rapidly that the time that elapses between an event occurring and its notification to the relevant authorities must be short enough for the appropriate decision to be taken and implemented effectively.

45. It must therefore be possible for surveillance systems to be used flexibly and to be capable of receiving and transmitting information to the appropriate authorities in a very short space of time. Furthermore, in recent years, theatres of operation have become much larger with pockets of fighting that are widely dispersed. Such factors make surveillance especially difficult and mean that the systems used must be fully complementary.

46. At present, satellites are not able, for the technical reasons which have just been referred to, to fully meet the requirements of flexibility, speed and precision which are now the order of the day.

47. In strategic and tactical terms, air reconnaissance is undeniably an asset when it comes to evaluating threats and conducting operations as it makes it possible to create the databases that are essential for compiling documentary intelligence, monitoring developments, drawing up orders of battle and producing theatre and target information kits.

48. At the political level, accurate information about the activities of a suspect state can, if conveyed with enough advance notice, help ensure that an appropriate decision is taken or serve to alert the attention of the international authorities. This preventative approach is a crucial one in today's world. However in order to make it possible, online observation and transmission are a must and surveillance and reconnaissance aircraft, helicopters and drones can meet this requirement.

*Other surveillance systems*

49. There are a number of air systems available to supplement surveillance by satellite, each with its own special features and designed to meet specific needs. Generally speaking, they complement one another in a given area.

*(i) The high-altitude flying platform*

50. The capabilities of this system, which seems the best suited to permanent observation, will be described in a later section. The system is one which allows very high-resolution images to be produced, making it possible to recognise medium-size targets, and enables a single zone to be observed using different types of sensor. These systems normally use wide-bodied aircraft as their platform.

*(ii) Helicopter systems*

51. These systems have the advantage of being very flexible in their use. Helicopters can take off quickly in an emergency and make directly for the surveillance area. Helicopter-mounted systems can be used independently provided the aircraft has the same equipment as the ground station.

52. A helicopter's field of action is restricted to tactical surveillance to assist ground forces and provides information about what lies ahead and whether it moves. Its operating range does not normally exceed 200 km. Helicopters may also be used in conjunction with high-altitude fixed-wing systems, for observing areas masked by the contours of the terrain. Finally, helicopters can be used in defining and optimising the tasks of drones or UAVs (unmanned air vehicles).

*(iii) Drones*

53. The importance of UAVs has grown since the end of the Gulf War and such drones are being increasingly widely used. Although their operating range is limited to a few hundred kilometres above the battlefield and their relatively slow speeds make them particularly vulnerable to surface-to-air defences, these systems are of major interest to armies owing to their low cost, flexibility of use and because no loss of life is involved.

54. Drones fall into three categories, each corresponding to a different operational level:

- regimental level: corresponding to a range of roughly ten kilometres and frequently used by army regiments;
- tactical level: corresponding to a range of approximately 100 km,

- strategic level corresponding to a range of some 1 500 km and used mainly by air forces

#### *IV. Capabilities of airborne observation systems*

55 The maximum flight altitude of an airborne system is of the order of 30 km. At that altitude the radio horizon lies at a distance of some 600 km – the optical horizon is nearer but this factor is of little interest since atmospheric attenuation very quickly restricts the observation range. It should be noted that distance from the radio horizon is not a useful measurement as it corresponds to a grazing angle. Now the earth's surface is made up of reliefs and superstructures which create large numbers of areas which are in shadow whose size is largely dependent on the angle of incidence and it is very difficult to determine the minimum angle necessary for effective observation.

56 Since flying at an altitude of 30 km requires the use of aerodynamics and propulsion technologies involving highly specialised development work, they are very costly. The question then arises as to whether there is an observation altitude that is more accessible financially.

57 An altitude of 20 km might be considered. This raises far fewer problems as it lies at the limit of altitudes used for commercial flights and is, by the same token, one where usable technologies have been mastered. At this altitude the effective observation ranges are 280 and 170 km.

58 For observation of the earth's surface to yield usable data for tactical purposes, it has to be virtually continuous. For permanent observation to be carried out effectively, the ratio of outward and inward journey times to time spent at the observation station must be very low, improving observation by reducing transit time is possible only by increasing speed – which is a costly option – while any improvement involving an extension of the time spent at the observation station has as its first consequence an increase in the amount of fuel carried aboard and the use of low-consumption engines.

59 The mass of fuel carried by an aircraft forms part of the authorised payload mass. If large quantities of fuel are to be carried, the mass of the observation system has to be reduced accordingly by taking aboard only what is strictly necessary.

60 Equipment that is strictly necessary obviously includes observation sensors and remote transmission systems for data gathered by the sensors. It will be noted that it is not necessary to have data merge and analysis systems aboard, much less operations control systems. Which, then are the observation sensors that are absolutely essential?

61 Remote observation (distances of over 100 km) implies the use of radar sensors and electromagnetic interception systems, while use of optronic sensors is confined to ranges under 50 km if propagation through the lower layers of the atmosphere takes place over a long distance. One can therefore conclude that this last type of sensor is only of any real advantage when it is possible practically to overfly the zones of interest – as satellites do – preferably when no cloud layers are present, even if these are broken.

62. The use of high-resolution synthetic aperture radar (SAR) and moving target indicator systems (MTIs) in conjunction with equipment for detecting, locating and identifying electromagnetic radiation would appear to be the basis of any long-range observation system. As this system can be installed in observation stations which are remote from analysis centres, it must also include a transmission facility capable of relaying data at high flow rates via satellite or, in the absence thereof, other air or surface systems.

63 The high-resolution SAR system must be capable of producing images with metric resolution and the moving target indicator system of detecting and tracking moving echoes on the surface within a required range of speeds.

64 The electromagnetic interception system should be capable of detecting and pinpointing most of the various emissions with a range compatible with the size of the area under observation.

65 It is interesting to note that a combination of these different systems on a single observation platform promotes synergy between their capabilities and makes for quicker reconstitution of the real situation in the zone observed – which is of course the prime purpose – by facilitating a merger of their output and above all by cueing sensors to home in quickly on items of interest.

66. It was stressed earlier that the time spent at the observation station should be as long as possible. The observation system should therefore

be light enough to allow large quantities of fuel to be carried on board and the total platform mass should allow the craft to be stationed at the required observation altitude from the start of the mission.

67. It should be recalled that the optimum cruising height of an aircraft increases with fuel consumption. Thus an aircraft may well have an airframe approved for flying at an altitude of 20 km but will only reach that altitude once it has used up nearly all of its fuel

68. As has been explained, the reduction in total platform mass achieved by optimising the mass of fuel on board presupposes optimal definition of the observation system so as to limit its mass, but can also lead to pilot and navigation systems becoming fully automated, in other words to the flight crew being eliminated. This solution is usually described as a "drone" and the American Global Hawk programme which has recently been launched provides a perfect illustration. Interesting though it is, this solution clearly calls for very heavy development investment

69. The trend towards automated airborne platforms or drones may lead to consideration being given, under certain circumstances, to overflying observation areas. As explained earlier, this would substantially ease requirements in terms of range which would mean that optronic sensors and much lighter radar sensors could be used, but above all it virtually overcomes the problem of areas in shadow. However the risks of the platform being destroyed by air defence means are high; hence the need to design a platform that operates with extreme stealth such as Darkstar – which is likely to involve high development and possibly production costs

## V. Operational requirements

### *At WEU level*

70. It has already been pointed out that WEU has not tackled the problem of airborne surveillance and apparently has no intention of doing so.

