



BAE SYSTEMS is a trading name of
BAE SYSTEMS (Operations) Limited
JAR 21 Approval CAA.JA.02034

NUMBER: ADE-46D-R-463-000792

ISSUE: 1

PAGE: 1 OF 1

ISSUE DATE: 3-11-2003

SITE: Woodford

COMPANY CLASSIFICATION:

BAE SYSTEMS 146 Aircraft
Atmospheric Research Aircraft

Location of Inlets and Sensors In Relation to the Boundary Layer

Summary

This document provides details of the location of certain scientific inlets and sensors on the BAe 146-301 Atmospheric Research Aircraft in relation to the aircraft boundary layer. The items discussed are shown to be outside the 99% boundary layer thickness except where other installation requirements have dictated mounting closer to the skin.

Circulation

B Taylor
M King
A Smart
A Lang
N Robertson
A Beard

B Wells (UMIST)

PREPARED BY (Author)	Delete as Applicable VERIFIED / APPROVED BY (Cert'n Report) / (Non-Cert'n Report)	AUTHORISED BY (external distribution only)
A James Principal Design Engineer	N Robertson Chief Aerodynamicist	B Taylor Chief Designer



BAE SYSTEMS is a trading name of
BAE SYSTEMS (Operations) Limited
JAR 21 Approval CAA.JA.02034

NUMBER: ADE-46D-R-463-000792

ISSUE: 1

PAGE: 2 OF 2

ISSUE DATE: 3-11-2003

SITE: Woodford

COMPANY CLASSIFICATION:

List Of Effective Pages

<u>Page</u>	<u>Issue</u>	<u>Date</u>
1	1	3-11-2003
2	1	3-11-2003
3	1	3-11-2003
4	1	3-11-2003
5	1	3-11-2003
6	1	3-11-2003
7	1	3-11-2003
8	1	3-11-2003
9	1	3-11-2003
10	1	3-11-2003
11	1	3-11-2003
12	1	3-11-2003

Issue Record

<u>Issue</u>	<u>Reason</u>	<u>Date</u>
1	Initial issue	3-11-2003



BAE SYSTEMS is a trading name of
BAE SYSTEMS (Operations) Limited
JAR 21 Approval CAA.JA.02034

NUMBER: ADE-46D-R-463-000792

ISSUE: 1

PAGE: 3 OF 3

ISSUE DATE: 3-11-2003

SITE: Woodford

COMPANY CLASSIFICATION:

Contents

<u>Section</u>		<u>Page</u>
1.0	Introduction	4
2.0	Determination of Boundary Layer Thickness	4
3.0	Location of Sensors	4
4.0	Discussions	5
5.0	Conclusions	6
6.0	References	6
Figures		7
Figure (1)	Location of Probes in Relation to Boundary Layer	7
Figure (2)	Location of Probes on the Aircraft	8



BAE SYSTEMS is a trading name of
BAE SYSTEMS (Operations) Limited
JAR 21 Approval CAA.JA.02034

NUMBER: ADE-46D-R-463-000792

ISSUE: 1

PAGE: 4 OF 4

ISSUE DATE: 3-11-2003

SITE: Woodford

COMPANY CLASSIFICATION:

1.0 Introduction

This document provides detailed information on the location of scientific inlets and sensors on the BAe 146-301 Atmospheric Research Aircraft in relation to the aircraft boundary layer.

The following scientific inlets and sensors are identified in the Contract as needing to be outside the aircraft boundary layer.

- Air Sample Pipe Intakes (Ref. Schedule A, Appendix B, B8)
- Rosemount Temperature Sensors (Ref. Schedule A, Appendix C, Ca)
- Johnson Williams Liquid Water Detector (Ref. Schedule A, Appendix C, Cf)
- Nevzorov Ice / Water Probe (Ref. Schedule A, Appendix C, Cg)
- Filter Intakes (Ref. Schedule A, Appendix C, Co)
- Total Water Contents Probe (Ref. Schedule A, Appendix C, Cr)
- SPEC CPI (Ref. Schedule A, Appendix C, Cy)

In addition, Instrument Requirement Documents (IRD) for the following inlets and sensors request location outside the aircraft boundary layer.

- General Eastern Humidity Sensor (Long and Short) (IRD Cb-GeneralEastern-1-v1)
- Fred Eisele Inlet (HOx) (IRD Cee-EiseleInlet-1-v1)
- Rosemount Pairs (Upper and Lower) (IRD Inlet-RosemountPairs-1v2)
- FWVS (Fluorescence Water Vapour Sensor) Inlet (IRD Inlet-FWVS-1-v1)

2.0 Determination of Boundary Layer Thickness

A graph of boundary layer thickness against distance from the aircraft nose was produced early in the project and used as a guide to the location of the scientific inlets and sensors [1]. The graph shows the 99%, 95% and displacement thickness of the boundary layer against distance from the nose. This graph was produced using ESDU methods (Ref. ESDU Item 79020) and was used as a design guide when positioning probes on the aircraft.

3.0 Location of Sensors

The location of the inlets and sensors listed in section 1.0 that are mounted on the fuselage was measured on a 3-dimensional Computer Aided Design (CAD) CATIA model. The dimensions recorded were as follows:

Inlet / Sensor	Distance aft of the Nose (in)	Distance from the Skin (in)
Air Sample Pipe Intakes	222.74	4
Rosemount a	86.87	3.2
Rosemount b	98.05	3



BAE SYSTEMS is a trading name of
BAE SYSTEMS (Operations) Limited
JAR 21 Approval CAA.JA.02034

NUMBER: ADE-46D-R-463-000792

ISSUE: 1

PAGE: 5 OF 5

ISSUE DATE: 3-11-2003

SITE: Woodford

COMPANY CLASSIFICATION:

Inlet / Sensor	Distance aft of the Nose (in)	Distance from the Skin (in)
Johnson Williams	98.92	5.8
Nevzorov	99.69	4.5
Filters	267.10	8.35
TWC	87.35	9.92
General Eastern - Short	241.65	0.31
General Eastern - Long	241.65	1.61
Fred Eisele	313.84	12.66
Rosemount Pair - Upper**	329.27	4
Rosemount Pair - Lower**	332.43	4
FWVS	385.63	4.2

** Note: The Rosemount Pairs on port hard point 4 were used for this measurement

These positions are plotted in Figure (1) against the boundary layer curves referred to in section 2.0 above. Figure (2) shows the position of the inlets on the aircraft.

No data is given for the SPEC CPI because its position outside the boundary layer is evident by inspection of its position at the base of the wing canister pylons.

4.0 Discussion

It can be seen from figure (1) that all the inlets / sensors with a requirement to be outside the boundary layer are located outside the 99% line presented. As stated in section 2.0, the curves presented were derived with ESDU methods. This is considered to be sufficiently accurate given the extent that the probes are located outside the 99% line.

Of the four inlets that requested location outside the boundary layer in their IRD, reasonable attempts have been made to minimise the boundary layer effect as follows:

- The Eisele inlet is seen to be outside the 99% line.
- The Rosemount pair at hard point P4 is approximately on the 99% line. The installation of these inlets has used machined plates to locate the inlets provided further away from the skin and therefore reduces the influence of boundary layer.
- The FWVS inlet is between the 95% and 99% lines. The inlet is designed to be mounted flush with the skin. Its protrusion into the boundary layer is then dictated by the overall size of the inlet and its agreed location on the most aft hard point P7.
- The General Eastern Humidity Sensor is approximately at the displacement thickness. The installation of the General Eastern was made flush with the skin to ensure close coupling with the aircraft skin panel as requested in the IRD and to reduce its effect on downstream instruments.



BAE SYSTEMS is a trading name of
BAE SYSTEMS (Operations) Limited
JAR 21 Approval CAA.JA.02034

NUMBER: ADE-46D-R-463-000792

ISSUE: 1

PAGE: 6 OF 6

ISSUE DATE: 3-11-2003

SITE: Woodford

COMPANY CLASSIFICATION:

This requirement and the agreed location of the inlet have dictated its protrusion into the boundary layer.

It is also worth noting that the Customer group has been involved with and agreed the positioning of the inlets and sensors on the aircraft.