71. The second part of the Petersberg Declaration (19 June 1992) deals with strengthening WEU's operational role and envisages military units organised on a multinational and multiservice basis being made available to the Organisation. These forces, acting under WEU authority, outside the framework of Article 5 of the Washington Treaty

and Article V of the modified Brussels Treaty, could be employed for humanitarian and rescue tasks, peacekeeping tasks and tasks of combat forces in crisis management, including peace-making

72. The Planning Cell was created in the wake of the Declaration. Its tasks consist *inter alia* of preparing contingency plans for the employment of forces under WEU auspices and making recommendations for the necessary operations command, control, and communications arrangements, including standing operating procedures for headquarters that might be selected.

73. Reference should also be made to subsequent declarations by the WEU Council of Ministers which also advocate strengthening the Organisation's operational role and highlight the importance in this connection of intelligence and surveillance. It is therefore most surprising that the Council has not yet tasked the Planning Cell to carry out a study of Europe's need for an autonomous intelligence and surveillance system.

74. The Assembly, through several of its committees, has emphasised the fact that such surveillance should not be confined to observation by satellite, which is only one source of information among others. "The results it produces, if combined skilfully, analysed and continuously updated, could provide the information needed for a reasonable and accountable common foreign, security and defence policy"<sup>5</sup>

75. Finally, it is regrettable to note that the Council has failed to instruct the Planning Cell to analyse areas where the needs of the various European armed forces converge, to identify and standardise possible common needs and draw up draft military specification sheets which would be extremely useful for guiding the work of WEAG Panel I: one of the latter's aims is in fact to promote equipment programmes which are cost-effective and meet the operational needs of the WEAG nations, thus improving Europe's industrial capacity and competitiveness in the defence field

### *At national levels*

76. As no assessment of Europe's overall intelligence and surveillance needs has yet been

5. Document 1517 "A European intelligence policy". Rapporteur, Mr Baumel.

made, notwithstanding the guidelines laid down by the Council of Ministers at its meeting in Madrid on 14 November 1995, we must confine ourselves to an analysis of the needs of individual European countries either where these have been defined and/or where information about them is available

77 In the early 1980s France launched a programme of airborne platforms intended for battlefield surveillance covering a relatively modest range (around 100 km) and limiting surveillance requirements to moving objects. The programme led to the Horizon system which will be discussed in the following chapter.

78 In 1995, Great Britain commissioned a preliminary definition study from two industrial groups – one American and one British – of an airborne battlefield surveillance system covering a range of over 200 km, covering both fixed and moving objects. The results of this study will also be discussed in the following chapter

79 Italy, for its part, has defined a communications and information system (CATRIN) which comprises three subsystems, one each for communications (SOTRIN) battlefield surveillance (SORAO) and airspace surveillance and control (SOATCC). The SORAO subsystem comprises sensors and a network of data merge centres. The sensors are both airborne (drones and Creso) and ground-based (radar, infrared, acoustic and laser). The Creso sensor will be described further on

80 Lastly, Germany's Egrett-Prisma programme got under way in 1987. This consisted of an airborne platform flying at very high altitude whose main feature was a very high-resolution imaging radar system, using American technology, for observing non-moving battlefield objects over a range of 200-250 km. The programme came to a halt in 1993

81 Four of the larger European countries therefore have been making considerable investments in ground surveillance for some time, without a single study having been undertaken with a view to European cooperation

82 Nevertheless an analysis of the work that has already been done reveals many similarities, a fact that can be explained by strongly converging needs

83 Consequently it can be inferred that at a time of tighter military expenditure budgets, it is more essential than ever to elicit a definition of European

requirements that encompasses virtually all national needs, to which might be added, within limits, certain items to meet highly specific requirements

## *VI. Airborne solutions envisaged*

84 In recent years, a number of European countries have made substantial efforts to develop airborne ground surveillance systems. Some of these projects are currently at a standstill, others are continuing and have reached their development or production stages, while others still, like the French Horizon system, are already in service.

85 These systems fall into three major categories: fixed-wing, rotary-wing and drones or UAVs

### *Fixed-wing systems*

#### *(i) The United Kingdom's Astor airborne system*

86 The British Defence Ministry is planning the development in a year or so of a new airborne battlefield surveillance system called Astor, for Airborne Stand-Off Radar. Although Astor's original design has in fact undergone changes in recent years, it now seems to have been consolidated. It consists of an aircraft flying at high altitude equipped with two types of extremely sophisticated radar systems: Moving Target Indicator (MTI) and Synthetic Aperture Radar (SAR), supplemented by optical facilities. This system should meet both army and air force requirements

87 Data collected will be analysed primarily in the ground centres, which have a radio relay link to the sensors. In fact the Astor-type solution works on the assumption that the airborne platform should only carry sensors while analysis and control facilities will be more efficient if located on the ground.

88 However the platform's small size makes it unlikely that it could accommodate the various complementary sensors that would be extremely useful. The Astor system competes with the United States' JSTARS system, which it is proposed should be carried on NATO surveillance aircraft in the future

89. The United Kingdom currently has two aircraft options for the new surveillance systems,

the Raytheon-modified Global Express and Lockheed Martin's converted Gulfstream V.

90 These were selected in February 1995 for preliminary feasibility studies for systems which should be operational between 2001 and 2003. The studies have led to two competing tenders for development and production of five aircraft and up to nine ground stations. Both tenders use commercial aircraft capable of reaching altitudes of around 15 000 metres as platforms.

91. The Lockheed Martin project involves a Gulfstream V fitted with a radar system which Racal has been developing for four years. Lockheed Martin's main associates in the project are Marconi Defence Systems, who will supply all the communications and data-processing systems, Logica for the software, Marshall for the mobile equipment and ACE for the logistical support.

92. With regard to the Raytheon project, at the recent 1996 Farnborough Air Show the company announced that it was to form a British subsidiary, Raytheon E-System Ltd (RESL), which would manage the project if it went ahead

93. The aircraft Raytheon is proposing is Bombardier-Canadair's new Global Express. RESL would incorporate a radar system derived from the ASARS system developed by Hughes for the U-2 spy plane, which would be modified in Europe by GEC-Marconi and Thomson CSF. The main project partners, apart from those already mentioned, would be Shorts, responsible for modifying the airframe, while Marshall would provide the mobile equipment and Motorola and Cossor the ground stations.

94. Two further projects have subsequently been added to this list. The first involves Northrop Grumman which, despite being eliminated at the start of the preliminary feasibility stage, has again entered the race with its JSTARS system (using a converted Boeing 707 as a platform) which has been in production since March 1996. The American air force has placed an order for 20 such systems

95 The second is a Lockheed Martin project. At the 1996 Farnborough Air Show the company promoted its old U-2, for which the British have asked for a cost study

96. To your Rapporteur's way of thinking, the last two projects raise a number of difficulties when

looking ahead beyond 30 years of use. Both use platforms that are no longer being built today; furthermore, it is not at all clear that the technology can be transferred to British industry.

97. Moreover it must be stressed that whatever project the United Kingdom chooses, it will in large part be American given that most of the companies involved in the bid have their origins on the other side of the Atlantic

*(ii) France's Mosta airborne system*

98. France duly took the decision to acquire a helicopter-mounted system. Horizon, which, as has been noted earlier, is currently in service. No decision has yet been reached on whether to acquire a fixed-wing system. However, studies have been carried out by French firms on a project for a European high-altitude surveillance system.

99 Hence Dassault Electronique is offering a European system called Mosta (optimum land and air surveillance system) which is essentially a platform accommodating a number of monitoring sensors whose complementarity means that precise information about the tactical situation in the zone under observation can be obtained online. In its basic configuration, the analysis station is located on the surface (on the ground or on a ship).

100 The system, which is equipped both with synthetic aperture and MTI radar systems, also has a receiver and electronics intelligence demodulator (ELINT), a receiver and demodulator (COMINT) for intelligence gathered by communications interception, wideband data links and a high-capacity memory.