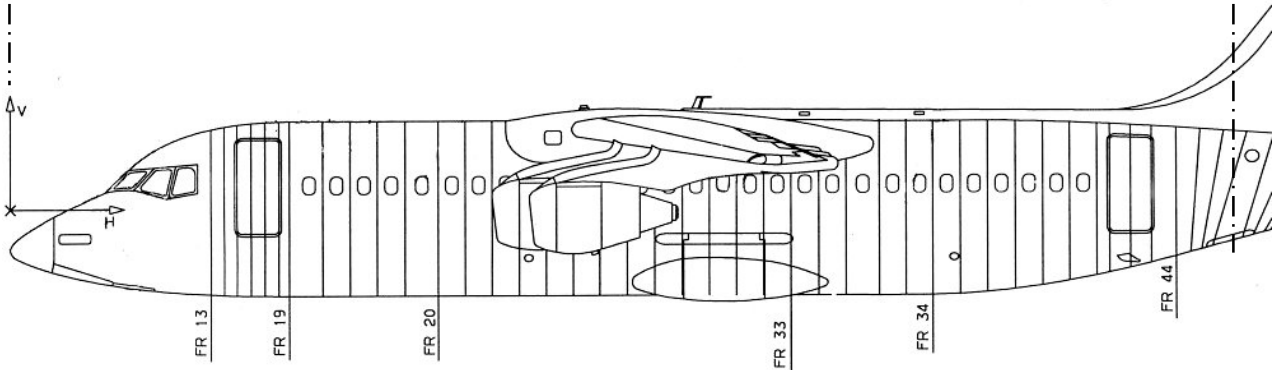
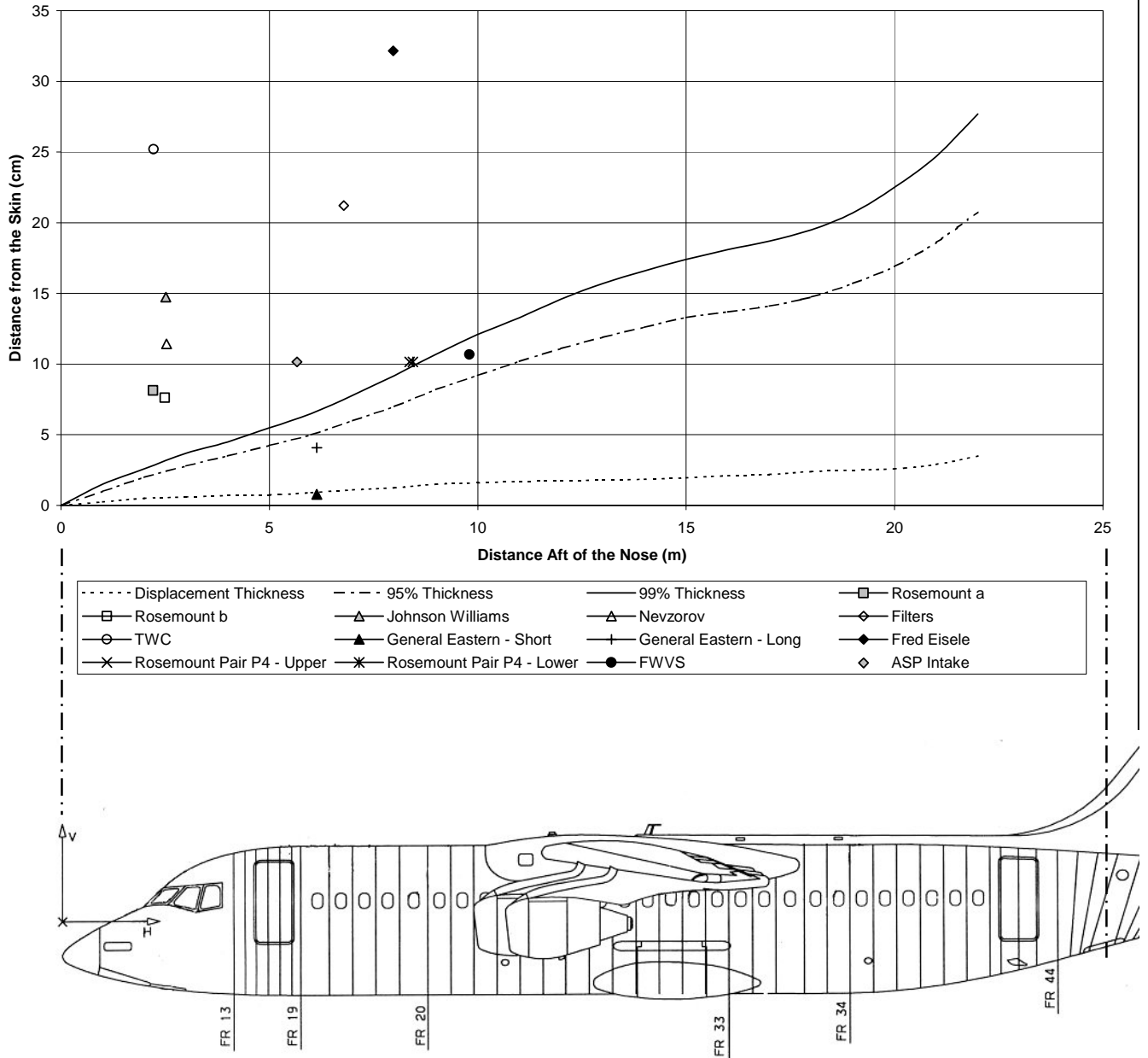
5.0 Conclusions

It is concluded that where other installation requirements allow, the inlets and sensors listed in this report are positioned well outside the 99% boundary layer curve. The contractual requirements in relation to inlets and sensors outside boundary layer are therefore met.