101. The airborne platform envisaged is an enhanced-capability Airbus A319. The aircraft would have a 9-hour flight range and would fly at over 12 000 metres; in-flight fuelling could extend that period to 19 hours. All the indications are that the European electronics industry is in a position to develop such systems in under ten years

*(iii) The United States system*

102 The JSTARS system on offer from the United States is the outcome of cooperation between the US army and air force. The system consists of a (Boeing 707) four-engined jet fitted with SAR and

many other sensors, covering, in theory, an area ranging from 16 km<sup>2</sup> to 250 000 km<sup>2</sup>.

103. A fairly large crew of some 15-17 members is required to operate the on-board system, which is very heavy, being designed to integrate detection, search and monitoring functions on a single airborne platform. It results from the need to be able to project an autonomous system for the surveillance and conduct of operations over a long distance on the assumption that long-distance, high data-rate communications are not possible. However it should be noted that this "autonomous" system must be combined with an AWACS and its escorts.

104. JSTARS was used during the Gulf War and more recently in Bosnia, where it operated with unmanned Predator-type aircraft. The American air force has only very recently secured approval for it to go into production, notwithstanding reservations in Congress and the Pentagon about one or two of its operational capabilities.

#### *Rotary-wing systems*

##### *(i) France's Horizon helicopter-mounted system*

105. The Horizon system is now operational. The French army took delivery of its first system in July 1996 and is to receive a second at the end of 1997. Horizon can take radar images of any vehicle moving faster than 6 km per hour. The system can detect, locate, analyse and automatically classify from a withdrawal position any moving target up to a range of 200 km over a huge area, day or night, irrespective of weather conditions. It can also provide instantaneous panoramic surveillance of an area of over 20 000 km<sup>2</sup> in ten seconds.

106. Horizon also has the advantage of being extremely flexible to use as, in the event of an emergency, an aircraft can take off rapidly for the observation zone where it can perform independent analysis operations because it carries the same equipment as the ground station. Each helicopter has a flight range of about four hours and can cover distances up to 1 000 km at an average height of 4 000 metres. It has a cruising speed of 270 km an hour and 180 km an hour when on observation duty. Its field of action is limited to tactical surveillance on behalf of land forces.

107. Each Horizon system comprises a ground station with two analysis units and one data-

transmission unit, as well as two AS 532 UL Cougar helicopters, adapted for all-weather flights, each with multimode radar (MTI, mapping and intercept), a data-processing unit, operator console for on-board processing, navigational and radio-communication systems and a secure data link.

108. It is worth noting that a European company, Eurocopter, is one of the principal production associates for the Horizon radar system, supplying the Cougar helicopters and the operator consoles. The other associates are Thomson CSF (radar applications) and Dassault Electronique (Agatha data links and ground stations).

109. The Horizon system can be used to supplement other surveillance systems, particularly for UAV mission definition and optimisation. It can also operate in synergy with fixed-wing surveillance systems, in observing areas masked by a site's topographical features, for example

##### *(ii) The Italian Creso helicopter-mounted system*

110. In 1987, Italy began development on its Creso project comprising an Agusta helicopter and an advanced radar system capable of observing moving battlefield objects over a 50-km range. The system has hostile radar detection systems, constituting an advantage over systems already described.

111. Data is transmitted by microwave link to the data merge and analysis centre. The system is able to detect movement at a distance of over 75 km. The helicopters have roughly a 4-hour flight range and an average speed of around 225 km per hour. The system is currently in its development phase.

#### *Drones*

112. At the present time, tactical and regimental drones are available to Europeans. Projects for the construction of high altitude-strength drones are being studied.

113. The French firm SAGEM has developed a series of drones such as the short-range Crecerelle, used by the French army for reconnaissance missions, or the medium-range Sperwer, for the Dutch army.

114. Crecerelle is the only European drone of its class and is used for tactical reconnaissance,



monitoring and target-acquisition tasks. It has a maximum speed of 250 km per hour, an operating range of 60-70 km and can reach a height of 3 500 metres.

115. The CL289, a joint French, German and Canadian-designed UAV, which came into operational service in 1990, is fitted with a Piver system, which draws upon Aerospatiale's experience in army intelligence-gathering. The system is capable of on- or off-line processing of images received from vehicles like the CL289.

116. The Piver-CL289 system is able to meet increasingly specific requirements – it has been used by the German Army since 1990 and the French Army since 1992. It has a maximum speed of 741 km per hour, an operating range of 180-200 km and operates at altitudes between 150 and 600 metres.

117. The Pirat unmanned air vehicle using fibreoptics technology, unveiled at Eurosatory 1994, was developed in response to new operational needs. This is a lower-performance system whose main task is to seek out, refine, or confirm "over-the-ridge" intelligence. It has a flight range of 30 to 60 minutes and a range of only 15 km

118. The Brevel is a small, light and stealthy UAV, developed jointly by France and Germany. The programme began in 1992 and the aircraft is due to go into service with the French and German armies in 1998, however the French army withdrew from the programme at the start of 1996.

119. The system is developed by Eurodrone, an economic interest grouping set up by Matra Defense and STN Atlas Electronik (part of the Bremer Vulkan Group). The Brevel carries out tactical surveillance, target-acquisition and designation tasks and damage assessment. Its flight range is roughly ten hours at speeds between 120 to 200 km per hour.

120. The French army's withdrawal has put an end to Europe's most ambitious UAV cooperation programme and one which would have been able to meet extremely demanding operational requirements over the next 20 years in widely varying theatres of operation.

121. The United Kingdom's Royal Air Force, for its part, is currently examining the possibility of replacing the system in service by a long-range UAV, such as Darkstar. Other European countries

are also working on the development of their respective drones.

122. Lastly, high-altitude drones are still at the design-study phase. Such is the case of Sarohale (long-endurance reconnaissance and observation aerospace system) which is able to undertake multiple tasks.

123. Aerospatiale is currently involved in the design study of this new system which is able to undertake virtually permanent reconnaissance of very remote areas, in conjunction with intermittent surveillance by satellite or otherwise. It could undertake a whole gamut of civil or military tasks ranging from observation, detection and early ballistic-missile warning (extended air defence) to target designation and including environmental surveillance. It will fly at altitudes of up to 18 000 metres, thus allowing it to avoid civilian air traffic problems and making it virtually invulnerable to anti-aircraft defence systems. It would have a flight range of between 20 and 24 hours.

124. Sarohale incorporates a modular payload system consisting of radar, optical, infrared and laser intercept systems. These may be used interchangeably according to a mission or all carried on board. The system as a whole may be operated by pilot or remote control.

125. SAGEM is currently designing the Horus-Predator UAV which would have 24-hour flight autonomy and a range limited only by the aircraft's flight endurance, as the latter would be equipped with satellite transmission. For this purpose, SAGEM would use a US-built carrier, the Predator, incorporating its own payload in the aircraft's interior, and would supply its own ground station.

126. Lastly, your Rapporteur feels that drones warrant special study by the Committee, both on account of their importance to airborne surveillance today and their even greater importance in the future, given that these are high-performance systems offering extra advantages at a time when both the armed forces and the general public are agreed on a "zero deaths" objective for military operations.

127. This special report should provide an exhaustive analysis of the subject, and look beyond Europe so as to include in its assessment such systems as the highly innovative CL327 vertical take-off and landing aircraft built by Bombardier-

Canadair, in which a large number of European countries are already showing interest and which might be one area where Europe and its transatlantic allies could cooperate.

### *VII. Conclusions*

128 European countries have seen their defence budgets substantially reduced in recent years and all the indications are that that trend is unlikely to be reversed. It is extremely important therefore that our present surveillance needs are met through a range of systems that are highly cost-effective.

129 As noted earlier, strategic needs can clearly be met by a satellite system that uses optronic and radar sensors but when it comes to tactical requirements, an airborne system is necessary.

130. In the light of the tasks it was decided to undertake at Petersberg and the recent decisions NATO reached in Berlin, it is not easy to comprehend why the Council has not instructed the Planning Cell to carry out a study to determine what WEU's operational needs are.

131 It is also difficult to understand the limited use the WEU Council is making of the Satellite Centre, and more specifically of the very useful tool it has in the Helios 1 satellite, especially as the countries involved in that project are prepared to respond to requests and as our own Organisation actually has sufficient financial resources.

132. As far as the airborne solutions described in this report, and particularly the rotary-wing option, are concerned, only one system – Horizon – is currently operational. This is largely due to European cooperation and it appears to offer the most advantageous features.

133. Your Rapporteur will refrain from drawing any conclusions where UAVs are concerned until a specialised, in-depth study has been carried out on this option. It is therefore for the Committee to take a decision to that end.

134. Turning to the fixed-wing option, the premise available on the second-hand market, in order to

hold down development costs and the unit cost of a platform, is a reasonable one, since a regular carrier aircraft reaching the end of its commercial life is of great interest to a military user both in terms of potential flying time and cost-effectiveness.

135. Gulfstream Aerospace's Gulfstream V aircraft and Bombardier's Global Express, now in the final stages of development, will take ten years to reach the second-hand market. These aircraft have a total liftoff mass of some 45 tonnes and are able to fly at an altitude of 20 000 metres carrying two tonnes of observation equipment, which suggests that they could only start their observation cruise at an altitude of some 12 000 metres.

136. Moreover, in the same family of aircraft, we have one (the Airbus A319) in the final stages of development and another (the Airbus A320) about to come on to the second-hand market. The total liftoff mass of these aircraft is some 68 and 77 tonnes respectively, they can fly at an altitude of 15 000 metres and, with an observation system weighing 3.7 tonnes, could start their observation cruise at an altitude of roughly 12 000 metres.

137. Their endurance periods at the observation station can be assumed to be comparable, the essential difference being in the maximum permitted mass for the observation system. All the indications are that, in principle, an observation system with a mass of 2 tonnes would have to be limited to radar modes plus satellite transmission, while a mass of 3.7 tonnes would mean that a complete system could be installed.

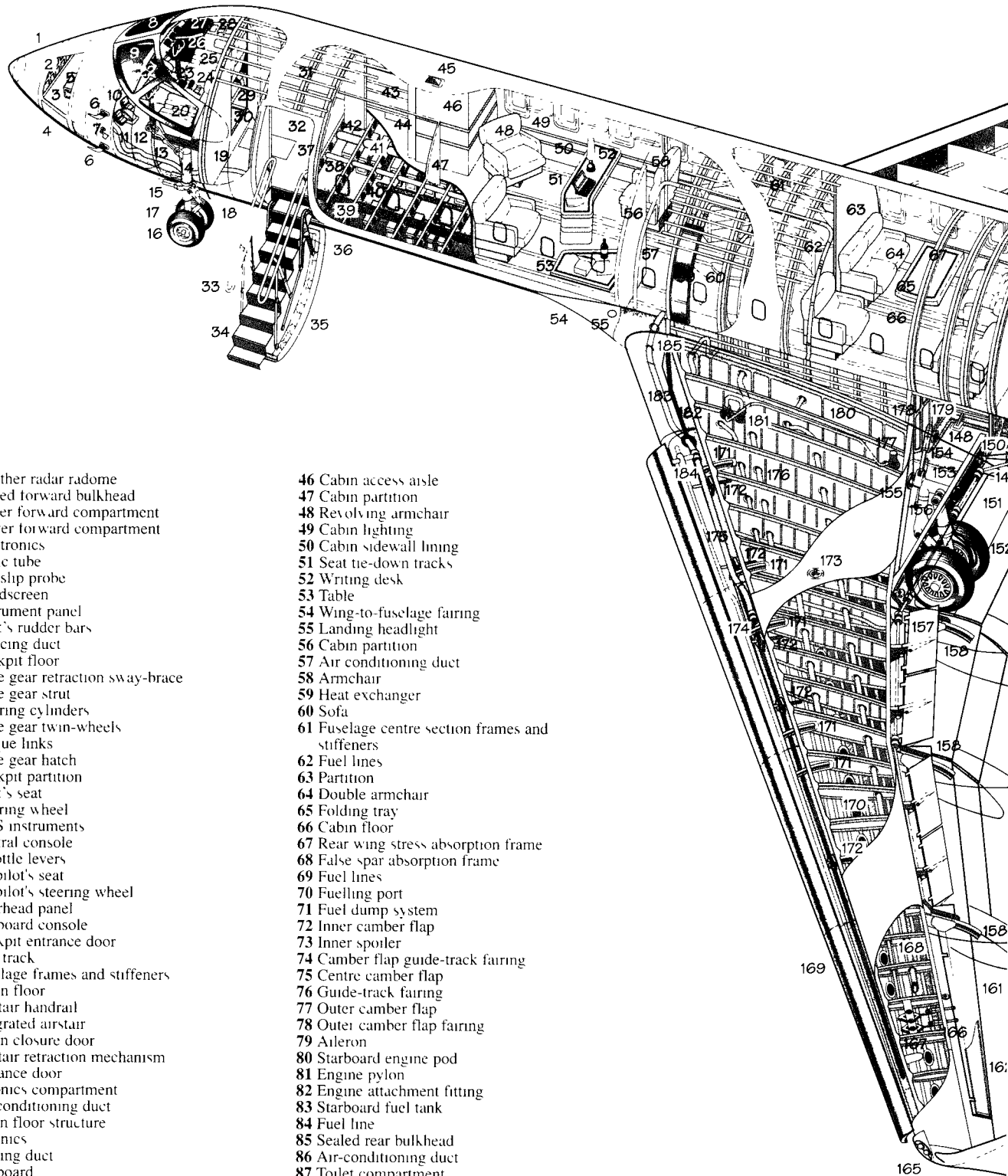
138. Furthermore, under certain circumstances it might be considered necessary to carry a small crew, capable of carrying out tasks in areas that might not be covered by high-flow satellite relay data.

139. Everything would seem to point to the conclusion that the A319/A320 platforms not only offer facilities that are of greater interest than those offered by other platforms, but are also superior to them.

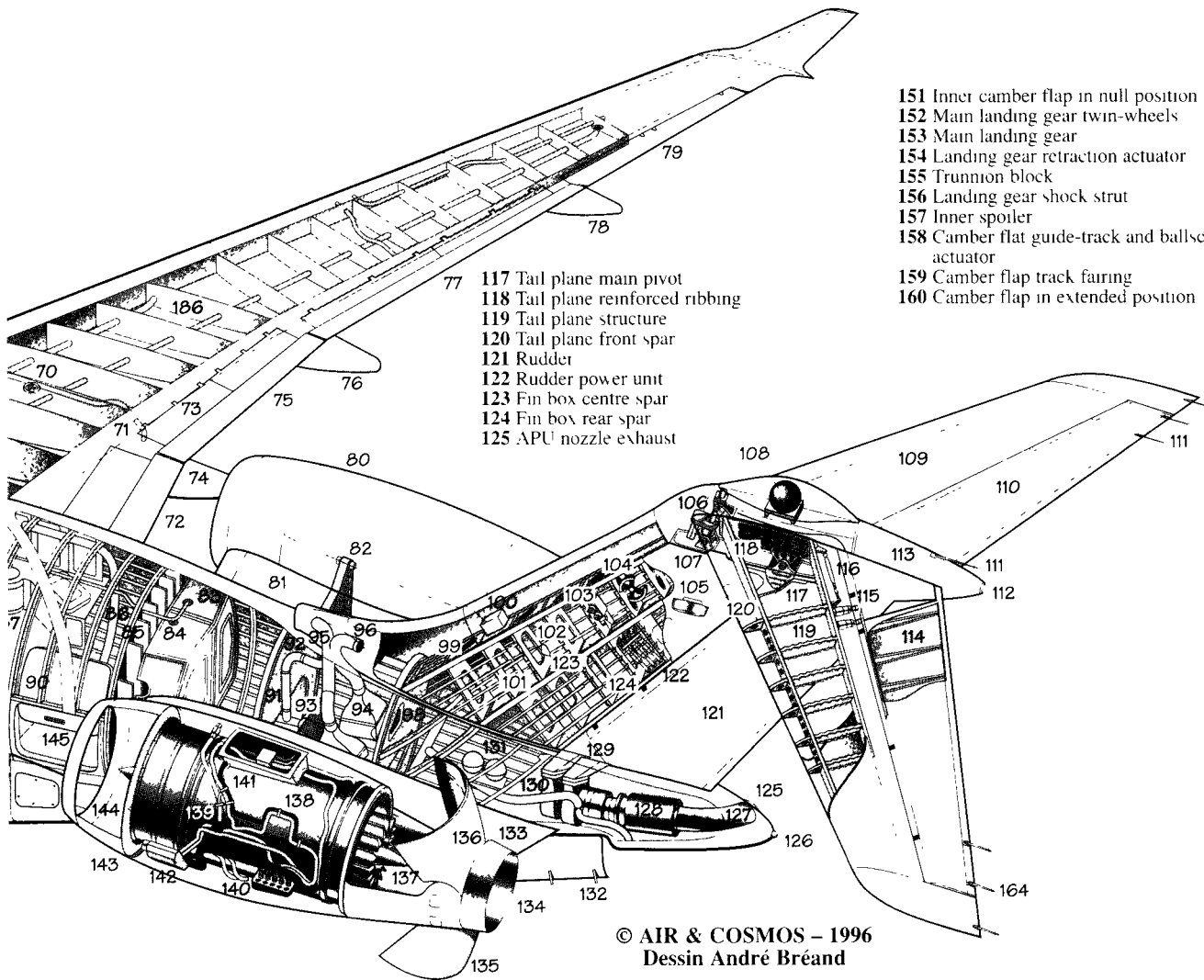


# GLOBAL EXPRESS

## (BOMBARDIER-CANADAIR)



- |                                    |  |
|------------------------------------|--|
| 1 Weather radar radome             | 46 Cabin access aisle                            |
| 2 Sealed forward bulkhead          | 47 Cabin partition                               |
| 3 Upper forward compartment        | 48 Revolving armchair                            |
| 4 Lower forward compartment        | 49 Cabin lighting                                |
| 5 Electronics                      | 50 Cabin sidewall lining                         |
| 6 Static tube                      | 51 Seat tie-down tracks                          |
| 7 Sideslip probe                   | 52 Writing desk                                  |
| 8 Windscreen                       | 53 Table   |
| 9 Instrument panel                 | 54 Wing-to-fuselage fairing                      |
| 10 Pilot's rudder bars             | 55 Landing headlight                             |
| 11 De-icing duct                   | 56 Cabin partition                               |
| 12 Cockpit floor                   | 57 Air conditioning duct                         |
| 13 Nose gear retraction sway-brace | 58 Armchair                                      |
| 14 Nose gear strut                 | 59 Heat exchanger                                |
| 15 Steering cylinders              | 60 Sofa  |
| 16 Nose gear twin-wheels           | 61 Fuselage centre section frames and stiffeners |
| 17 Torque links                    | 62 Fuel lines                                    |
| 18 Nose gear hatch                 | 63 Partition                                     |
| 19 Cockpit partition               | 64 Double armchair                               |
| 20 Pilot's seat                    | 65 Folding tray                                  |
| 21 Steering wheel                  | 66 Cabin floor                                   |
| 22 EFIS instruments                | 67 Rear wing stress absorption frame             |
| 23 Central console                 | 68 False spar absorption frame                   |
| 24 Throttle levers                 | 69 Fuel lines                                    |
| 25 Co-pilot's seat                 | 70 Fuelling port                                 |
| 26 Co-pilot's steering wheel       | 71 Fuel dump system                              |
| 27 Overhead panel                  | 72 Inner camber flap                             |
| 28 Starboard console               | 73 Inner spoiler                                 |
| 29 Cockpit entrance door           | 74 Camber flap guide-track fairing               |
| 30 Seat track                      | 75 Centre camber flap                            |
| 31 Fuselage frames and stiffeners  | 76 Guide-track fairing                           |
| 32 Cabin floor                     | 77 Outer camber flap                             |
| 33 Airstair handrail               | 78 Outer camber flap fairing                     |
| 34 Integrated airstair             | 79 Aileron                                       |
| 35 Cabin closure door              | 80 Starboard engine pod                          |
| 36 Airstair retraction mechanism   | 81 Engine pylon                                  |
| 37 Entrance door                   | 82 Engine attachment fitting                     |
| 38 Avionics compartment            | 83 Starboard fuel tank                           |
| 39 Air conditioning duct           | 84 Fuel line                                     |
| 40 Cabin floor structure           | 85 Sealed rear bulkhead                          |
| 41 Avionics                        | 86 Air-conditioning duct                         |
| 42 Heating duct                    | 87 Toilet compartment                            |
| 43 Cupboard                        | 88 Toilet door                                   |
| 44 Cupboard sliding door           | 89 Galley  |
| 45 VHF communications antenna      |  |



© AIR & COSMOS - 1996  
Dessin André Bréand

- 151 Inner camber flap in null position
- 152 Main landing gear twin-wheels
- 153 Main landing gear
- 154 Landing gear retraction actuator
- 155 Trunnion block
- 156 Landing gear shock strut
- 157 Inner spoiler
- 158 Camber flat guide-track and ballscrew actuator
- 159 Camber flap track fairing
- 160 Camber flap in extended position

- 117 Tail plane main pivot
- 118 Tail plane reinforced ribbing
- 119 Tail plane structure
- 120 Tail plane front spar
- 121 Rudder
- 122 Rudder power unit
- 123 Fin box centre spar
- 124 Fin box rear spar
- 125 APU nozzle exhaust

- 90 Baggage hold door
- 91 Engine mounting frame
- 92 Air-conditioning duct
- 93 Heat exchanger
- 94 Air-conditioning unit
- 95 Air-conditioning system air inlet
- 96 Air outlet
- 97 Avionics
- 98 Rear engine mounting frame
- 99 Fin front spar
- 100 HF communications antenna
- 101 Fin box ribbing and stiffeners
- 102 Yaw damper
- 103 Automatic pilot servo-control unit
- 104 Elevation quadrant
- 105 VOR/LOC antenna
- 106 Tail plane
- 107 Front pivot
- 108 Satellite communications antenna
- 109 Tail plane
- 110 Elevator
- 111 Antistatic trailed wires
- 112 Parking light
- 113 Fin upper fairing
- 114 Elevator structure
- 115 Elevator booster
- 116 Elevator rods

- 126 Parking light
- 127 APU nozzle
- 128 Auxiliary power unit (APU)
- 129 APU air inlet
- 130 APU duct
- 131 Oxygen
- 132 APU bay access hatch
- 133 Port engine pylon
- 134 Port engine nozzle
- 135 Thrust inverter lower clamshell
- 136 Thrust inverter upper clamshell
- 137 Engine nozzle cage
- 138 BMW Rolls-Royce BR710 turbojet engine
- 139 Engine feed lines and ducts
- 140 Equipment unit
- 141 Engine setting access hatch
- 142 Full authority digital engine control (FADEC)
- 143 Engine pod
- 144 Engine air inlet
- 145 Luggage hold
- 146 Equipment bay
- 147 Camber flap drive motor
- 148 Main landing gear hatch
- 149 Camber flap control drive shaft
- 150 Aileron control cables and pulleys

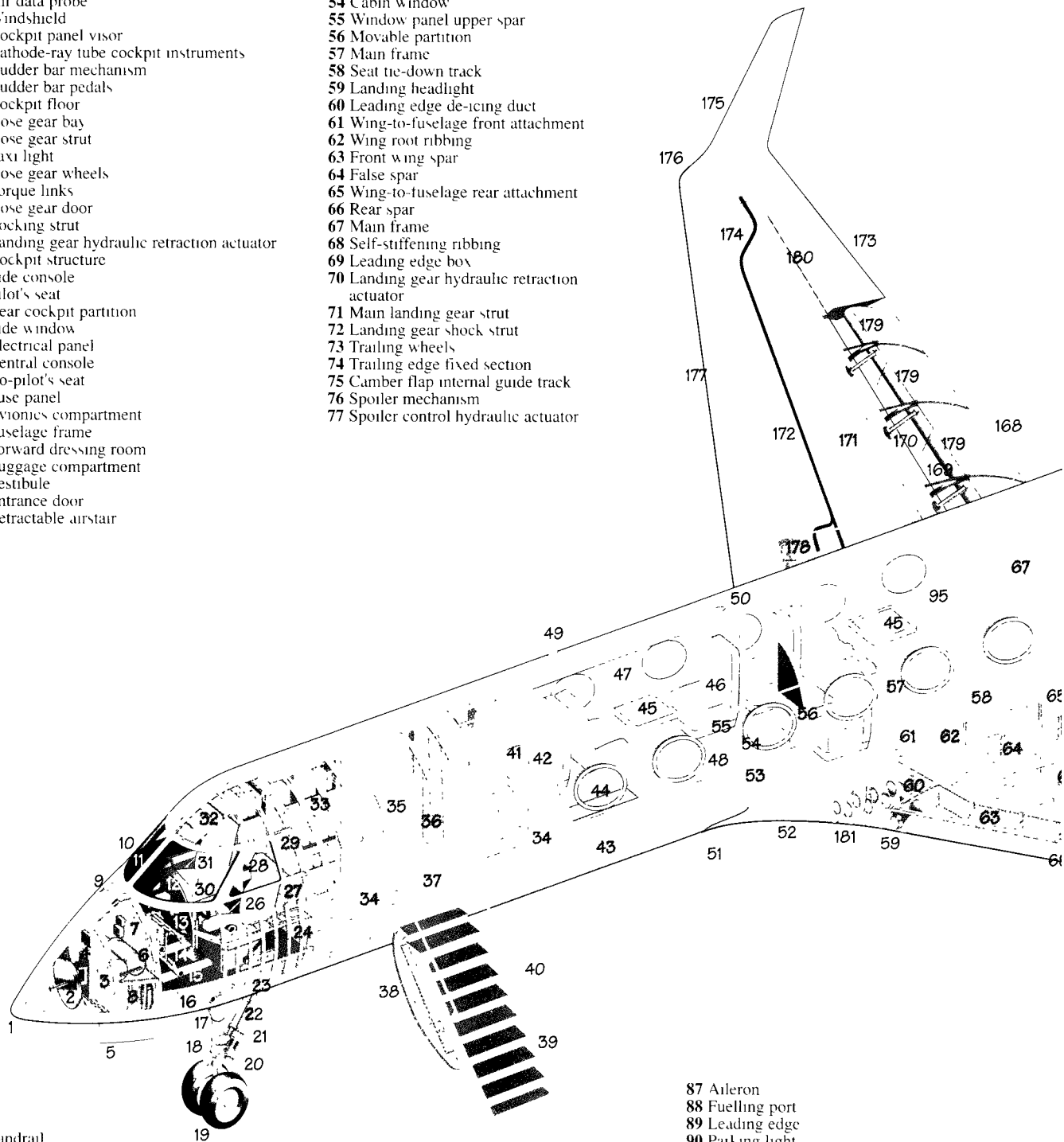
- 161 Aileron
- 162 Aileron structure in composites
- 163 Winglet
- 164 Antistatic trailed wire
- 165 Navigation and parking lights
- 166 Warpage servo-unit
- 167 Aileron control quadrant
- 168 Fuel line
- 169 Mobile leading edge
- 170 Wing structure box
- 171 Mobile slat guide-track
- 172 Slat control ballscrew actuator
- 173 Fuelling port
- 174 De-icing duct
- 175 Fuel feedline
- 176 Internal fuel lines
- 177 Fuel pump
- 178 Rear wing-to-fuselage junction
- 179 Wing-to-fuselage reinforced frame
- 180 Wing box reinforced ribbing
- 181 Boost pump
- 182 Front wing spar
- 183 Mobile slat control torque shaft
- 184 De-icing duct coupler
- 185 Front wing-to-fuselage junction
- 186 Structural fuel tank

# GULFSTREAM V

- 1 Radome
- 2 Weather radar antenna
- 3 Radar mechanism support frame
- 4 Radar mechanism
- 5 Nose gear hatch
- 6 Oxygen cylinders
- 7 Sealed forward bulkhead
- 8 Nose gear wheel housing
- 9 Air data probe
- 10 Windshield
- 11 Cockpit panel visor
- 12 Cathode-ray tube cockpit instruments
- 13 Rudder bar mechanism
- 14 Rudder bar pedals
- 15 Cockpit floor
- 16 Nose gear bay
- 17 Nose gear strut
- 18 Taxi light
- 19 Nose gear wheels
- 20 Torque links
- 21 Nose gear door
- 22 Locking strut
- 23 Landing gear hydraulic retraction actuator
- 24 Cockpit structure
- 25 Side console
- 26 Pilot's seat
- 27 Rear cockpit partition
- 28 Side window
- 29 Electrical panel
- 30 Central console
- 31 Co-pilot's seat
- 32 Fuse panel
- 33 Avionics compartment
- 34 Fuselage frame
- 35 Forward dressing room
- 36 Luggage compartment
- 37 Vestibule
- 38 Entrance door
- 39 Retractable airstair

- 46 Revolving seat
- 47 Sidewall lining
- 48 Three-seater studio couch
- 49 VHF antenna
- 50 Anti-collision light
- 51 VHF antenna
- 52 Wing-to-fuselage fairing
- 53 Window panel lower spar
- 54 Cabin window
- 55 Window panel upper spar
- 56 Movable partition
- 57 Main frame
- 58 Seat tie-down track
- 59 Landing headlight
- 60 Leading edge de-icing duct
- 61 Wing-to-fuselage front attachment
- 62 Wing root ribbing
- 63 Front wing spar
- 64 False spar
- 65 Wing-to-fuselage rear attachment
- 66 Rear spar
- 67 Main frame
- 68 Self-stiffening ribbing
- 69 Leading edge box
- 70 Landing gear hydraulic retraction actuator
- 71 Main landing gear strut
- 72 Landing gear shock strut
- 73 Trailing wheels
- 74 Trailing edge fixed section
- 75 Camber flap internal guide track
- 76 Spoiler mechanism
- 77 Spoiler control hydraulic actuator

- 83 Centre track
- 84 Outer spoiler
- 85 Wing stiffeners
- 86 Outer track



- 40 Handrail
- 41 Cabin entrance
- 42 Cabin partition
- 43 Air conditioning duct
- 44 Bar
- 45 Folding table

- 78 Fowler-type camber flap
- 79 Spoiler
- 80 Wing box ribbing
- 81 Fuel line
- 82 Camber flap strut

- 87 Aileron
- 88 Fuelling port
- 89 Leading edge
- 90 Parking light
- 91 Trailing edge fixed section
- 92 Winglet
- 93 Trailing edge fairing
- 94 Rear cabin partition
- 95 Fixed seat

- 96 Two-seater sofa
- 97 Folding table
- 98 Galley entrance
- 99 Reinforced rear bulkhead
- 100 Galley
- 101 Bar
- 102 Toilets
- 103 Dressing room
- 104 Access to rear luggage hold
- 105 Air-conditioning duct
- 106 Pressure-sealed rear bulkhead
- 107 Engine air inlet
- 108 Engine pod
- 109 Air-inlet front baffle
- 110 Engine fan
- 111 Engine mount front fitting
- 112 BMW/Rolls-Royce BR710-48 turbojet engine
- 113 Full authority digital engine control (FADEC)

- 126 Engine nozzle
- 127 Engine pylon
- 128 Water extractor
- 129 Tail fin rear attachment frame
- 130 Electronics

- 138 Fin centre spar
- 139 Elevation trimmer shaft
- 140 Fin front spar
- 141 Fin leading edge
- 142 Fin de-icing duct
- 143 Fin box
- 144 VHF omnirange antenna
- 145 Rudder centre bearing
- 146 Elevation countershaft

- 147 Rudder spar
- 148 Rudder structure
- 149 Stabilator ballscrew actuator
- 150 Elevation rod
- 151 Tail plane leading edge de-icing duct
- 152 Tail plane front spar
- 153 Tail plane ribbing and stiffeners
- 154 Rear spar
- 155 Tail plane swivel fitting
- 156 Elevation spar
- 157 Elevation rudder structure
- 158 Elevation rudder
- 159 Elevation trimmer
- 160 Antistatic trailed wires
- 161 Elevation equaliser
- 162 Fin fairing
- 163 Elevation rudder
- 164 Starboard tail plane
- 165 Engine nozzle
- 166 Starboard engine
- 167 Engine pylon
- 168 Camber flap in lowered position
- 169 Camber flap guide-track
- 170 Camber flap ballscrew actuator
- 171 Integrated fuel tank
- 172 Fuel lines
- 173 Starboard aileron
- 174 Fuelling port

- 114 Hot section
- 115 Thrust reverser lower section
- 116 Thrust reverser upper section
- 117 Engine mount rear fitting
- 118 Hydraulic tank
- 119 Auxiliary power unit (APU)
- 120 APU nozzle
- 121 Air-conditioning duct
- 122 Cabin conditioning air inlet
- 123 ADF antenna
- 124 Tail fin front attachment frame
- 125 Elevation and course control hydraulic actuator

- 131 Fuselage rear section stiffeners
- 132 Trail fin central attachment frame
- 133 Doppler navigation antenna
- 134 Rudder
- 135 Rudder lower bearing
- 136 Fin rear spar
- 137 Elevation lever

- 175 Winglet
- 176 Parking light
- 177 Leading edge de-icing duct
- 178 Tank closure ribbing
- 179 Spoilers
- 180 Aileron equaliser
- 181 Wing-to-fuselage fairing structure

© AIR & COSMOS — 1996  
Dessin André Bréand

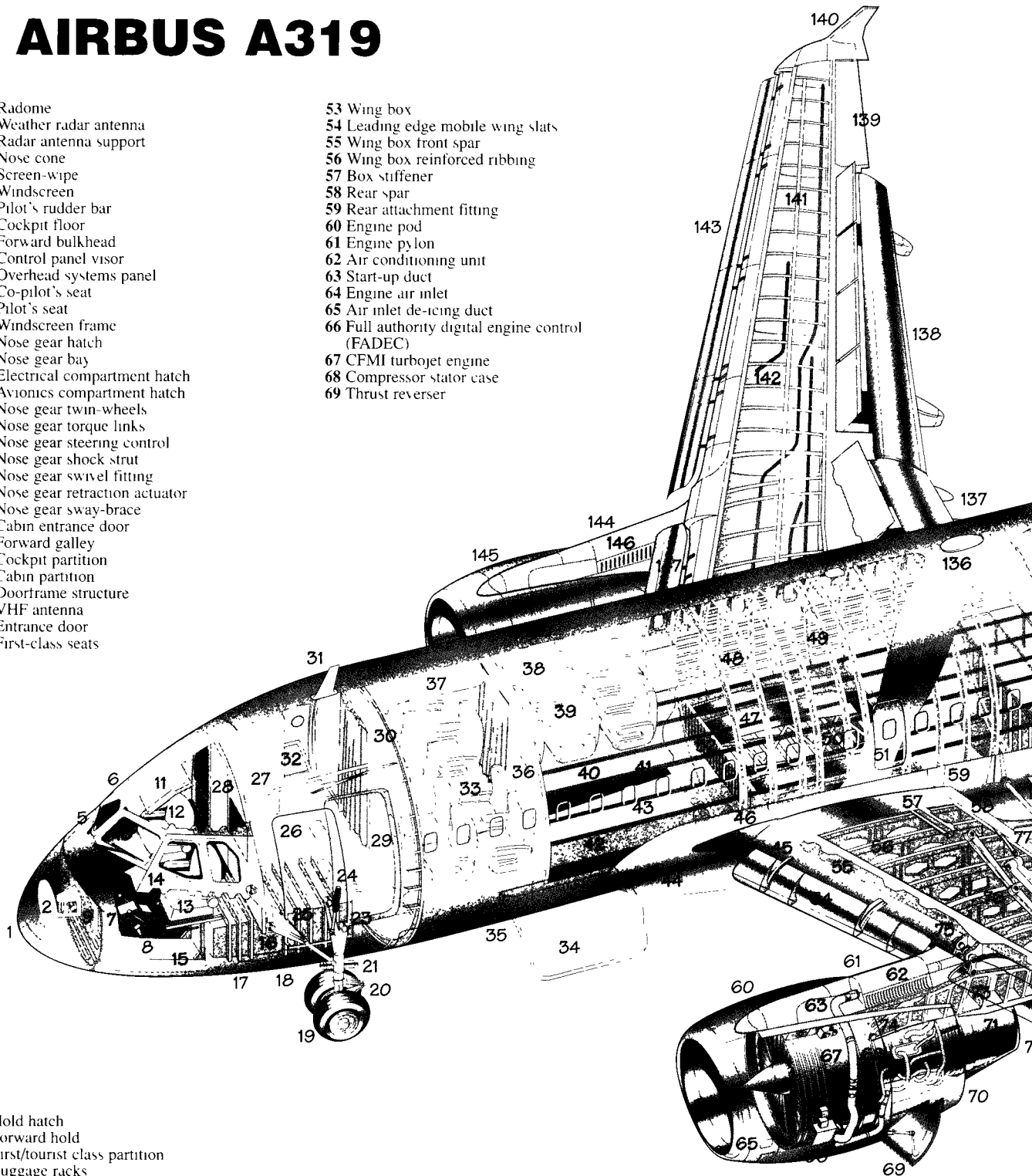
# AIRBUS A319

- 1 Radome
- 2 Weather radar antenna
- 3 Radar antenna support
- 4 Nose cone
- 5 Screen-wipe
- 6 Windscreen
- 7 Pilot's rudder bar
- 8 Cockpit floor
- 9 Forward bulkhead
- 10 Control panel visor
- 11 Overhead systems panel
- 12 Co-pilot's seat
- 13 Pilot's seat
- 14 Windscreen frame
- 15 Nose gear hatch
- 16 Nose gear bay
- 17 Electrical compartment hatch
- 18 Avionics compartment hatch
- 19 Nose gear twin-wheels
- 20 Nose gear torque links
- 21 Nose gear steering control
- 22 Nose gear shock strut
- 23 Nose gear swivel fitting
- 24 Nose gear retraction actuator
- 25 Nose gear sway-brace
- 26 Cabin entrance door
- 27 Forward galley
- 28 Cockpit partition
- 29 Cabin partition
- 30 Doorframe structure
- 31 VHF antenna
- 32 Entrance door
- 33 First-class seats

- 53 Wing box
- 54 Leading edge mobile wing slats
- 55 Wing box front spar
- 56 Wing box reinforced ribbing
- 57 Box stiffener
- 58 Rear spar
- 59 Rear attachment fitting
- 60 Engine pod
- 61 Engine pylon
- 62 Air conditioning unit
- 63 Start-up duct
- 64 Engine air inlet
- 65 Air inlet de-icing duct
- 66 Full authority digital engine control (FADEC)
- 67 CFMI turbojet engine
- 68 Compressor stator case
- 69 Thrust reverser

- 34 Hold hatch
- 35 Forward hold
- 36 First/tourist class partition
- 37 Luggage racks
- 38 Sidewall lining
- 39 Tourist class seats
- 40 Cabin floor
- 41 Seat tie-down track
- 42 Hold
- 43 Windows
- 44 Wing-to-fuselage fairing
- 45 Leading edge slat guide-tracks
- 46 Wing stress absorption frames
- 47 Central fuselage bulkhead box
- 48 Hoop frames
- 49 Fuselage stiffeners
- 50 Box reinforced ribbing
- 51 Emergency exit
- 52 Front box spar

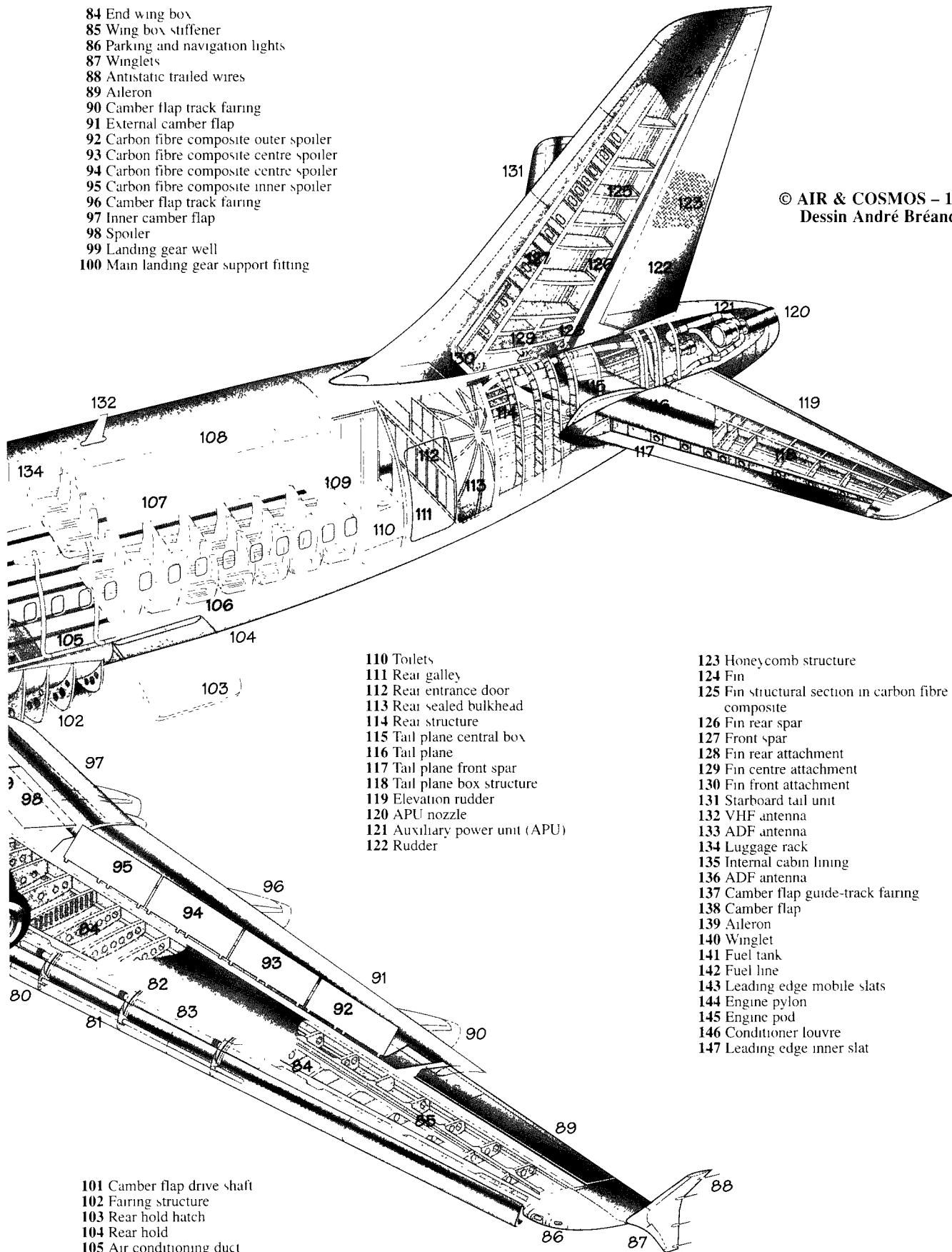
- 70 Fan outlet
- 71 Nozzle pipe
- 72 Nozzle
- 73 Pylon attachment
- 74 Engine front attachment
- 75 Engine rear attachments
- 76 Main landing gear sway-brace
- 77 Main landing gear retraction actuator
- 78 Main landing gear twin-wheels
- 79 Main landing gear shock strut
- 80 Leading edge outer slats
- 81 Slat de-icing duct
- 82 Mobile slat guide-tracks
- 83 Mobile slat drive shaft





- 84 End wing box
- 85 Wing box stiffener
- 86 Parking and navigation lights
- 87 Winglets
- 88 Antistatic trailed wires
- 89 Aileron
- 90 Camber flap track fairing
- 91 External camber flap
- 92 Carbon fibre composite outer spoiler
- 93 Carbon fibre composite centre spoiler
- 94 Carbon fibre composite centre spoiler
- 95 Carbon fibre composite inner spoiler
- 96 Camber flap track fairing
- 97 Inner camber flap
- 98 Spoiler
- 99 Landing gear well
- 100 Main landing gear support fitting


© AIR & COSMOS - 1996  
 Dessin André Bréand



- 110 Toilets
- 111 Rear galley
- 112 Rear entrance door
- 113 Rear sealed bulkhead
- 114 Rear structure
- 115 Tail plane central box
- 116 Tail plane
- 117 Tail plane front spar
- 118 Tail plane box structure
- 119 Elevation rudder
- 120 APU nozzle
- 121 Auxiliary power unit (APU)
- 122 Rudder

- 123 Honeycomb structure
- 124 Fin
- 125 Fin structural section in carbon fibre composite
- 126 Fin rear spar
- 127 Front spar
- 128 Fin rear attachment
- 129 Fin centre attachment
- 130 Fin front attachment
- 131 Starboard tail unit
- 132 VHF antenna
- 133 ADF antenna
- 134 Luggage rack
- 135 Internal cabin lining
- 136 ADF antenna
- 137 Camber flap guide-track fairing
- 138 Camber flap
- 139 Aileron
- 140 Winglet
- 141 Fuel tank
- 142 Fuel line
- 143 Leading edge mobile slats
- 144 Engine pylon
- 145 Engine pod
- 146 Conditioner louvre
- 147 Leading edge inner slat

- 101 Camber flap drive shaft
- 102 Faring structure
- 103 Rear hold hatch
- 104 Rear hold
- 105 Air conditioning duct
- 106 Passenger cabin
- 107 Luggage rack
- 108 Cabin ceiling
- 109 Passenger cabin rear partition

IMPRIMERIE  ALENÇONNAISE  
Rue Édouard-Belin · 4<sup>e</sup> trimestre 1996  
N° d'ordre : 37194

PRINTED IN FRANCE