6.0 References

[1] Memorandum ADE-46A-M-463-FM1524

Figure (1): Location of Probes in Relation to the Aircraft Boundary Layer



Note: Aircraft Representation Approximately to Scale only for aid to interpretation

αβγδ

BAE SYSTEMS is a trading name of
BAE SYSTEMS (Operations) Limited
JAR 21 Approval CAA.JA.02034

NUMBER: ADE-46D-R-463-000792

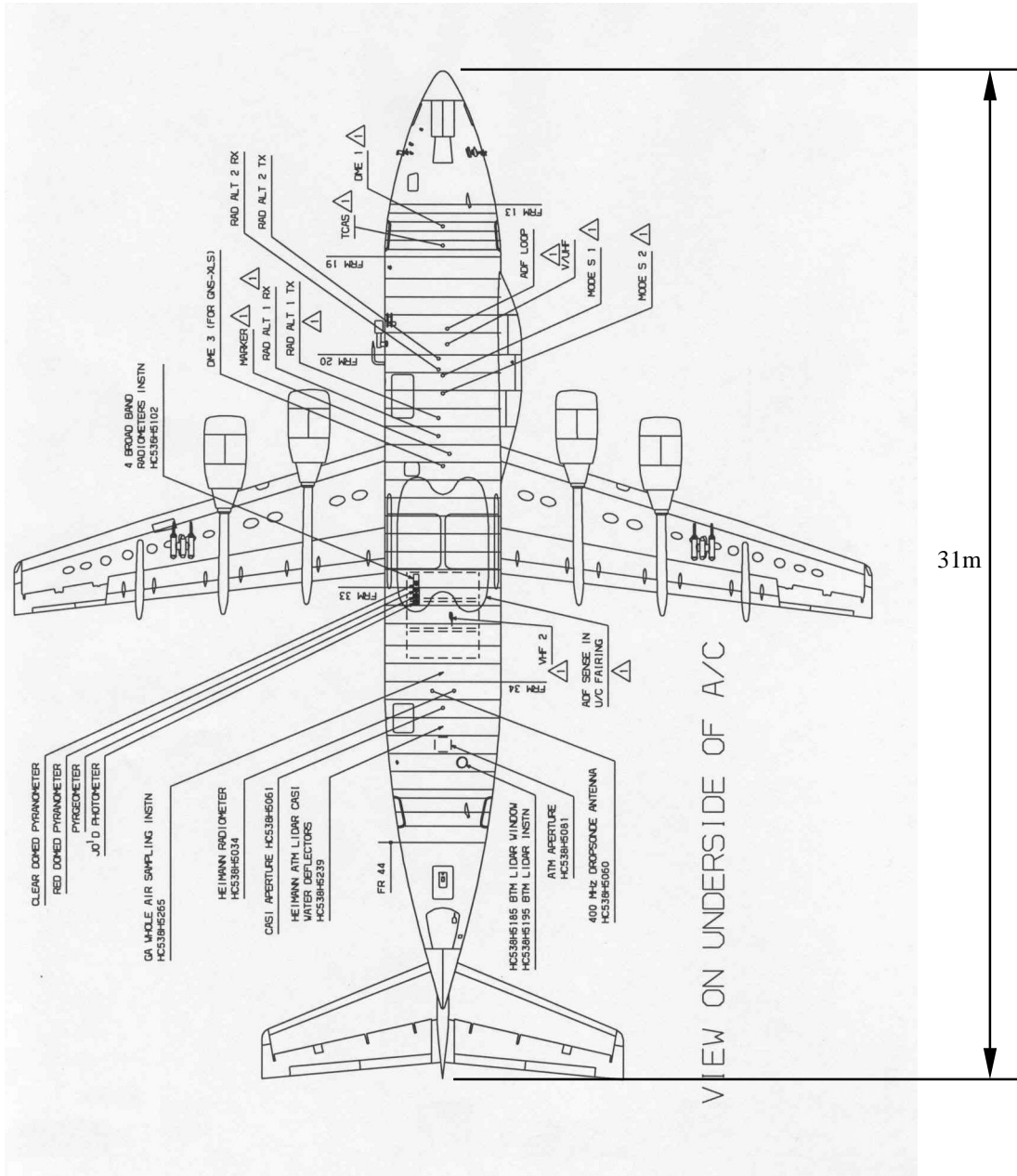
ISSUE: 1

PAGE: 9 OF 9

ISSUE DATE: 3-11-2003

SITE: Woodford

COMPANY CLASSIFICATION:



αβγδ

BAE SYSTEMS is a trading name of
BAE SYSTEMS (Operations) Limited
JAR 21 Approval CAA.JA.02034

NUMBER: ADE-46D-R-463-000792

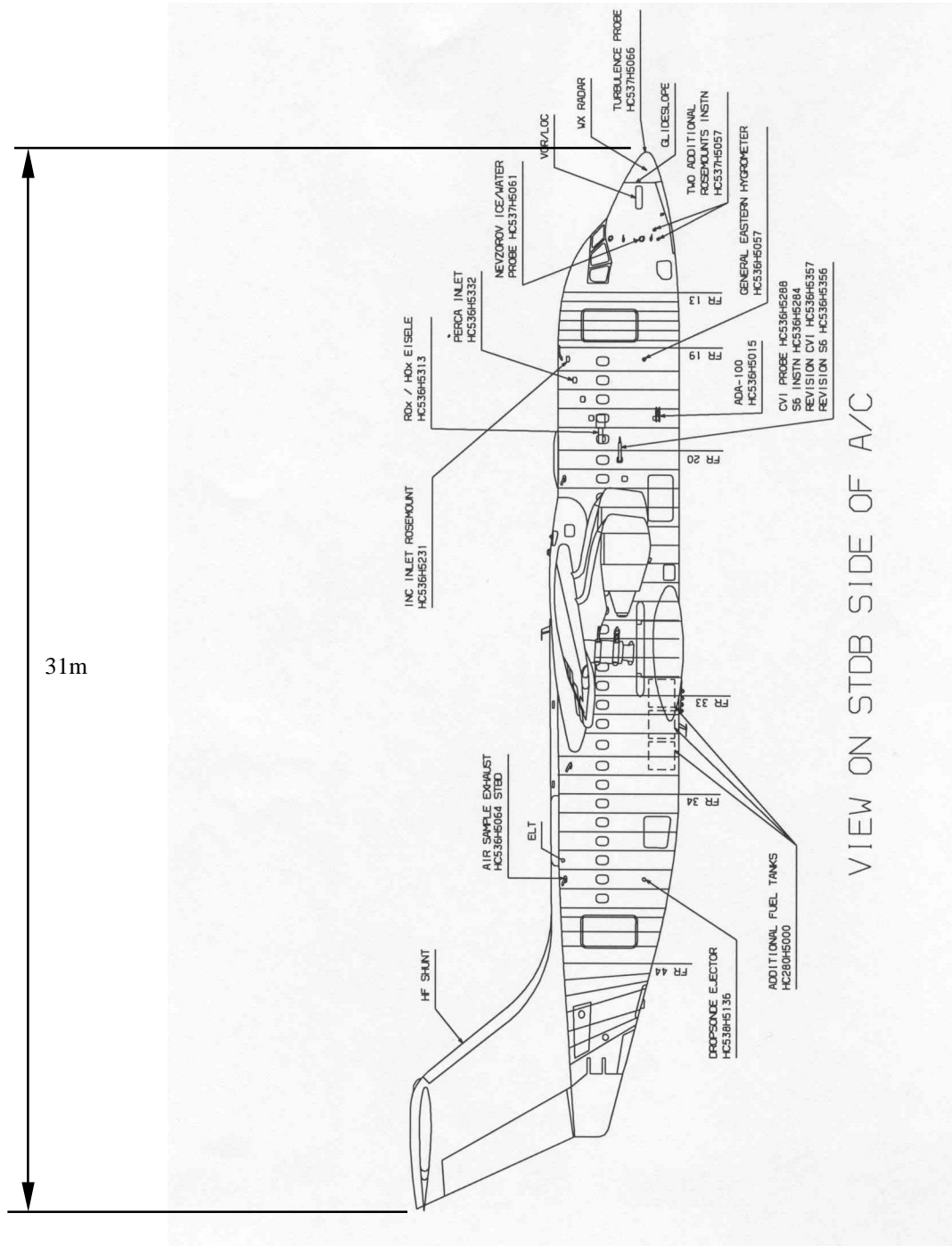
ISSUE: 1

PAGE: 11 OF 11

ISSUE DATE: 3-11-2003

SITE: Woodford

COMPANY CLASSIFICATION:



αβγδ

BAE SYSTEMS is a trading name of
BAE SYSTEMS (Operations) Limited
JAR 21 Approval CAA.JA.02034

NUMBER: ADE-46D-R-463-000792

ISSUE: 1

PAGE: 12 OF 12

ISSUE DATE: 3-11-2003

SITE: Woodford

COMPANY CLASSIFICATION:

