NRA- Internal 40

Air Atlantique

ATLANTIC RECONNAISSANCE LTD.

ANALYSIS OF

AIRBORNE PLATFORM SPECIFICATIONS

AND OPERATIONS

FOR THE

NATIONAL RIVERS AUTHORITY

BY

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1. Introduction

The purpose of this report is to advise and assist the NRA in its choice of airborne survey platform, and the optimum method of operating that platform from both a financial, and operational standpoint.

The only task to be considered in this report was the coastal UK survey, however, we have attached an addenda following a perusal of the NRA flight operations to date.

As one of the options open to the NRA is the purchase of an aircraft, the major emphasis will be on aircraft that would be suitable for the NRA to own. It is more than likely that if the NRA opt for some form of leasing, other aircraft may be offered by specialist operators which can fulfil the task.

This report is not intended to exclude such aircraft from this option. We have listed a number of airframes which fall into this category.

Most of the aircraft in the range are designed for the same market sector, so the performances are very similar.

Their attributes as a survey platform are, to a certain extent, subjective;

The subjective factors are based on long experience around the world, both flying and operating equipment in the rear of these airframes.

The four people who compiled this report have a combined experience of over 40,000 hours of survey flying, mostly in this type of aircraft. All of the people involved have flown and operated in each of these aircraft on photographic, remote sensing and geophysical survey and all agree on the subjective part of the analysis.

We currently operate all the aircraft considered, with the exception of the Queen Air, Dornier Skyservant and Turbo Commander.

We have operated a Turbo Commander in the past in the USA.

All are operated on aerial work or surveillance of one type or other.

2. Task Requirements

The current requirement is for a survey aircraft capable of uplifting 365 kilos of survey equipment comprising of:-

Survey Camera.

Casi Scanner.

HGH I/R Scanner.

2 X GPS.

The remote sensing constraints on the operation, limit flying to 2 hours either side of solar noon: Therefore its endurance should be 4.75 to 5 hours.

The operational altitude is too be 10,000ft.

3. Aircraft Configuration

High/low wing stability.

There are two schools of thought regarding the attributes of a high wing aircraft.

One states that high wing aircraft are a more stable platform than low wing and offer better visibility to the crew.

The other states that low wing can be equally as stable as a high wing and the visibility is not a disadvantage as operational techniques are changed to match the air frame, the visibility for pilots is the same, as they are ahead of the wing and the operator can use the rear fuselage behind the wing for viewing.

In the relatively small class of aircraft which are of interest for this task, the nearest to an ideal survey platform for stability in both clean air and turbulence is the Cessna 404 Titan which is a low wing aircraft. This is one of the reasons it has become the industry "standard" aircraft.

The majority of small aircraft are now low wing , the two major exceptions are the BN Islander and Rockwell Turbo Commander.

The prevalence of low wing aircraft in survey is that generally speaking they have better overall performance and are cheaper to purchase.

For the task in hand we would see no advantage in having a high wing.

Endurance

As the four hour window needs to be utilised to the full, the aircraft requires 4.75 to 5 hours endurance.

The cost of any shorter duration is very high. If we take a descent or climb rate of 750ft/min, which would be a good maximum average for the aircraft concerned, and a perfectly positioned airfield the time taken from end of line to start of a new one has to be a minimum of 1 hour, of which 26 - 30 minutes is flight time.

The resultant is loss of 25% of the available survey time and an increase in costed flying time of 10% - 15%.

Given the ball park figure of 120 hours to complete each circuit, the increase of 10% is 12 extra hours flying at approximately £400/hour and the probability that on average one would fly only every other day because of weather, the figure of 70 days for a normal survey would go up to 84 days

and it should be noted that the cost of a 3 man crew in the field is more than that of the aircraft.

Survey Ports

The aircraft will require one full size camera port for the Wild/Zeis Camera.

It would appear from the HGH drawings that this would not be easy to mount in a standard port due to its rectangular shape.

Therefore we would recommend mounting of this unit inside the skin on a specially prepared mounting with a small rectangular hole cut and faired for it to look through.

The CASI can be mounted above a 4" to 6" hole in the skin of the aircraft. The precise hole size would depend an height of the sensor above the skin.

These two smaller holes and one for a drift sight would be minor mods to an airframe, the full camera hole a major mod.

Layout of the holes would depend on the actual airframe used and should be left to the contractor:

Provision must be made for weight and balance as well as an ergonomic layout for the operating console.

Electrical Requirements

It has been found that these cameras can generate some noise on the power lines, it is therefore suggested that 2 separate power lines be connected to as close to the battery as possible after the aircraft master breaker and the ground be connected to the main aircraft grounding point.

One power line for the camera to be breakered at 25A.

The second at 60A and split into two 30A separate breakered lines to the rear cabin.

The two GPS would be connected into the avionics bus.

It is preferable that there be enough power from each alternator such that an automatic load shed is not required, ie, approximately 100 amps each.

Automatic load shedding devices have caused endless trouble to electronic equipment by switching on and off whilst on the ground, ie, during run ups etc.

Cargo Doors

These are essential for ease of loading and unloading equipment, it is also an advantage to have a pilot door to stop them climbing over equipment in the cabin.

Altitude

The operational altitude presents no problems to any aircraft in this range and is below the height at which oxygen is necessary therefore it is not required.

Auto Pilot

It would be extremely unusual to fly a remote sensing survey on an Auto Pilot, as the way in which they control the aircraft is not necessarily conducive to scanner operations. It has been found by experience that a pilot can control the aircraft in a manner which produces better overall results.

De Icing Equipment

The aircraft should carry full de-icing equipment as a precautionary resource but will not fly into known icing conditions as camera doors and holes could be a problem in these conditions.

IFR Equipment

For the survey task, which by its nature has to be in good VFR conditions, a full IFR equipment suite is unnecessary. However, for operational efficiency, ie, transit flights, positioning etc, particularly during the winter months the aircraft should be equipped for IFR flight.

4. Aircraft Selection

It is of primary importance that the aircraft is on the British Register, with a current Certificate of Airworthiness.

This ensures that the aircraft will comply with all CAA standards regarding performance (particularly on one engine) handling and safety.

These standards are the highest in the world.

There is a distinct advantage in using an unpressurised aircraft for this work as modification costs are considerably cheaper than for a pressurised aircraft.

The aircraft in the following section can be divided into two groups;

1. Aircraft that the NRA could consider purchasing for the current task.

2. Aircraft that would perform the task adequately, but the NRA should not consider purchasing, but should the lease option be adopted they should not be excluded.

Group One

Cessna 404.

This aircraft is larger than the current task really justifies. It has been included as it has become the survey industry "standard aircraft" for general purpose work.

There is a lore which applies to survey aircraft, that as soon as it is equipped, more equipment will be required on board. All the other aircraft listed are on their maximum for both weight and cabin space. This is the only one allowing an upgrade capability.

It has a number of distinct advantages over all other aircraft of this type.

A. It is a near perfect survey platform being extremely stable.

B. It has a large cabin.

C. It can carry two full survey holes plus a scanner installation.

D. It has a very high uplift capability.

E. It has up to 11 hours endurance on survey.

F. It has no wing spar life.

G. Geared engines make the aircraft quieter and have less vibration effect on the sensors.

The disadvantages are higher purchase price and operating costs.

402C

Has the same wing design as the C404 and is generally a smaller 404 so is also very stable. More useable space in the cabin than the PA31. Wider cabin than PA31.

402B

Less stable wing and lower uplift than the 402C. Generally not as nice an airplane for survey work, but significantly less expensive.

PA31- 350.

Not a particularly stable platform. Linked rudder and aeleron lead to a fairly unpleasant motion in the back in any sort of turbulence. Currently used for survey, but considered a poor working environment.

BN2A - 260 and BN2B - 260

High wing, stability is about average. Cabin is very narrow and small, particularly with holes in the bottom. It is by far the noisiest both inside and outside of the range of aircraft considered, access round 19" racks is very difficult.

Smaller engined versions of the Islander will not meet the spec.

There is a 300HP version available the -20, but it has slightly less payload than the 260 due to heavier engines.

All of these aircraft would be suitable for the current task. The 402B, 402C and PA31 - 350 all have wing spar lives imposed by the CAA of around 8000 hours, at which point the only viable option is to sell them overseas as no other airworthiness authority has such short lives on the spars.

The BN2A Islander wings are on regular inspection for corrosion which can lead to lengthy and expensive repair.

Group Two

There are other aircraft which may be tendered for such a contract or lease, but we not recommend the NRA purchasing one due to age; high running costs and a very high maintenance costs or higher purchase prices.

In this class one would put:-

Queen Air.

Twin Pioneer.

Dornier Skyservant.

Turbo Commander 690.

Cessna 406 Caravan 2.

Both the latter two are turbine aircraft.

5. Camera Ports

The current requirement is for 1 full size camera port, drift sight port, I/R scanner port and Casi port.

The three smaller ports are likely to cost of the order of £2,500 to £3,000 each.

Port sizes are:

I/R Scanner	approximately	8" square.
Casi Scanner	approximately	6" round.
Drift Sight	approximately	5" X 8".

The camera hole is a major modification which in most aircraft requires re-routing the control runs which is a very costly exercise.

90% of the camera holes installed in aircraft in Europe have been carried out by Mann Aviation at Fairoaks.

Their budgetary prices for a single hole installation in a PA31 - 350 is:-

£40,000.

For 2 holes £52,000.

Britten Norman prices for the Islander

£30,000 for the kit

+ 1000 man hours, ie approximately £20,000.

Atlantic Aeroengineering

For a single hole in a 402

£22,000.

All of these mods will need CAA approval.

6. Equipment Installation

The object of the installation exercise is to completely remove all aircraft generated noise from the sensors, therefore providing optimum signal conditions from the sensors. This becomes even more important when working over water, where the gain of sensors is set to very high levels.

The camera presents no problem as it is a standard fit.

Electro optic systems are notoriously sensitive to airframe and installation.

Sources of problems are:-

1. Electrical Noise.

2. Airframe Mechanical Noise.

3. Engine/Propeller Noise.

4. Airflow Noise.

1. Most of the electrical noise can be isolated by use of the correct power supply as outlined in the aircraft configuration, any further noise found during testing will have to be addressed as appropriate (eg, on one BN2 to reduce electrical

noise on cabin fitted equipment it was necessary to re-wire and re-locate the main power lines from one alternator).

2 & 3. The whole installation of sensors has to be matched to the individual airframe. The design and construction methods of such an installation should take into account both empirical data and experience to reduce these effects to a minimum.

Selection of AV mounts can be carried out empirically but mounting methods and types of material are generally based on past knowledge of the type of airframe and problems previously encountered.

4. Correct design of baffles, deflectors and damping materials can reduce noise considerably.

7. Type of Air Operator

For the NRA to obtain the maximum benefits from its air operator, they should have the following attributes.

Unless the NRA have staff initially who have comprehensive air survey experience, ie, air electronic engineers/operators with considerable operational experience of many types of sensors, navigators/camera operators with the same experience.

In which case they can touch the operational aspects to newcomers and the NRA could then consider using air taxi and charter companies for its operation.

Survey Experience

Survey flying is a specialist form of flying, each individual sensor requires different techniques in installation and flight characteristics. The majority of survey companies will have experience of remote sensing, photographic and geophysical flying over all types of terrain at all levels from below 100ft to above 20,000ft.

They will have knowledge of specialist equipment to enable any task to be carried out with the maximum efficiency and safety.

Pilots

Must have as a minimum qualification, a commercial licence and suitable experience, which is to include survey flying.

On any type of survey operation, an experienced survey pilot is preferable as significant increases in efficiency and data quality will be achieved.

Maintenance

The operator should be able to carry out in house maintenance to all levels on the aircraft and have sufficient infra structure to rapidly repair any defects, including engine changes:

The company should therefore have licenced engineers, and an adequate spares holding.

Modification Capability

The ability to design and clear minor mods with the CAA and then carry out the mod, is an advantage, as survey aircraft seem to continuously require such mods.

To have to go outside to a design company always takes time and costs money.

The ability to carry out major mods is a plus.

Dispensations

Experience in obtaining special dispensations of unusual aircraft activities is very useful.

A rapport with the CAA is built up over the years and though difficult to obtain are more readily granted to operators who have proved their abilities at special operations.

Consultancy

If the operator has a wealth of experience in survey and special operations, the NRA has a free consultant for its future expansions as well as current operations other than the primary task.

Back-up Aircraft

There is always the chance that a serious problem can hold the aircraft on the ground. Therefore it is a distinct advantage if the operator has other survey aircraft in its fleet that could provide a back up aircraft. Obviously writing this into a contract is not practical as the cost would increase dramatically.

Avionics

If possible the operator should have an avionics repair facility.

8.AIRCRAFT OPERATING CRITERIA

Aircraft Certificate of Airworthiness and maintenance requirements.

An aircraft may hold a Certificate of Airworthiness, in one of the following categories which are in descending precedence e.g. an aircraft with a PT C of A may be used for any purpose but a Special Category Certificated aircraft may only be used under the specific conditions endorsed on the Certificate of Airworthiness.

a) Public Transport (Passenger)

b) Public Transport (Cargo)

c) Aerial Work

d) Private

e) Special Category

f) Permit to fly (Normally homebuilt aircraft only)

An aircraft operated commercially (i.e. for hire and reward) must be certificated in either the Public Transport or Aerial

Work Categories. Should operations be restricted to solely 'in house' flying (i.e. no invoices in respect of flying are raised to third parties) Private or Special Category Certification is acceptable; however Special Category is not suitable for overseas flying and is not therefore considered a viable option.

Public Transport and Aerial Work aircraft require a maintenance schedule formally approved by the CAA which in the proposed class of aircraft could be expected to require minor maintenance checks at 100 hr/three monthly intervals with more extensive work annually. A 10% variation is available on these maintenance requirements to accommodate unforeseen operational needs.

Private Category aircraft may be maintained according to the manufacturer's recommendations which typically require maintenance at 100 hr intervals with no calendar requirements other than annual checks.

The CAA approved schedules normally include some additional UK requirements which make them more expensive to implement however the resale value of the aircraft is usually enhanced and some satisfaction may be gained from the knowledge that the aircraft is maintained to the highest standard.

(This is not to suggest that non-approved maintenance is necessarily unsatisfactory if a Private Category Certificate of Airworthiness is considered sufficient).

Aircraft Modifications

Aircraft operated for aerial survey always require extensive structural modifications to enable the role equipment to be fitted. Provided that such modifications do not affect the external profile of the a/c (and therefore the performance) it may be possible to accomplish these whilst retaining a Public Transport C of A. However, temporary installations of equipment invariably involve downgrading of the C of A to Aerial Work status. As there is no requirement for Public Transport Certification in the Aerial Work category is recommended on grounds of flexibility.

Aircraft Operating Regimes

Parallel to the aircraft certification status there are a number of different operating regimes.

a) Public Transport

This requires the operator (be it the NRA or a subcontractor) to hold an Air Operators Certificate issued by the CAA. This is an expensive and restrictive operating regime and as the NRA

has no requirement to carry fare paying passengers or freight is not recommended.

b) Aerial Work

Maintenance and crew qualification standards are essentially similar to Public Transport but operating parameters such as crew duty times and rest days are far less restrictive. Also in contrast to an AOC there is minimal legal requirement for record keeping. It is possible to lease out the aircraft to third parties for survey activities and Aerial Work is the operating category recommended therefore.

c) Private Category

It is technically legal for the aircraft to be operated by NRA as a company private aircraft and may even be flown under a Private Pilot's Licence provided the pilot is an employee of NRA. Nevertheless the success of survey flying is primarily dependent on the skill and experience of the pilots and we would strongly advise against such a policy. If the aircraft is certificated privately and flown by a Commercial Pilot it will nevertheless not be possible to lease it out to third parties. There are also potential problems in ensuring adequate operating standards in this scenario.

9. Aircraft and Operating Costs

Typical buying prices for these aircraft are as follows. The prices include importation costs, if these have been necessary, and UK modification and certification.

The types of aircraft considered are:

Cessna 404.

Cessna 402C.

Cessna 402B.

Piper Navajo Chieftain.

Britten Norman Islander.

Cessna F406.

Acquisition Option

Aircraft Purchase Prices

Cessna 404 Prices from: £180,000 - £300,000.

These have held their prices very well, in fact there is some evidence that the price is appreciating.

In the world at any one time there will probably only be 10 for sale.

We would expect to purchase one in the lower end of this range which would be ideal for the work.

Cessna 40C Prices from: £130,000 - £220,000.

This was a very popular aircraft with US commuter operators, and the best version of the 402. Production continued until 1985. Some very high time examples, not in particularly good condition, can be bought in the USA for less than half the lower figure above, but by the time they were bought up to scratch they will have cost more than £130,000. A better bet is to a good example, preferably from Europe, which will have full corrosion proofing, and most of the mods required by the British. There are not many offered for sale in Europe, and one could expect to pay slightly more for one than the equivalent purchase in America plus ferry and certification costs.

Cessna 402B Prices from: £50,000 - £100,000.

This is a fine aircraft, but has not the power and payload of the 402C. There are always plenty for sale, because a lot were built in the years 1971 to 1976. Not many are corrosion proofed, and proofing would have to be carried out when the aircraft was imported (for there are very few for sale in Europe).

Piper PA 31 Chieftain Prices from: £70,000 - £175,000.

In production form 1974 to 1984, these aircraft were popular in the UK during the period when the Cessna 400 series were not approved by the CAA without an expensive windscreen modification, although they were not so popular in the USA. There are, therefore, fewer Chieftains available worldwide than 402's, but still a fair number, and a choice can be made between an older example, at the lower figure, or a newer one at the upper end.

Britten Norman Islander Prices from: £60,000 - £200,000.

You might be able to pay more for a newish example, but there is no point. In production from 1967, and still in production (albeit about to finish), a good Islander can be bought for £120,000.

Cessna 406

We have just included this in the acquisition and lease options, as the market in these aircraft has just stagnated and the prices have dropped as a consequence. It will also give you the option of a turbine price.

Cost New:	£750,000.
Cost Used (3 years old):	£575,000.

Lease from an Operator

Each operator will have his own way of working out a leasing price. Those operators with an appropriate aircraft type in their fleet, who have perhaps written down the cost of their aircraft already, have the chance to offer an aircraft at a lower figure than those operators who are going to buy an aircraft especially for the job, and who will want to recover their investment, or a large part of it, during the period of the contract.

In the end, however, there is a narrowing of the gap, for a variety of reasons, and one might expect to be offered aircraft based on their value or cost, factored by the length on the contract being bid for, the extent of the utilisation during the contract, the likelihood of a renewal, and the usefulness of the aircraft post-contract.

In the case of NRA's requirements, companies might offer aircraft on an annual lease basis alone, rather than annual lease plus hourly lease, because of the relatively small amount of flying (400 hours) each year.

It all amounts to the same thing, anyway. Each operator will try and recoup all or part of his investment during the contract, but will be forced by his desire to gain the contract to take a more pragmatic approach. Thus, he will have to take

account of the residual value of the aircraft concerned. He will decide to write the aircraft down over a number of years, commonly either 10 or 7, with no residual value, or 3 or 5, with a residual. The size of the residual will depend on several factors: the aircraft type, whether that type fits into his normal operation, whether he likes the type etc.

Because aircraft operators do not make much money in the normal course of things, and because they are subject to the vagaries of the airworthiness authorities, the economy, environmental concerns, vagaries of the public etc, few operators are sanguine enough to forecast more than two years ahead. They feel that ANYTHING could happen in three or four years. They are therefore loath to take any risks. Their past experience tells them that those people that took risks are no longer in the aviation business.

The conservative approach is therefore likely to be prevalent, and the residual value placed on the aircraft is unlikely to be more than 30% even for a 3 year lease, for all the lower valued, secondhand aircraft. The same 30% residual value would probably be used for a five year lease of older aircraft.

On top of this, capital in use will be considered. Some operators will determine that they want 100% return on their capital, whilst others want only 25%. This is not quite the same thing as writing down an aircraft over a number of years

with a residual at the end of the period, although it can be. Most businessmen want to see a 100% return on capital invested in 3/4 years, although this is hard to achieve in aviation. Some companies will buy aircraft outright to lease on, whilst others will finance the acquisition of the aircraft, at interest rates currently in the order of 10 - 12%.

For new aircraft, however, and only the Cessna F406 qualifies from the list we have provided, a residual of 30% after 3 years would be unrealistic. 50% would be more likely, with the 30% residual appearing again for 7 to 10 year leases. However, the F406 is a special case, in that it is possible to lease after these aircraft from a Dutch bank for $23,000 a month. Therefore it is likely that an operator bidding for a contract lasting no more than three years would take the route of leasing in from the Dutch, then leasing on, with a small (perhaps 10%) mark-up to the client.

Assuming a three year lease, and bearing all the above factors in mind, NRA might expect to be offered aircraft (in an unmodified state) in the following ranges:

Cessna F406:	New: £14,000 per month. Used: £12,000 per month.
Cessna 404:	£4,000 to £7,000 per month.
Cessna 402C:	£3,500 to £5,500 per month.
Cessna 402B:	£2,500 to £3,500 per month.
Piper Chieftain (PA31):	£3,000 to £5,000 per month.
BN-2 Islander:	£3,000 to £5,500 per month

Operating Costs

The prime factors for determining operating costs are:

Fuel and Oil

Maintenance

Pilots

Insurance

Landing fees

Hangarage

Aircraft lease or purchase costs.

Fuel and oil

Apart from the F406, all the aircraft in the list burn avgas, at the following average ranges:

Cessna 404:	33 ig/hr @ £2/ig	= £67 / hour.
Cessna 402C:	28 ig/hr	= £56 / hour.
Cessna 402B:	25 ig/hr	= £50 / hour.
Piper Chieftain:	31 ig/hr	= £61 / hour.
BN-2:	25 ig/hr	= £50 / hour.
Cessna 406:	61 ig/hr @ 0.8/ig	= £49/hr.

Long patrols at low power settings can reduce consumption by up to 15%.

All the aircraft can operate on a suitable aerial work schedule of 100 hours and annual checks. essentially the time spent on these checks is divided in the ratio of 1:3 between checks and rectification. The former is basically inspection work, the latter the rectification work of things found in the inspection, as well as work carried out between and checks. Engine overhaul periods vary, as do the costs of overhauling the engines, as per below. Propeller overhauls and repairs are not expensive, in hourly terms, and may be considered to £5 per aircraft per hour, all types.

The fuel has been factored, but the maintenance has not, as much of the maintenance is based on the annual check which arises every year however many hours have been flown. The figure of 420 hours was used to provide a rough basis for the computation. Oil costs have been added to the fuel costs in the columns above. The addition is £1000 in each case, except for the C406, which basically does not use oil.

The NRA will have its own way of working out how much money it costs, so if it were to think about buying an aircraft, it could use the projected purchase prices listed above, and add a suitable annual figure the operating cost figure, without the addition of leasing.

As can be seen, there is not really very much in them. The F406 is clearly more expensive, to the tune of £100,000 a year, but it is the most capable, and could probably find a lot of work for other bodies and organisations when the NRA did not want the aircraft.

The Cessna 404 is the next most expensive, as it is the next most capable. It has a prodigious endurance (11 hours), which is essential for certain operations. The F406 and C404 have excellent payload capabilities.

The C402B and the Islander are the least capable in terms of payload range, the Islander being the worse. The C402C and Chieftain are more or less on a par in this respect.

Engine Lives and Costs

Cessna F406	5000 hours at £140,000	= £28/hr x 2 = £56/hr.
Cessna 404	1500 hours at £20,000	= £13.33 x 2 = £27/hr.
Cessna 402C	1600 hours at £16,000	= £10.00 x 2 = £20/hr.
Cessna 402B	1400 hours at £16,000	= £11.43 x 2 = £23/hr.
Piper Chief	1600 hours at £18,000	= £11.25 x 2 = £23/hr.
Islander	2000 hours at £13,000	= £ 6.50 x 2 = £13/hr.

Scheduled and Unscheduled Maintenance Costs:

One can only provide an average expected figure here. Individual aircraft may require much more maintenance than another of similar age and apparent condition. One aircraft may corrode faster than another, requiring more labour when on check, so one must be cautious when reading these figures. They SHOULD be about right, but may be anything from 30% too high to 60% too low.

Cessna F406 £50/hr maintenance + £56 engines + £5 props = £111/hr

Cessna 404 £70/hr maintenance + £27 engines + £5 props = £102/hr

Cessna 402C £50/hr maintenance + £20 engines + £5 props = £75/hr

Cessna 402B £60/hr maintenance + £23 engines + £5 props = £88/hr.

Chieftain £80/hr maintenance + £23 engines + £5 props = £108/hr.

Islander £60/hr maintenance + £13 engines + £5 props = £78/hr.

Pilots

All the aircraft in the list can be flown by a single pilot. A Pilot's salary for a job such as this is anything from £15,000 to £35,000 a year, depending on his experience, ratings etc. For this job we would expect a pilot to be costed at about £25,000 including NIC etc. If a contractor were asked to have a pilot available whenever the NRA needed one, then they would most likely wish to account for part, say 33%, of another pilot, who would stand by in case the first one was ill, on leave, or suddenly left.

Landing Fees

These are not directly attributable to the aircraft, although the size of them is. An aircraft can fly 400 hours a year and incur no landing fees whatsoever, if it is operating from an airfield that does not levy landing fees.

More often, aircraft are attached to one base, and the company has a contract landing fee agreement with the airport, in the order of £1000 to £3000 a year, depending on the airport concerned, and how important they think they are, and also on the aircraft weight, and the number of flights expected to be made from the base.

Not all airports will issue landing fee contracts for aircraft above 2000kg all up weight, and all the aircraft in the list weigh more than 2000kg. Instead they will ask for a full landing fee each time the aircraft lands at the airport.

The rate for 1992 is about £11 per tonne, so individual fees might be:

Cessna 406:	£44.
Cessna 404:	£44.
Cessna 402C:	£44.
Cessna 402B:	£33.
Chieftain:	£44.
Navajo:	£33.
Islander:	£33.

Hangarage

Hangarage costs vary widely. Sometimes it is not possible to find hangarage, and many general aviation aircraft in the UK are never hangared. NRA's aircraft will need secure hangarage, and that can be at a premium.

All the aircraft are about the same size, so suffice it to state that hangarage will cost between £3000 and £6000 per annum at most airports.

Aircraft Lease and Purchase Costs

The monthly leasing figures given above may be used to work out the relative operating costs of a particular type of aircraft. It is entirely probable that some money will be saved if the

NRA buy an aircraft themselves, but the proportion saved will be more or less the same whichever type is purchased. The exception to this may be the F406: there will not be much of a saving over the leasing cost if NRA were to buy one instead.

The final figures for operating costs, using the task as the criterion, and assuming that it would take the F406 420 hours utilisation in a year to achieve it, are as follows:

	F406	C404	C402C	C402B	P CHT	BN2
Fuel & Oil (in 000s)	24	32	26	25	32	29
Maintenance (eng/prop)	44	41	30	35	43	31
Pilots (£25k+£8=£33)(*)	38	38	38	38	38	38
Insurance	17	11	8	7	8	7
Total,w/o acquisition	123	125	102	105	120	105K
Add leasing	132	66	54	36	48	48
Total, with leasing	255	191	156	141	168	154K

The Cessna F406 burns turbine fuel. This is much less expensive than avgas, but the aircraft uses more fuel per hour:

Cessna F406: 75ig/hr @ 80p/ig = £60/hour.

Once again fuel prices vary, but not as much as avgas. 80p/gallon is a reasonable average price for a regular uplifter, ie, a company that has a contract with a major fuel company.

Insurance

If the NRA opt for either purchase with an operating contract or lease from an operator. That operator should provide both the hull insurance and third party liability.

The operators should on their fleet policies be able to obtain a better price than the NRA on a one off basis.

The suggested value for third party liability on this type of coastal work is TEN MILLION POUNDS.

This would obviously need to be increased if the aircraft task was changed to continuous operation over Central London for instance.

Third party liability to the value of ten million pounds will cost in the region of £5,000 per annum.

The hull insurance should cover the whole of the hull and installed equipment and should be of the order of 2% of the hull value per year.

CONCLUSIONS

Purchase Option

If the NRA were to consider purchasing the aircraft, it should be looking at 5 - 10 years of use.

Due to the age of the C402's and PA-31, the choice model with less than 4000 hours may be limited.

The Islander has a history of wing corrosion which often necessitates lengthy and expensive repairs, (the problem occurs between laminates on the wing, so little can be done in the way of prevention measures).

The Islander has a small narrow cabin, which, with cameras and scanners installed on the floor and 19" racks for electronics, will be extremely cramped for the operations crew. Access round 19" racks is also extremely difficult in this aircraft.

If the NRA budget can accommodate this aircraft, then the Cessna 404 is the obvious choice both on technical merits and longevity.

If not then the Cessna 402C, with its greater stability would be the second choice.
Third choice the PA31-350.
or the Cessna 402B, and finally the Islander.

Lease Option

All of the aircraft analysed and those mentioned in the lease option will perform the task considered. Wing spars and indeed any other costings to do with the airframe will be immaterial to the NRA on a lease basis.

The NRA has, in this case, the luxury of vetting the proposals to ascertain which is to be of greatest value to the NRA and can weigh those factors accordingly.

Lease Vs Purchase

A difficult decision. There are many financial factors within the NRA of which we are obviously unaware.

We have not analysed the purchase and operation of the aircraft by the NRA as the infra structure required would be considerable and hence its costing. Aircraft operation is a specialist task and should be treated as such.

The option to lease in for each individual task has been discounted as not viable, due to the number of days the aircraft will be unable to fly due to weather during the three circuits of the UK, as outlined in the configuration - endurance section.

The purchase of the aircraft requires a high initial capital outlay, but is cheaper in the long term.

The disadvantages are:

i) Sensors will change in the next 10 years, which may require a different platform.

ii) There are still administrative costs within the NRA.

Leasing the aircraft, although more expensive in the long term, does have free capital for further investment in sensors where it is obviously required and the lease, inclusive of the 420 flying hours reduces NRA administrative costs to an absolute minimum.

It is our opinion that if the Cessna 404 option was chosen then purchase by the NRA would be preferable.

If the smaller aircraft was selected, the lease option would be preferable as there would be little growth potential.

If the NRA opt for the purchase of an aircraft, it should ask for tenders for supply, modification and operation of that aircraft as a single contract.

AIRCRAFT TECHNICAL SPECIFICATION ANNEX 1

In the following table, the basic weights are manufacturers figures and will vary from aircraft to aircraft. Survey aircraft tend to be heavier due to mods and extra avionics equipment. Transit speeds and fuel burn figures are from practical experience of operating these types.

On survey, fuel burn is generally less than transit fuel burn.

		BN2A-6	PA31-350	C402B	C402C	404
Maximum Take Off Weight	(lb)	6600	7000	6300	6850	8400
Basic Weight	(lb)	4317	4890	4380	4540	4980
Maximum Fuel	(lb)	822	1092	978	1224	2100
Speed (Transit)	(kts)	130	160	170	175	218
Range (max)	(nms)	624	735	976	1056	1809
Endurance (max)	(hrs)	5.2	4.9	6.1	6.4	11.01
Fuel Burn (Transit)	(lb/hr)	180	220	180	200	240
Engines	(hp)	260	350	300	310	375
Ceiling	(ft)	13600	24000	24700	26900	26000
Single Engine Ceiling		4400	1400	13000	14800	10100
Rate of Climb	(ft/min)	860	1100	1450	1450	1575
Single Engine Climb	(ft/min)	145	230	300	301	230

BN2 - Can carry NRA with 3 crew and full fuel.

PA31 - Can carry NRA with 3 crew and full fuel (28lb to spare).

C402B - Can carry NRA with 3 crew and full fuel.

C402C - Can carry NRA with 3 crew and full fuel (98lb to spare).

C404 - Can carry NRA with 3 crew and full fuel (200lb to spare. With same endurance as aircraft above, 1200lbs + to spare).

ANNEX 2

Contents List.

CESSNA CARAVAN II

Performance & Specifications

Takeoff (sea level)
- Ground Run.....2121 ft
- Over 50 ft obstacle.....2635 ft

Rate of Climb
- Twin Engine.....1851 fpm
- Single Engine.....396 fpm

Service Ceiling
- Twin Engine.....30000 ft
- Single Engine.....16200 ft

Max. Cruise Speed.....246 kts

Range at Max. Criuse Speed.....1027 mn
(includes fuel allowance for takeoff, climb, descent and 45 min reserve)

Landing Distance
- Over 50 ft obstacle.....2485 ft

Maximum Ramp Weight.....9435 lbs

Maximum Takeoff Weight.....9360 lbs

Maximum Loading Weight.....9360 lbs

Maximum Zero Fuel Weight.....8500 lbs

Standard Empty Weight.....5033 lbs

Maximum Useful Load.....4402 lbs

Usable Fuel Capacity.....475 U.S. gal

Engine.....Pratt and Whitney PT6A-112

Horsepower.....500 shp

Baggage Capacity (outside of cabin).....1000 lbs

All performance data is based on the International Standard Atmosphere at maximum gross weight. The maximum cruise speed and range is at midcruise weight. Takeoff and landing distances are based on level, hard surface, dry runways with zero wind.

CESSNA CARAVAN II

Exterior/Interior Dimensions

Exterior Dimensions

Total height.....13.15 ft

Total length.....39.02 ft

Wing span.....49.5 ft

Wing area.....252.74 sq ft

Horizontal tail span.....19.26 ft

Horizontal tail area.....62.59 ft^2

Vertical tail span..... 7.62 ft

Vertical tail area.....43.55 ft^2

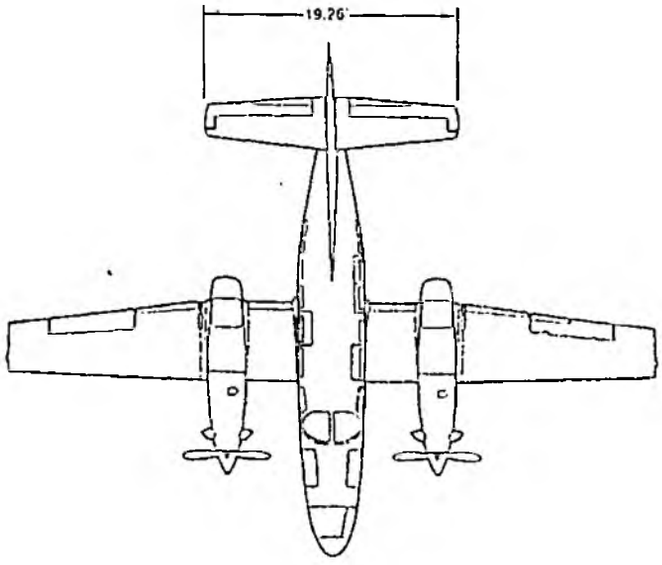
Minimum turning distance.....63.39 ft

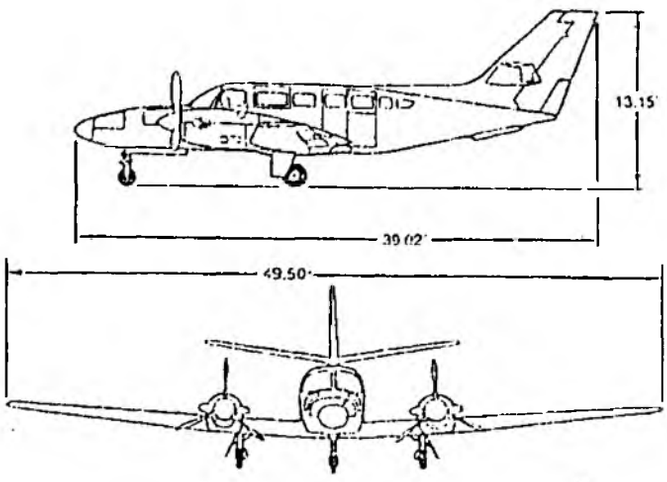
Interior Dimensions

Cabin height (floorboard to headliner).....54.4 in

Cabin length (fwd to rear bulkhead).....18.74 ft

Cabin width (max).....56 in





CESSNA 406 SURVEY AIRCRAFT

MARINE POLLUTION SURVEILLANCE AIRCRAFT IN ATLANTIC GROUP FLEET

CESSNA 404

Performance & Specification

Takeoff
Ground roll.....1788 ft
Over 50 ft obstacle.....2367 ft

Rate of Climb
All engines.....1575 fpm
Singlr engine.....230 fpm

Service Ceiling
All engines.....26000 ft
Single engine.....10100 ft

Max. Cruise Speed
77.5% power at 20000 ft.....218 KTAS

Max. Range
20000 ft (2040 lbs usable fuel).....11.01 hours
and 1809 Nautical Miles

Landing Performance
Ground roll.....1100 ft
Over 50 ft obstacle.....2130 ft

Takeoff Weight.....8400 lbs

Landing Weight.....8100 lbs

Standard Empty Weight
Titan Courier II.....4980 lbs

Fuel Capacity.....348 gal (340 gal usable)

Engines.....GTSIO-520-M

Horsepower.....375 hp

Baggage Allowance.....1500 lbs

CESSNA 404

Exterior Dimensions

Total height	14.08 ft
Total length	39.53 ft
Wing span	46.33 ft
Wing area	242 sq ft
Horizontal tail span	19.08 ft
Minimum turning distance	61.85 ft

ATLANTIC RECONNAISSANCE REMOTE SENSING SYSTEM INSTALLED IN CESSNA 404 AIRCRAFT

CESSNA 402C

Performance & Specifications

Takeoff
Ground Roll.....1763 ft
Over 50ft. obstacle.....2195 ft

Rate of Climb (sea level)
All engines.....1450 fpm
Single engine..... 301 fpm

Service Ceiling
All engines.....26900 ft
Single engine.....14800 ft

Max. Cruise Speed
72% power at 10000 ft.....194 KTAS
72% power at 20000 ft.....213 KTAS

Max. Range
10000 ft (1224 lbs usable fuel).....8.36 Hours
and 146 KTAS

Landing Performance
Ground Roll.....1055 ft
Over 50 ft. obstacle.....2485 ft

Maximum Ramp Weight.....6885 lbs

Maximum Takeoff Weight.....6850 lbs

Maximum Landing Weight.....6850 lbs

Maximum Zero Fuel Weight.....6515 lbs

Standard Empty Weight.....4105 lbs

Fuel Capacity
Standard (204 Gallons usable).....213.4 gal

Engines.....TSIO-520-VB

Horsepower.....310 shp

Baggage Allowance.....1500 lbs

CESSNA 402C

Exterior Dimensions

Total height.....11.45 ft

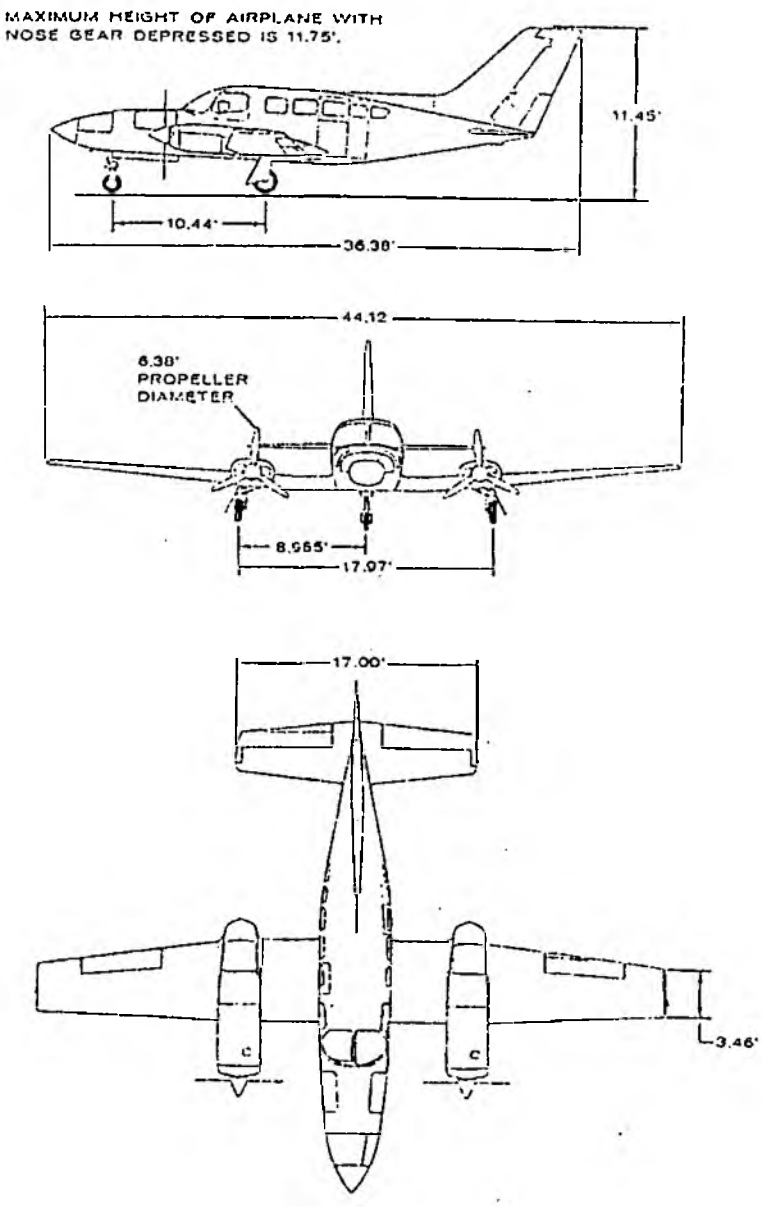
Total length.....36.38 ft

Wing span.....44.12 ft

Wing area.....225.8 sq ft

Horizontal tail span.....17 ft

Minimum turning distance.....62.10 ft



CESSNA 402C SURVEY AIRCRAFT

PIPER PA31 CHIEFTAIN

Performance & Specifications

Max. Authorised Altitude.....24000 ft

Maximum Ramp Weight.....7045 lbs

Maximum Takeoff Weight.....7000 lbs

Maximum Landing Weight.....7000 lbs

Maximum Zero Fuel Weight.....8500 lbs

Standard Empty Weight.....4319 lbs

Maximum Useful Load.....2050 lbs

Usable Fuel Capacity.....182 U.S. gal

Engine.....Lycoming L/TIO-540-J2BD

Horsepower.....350 shp

Endurance (Range).....4 hours (950 n miles) approx

True Airspeed (transit).....150-170 knots

True Airspeed (on task).....100-170 knots

Exterior/Interior Dimensions

Total height.....13 ft

Total length.....35 ft

Wing span.....41 ft

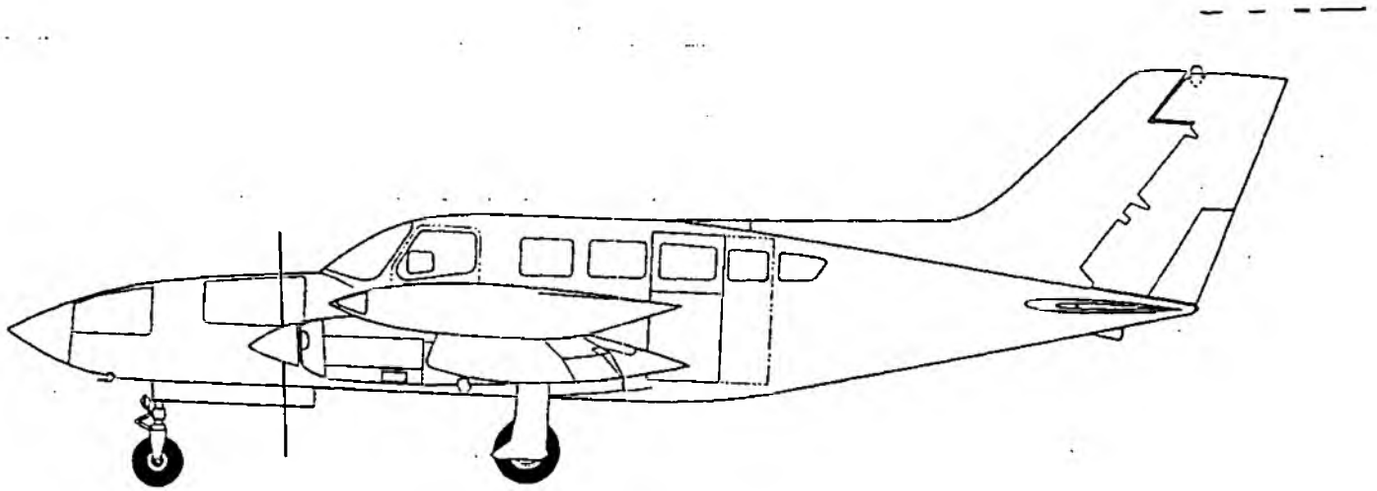
Wing area.....229 sq ft

Horizontal tail span.....18 ft

Cabin height (floorboard to headliner).....50 in

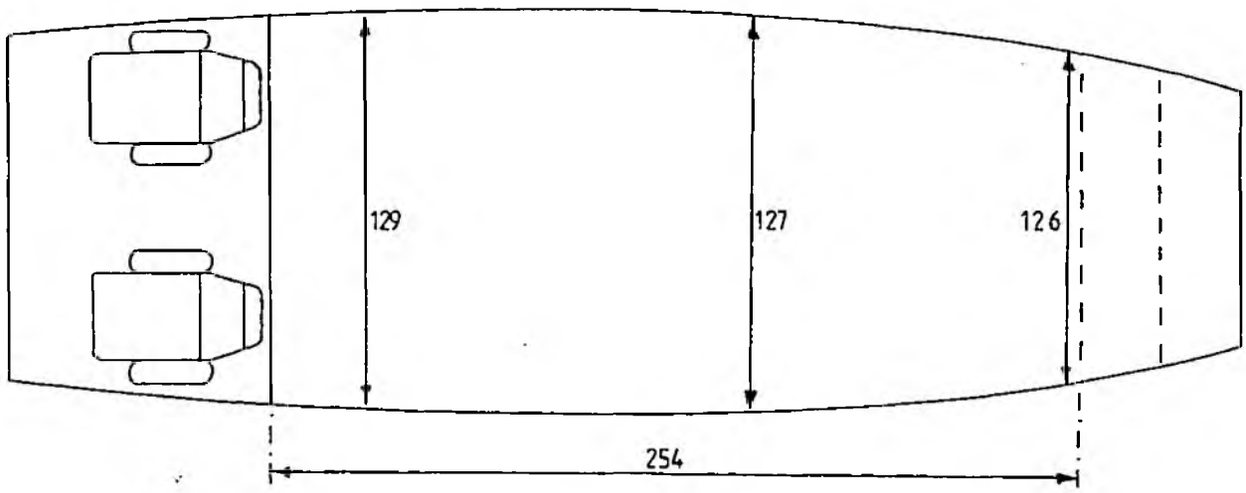
Cabin length (fwd to rear bulkhead).....13 ft

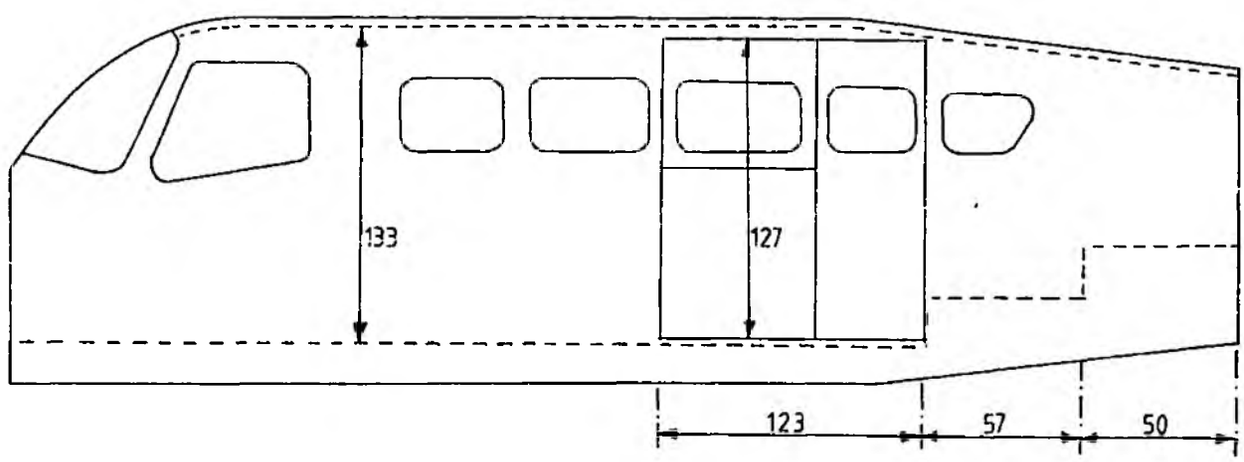
Cabin width (max).....51 in

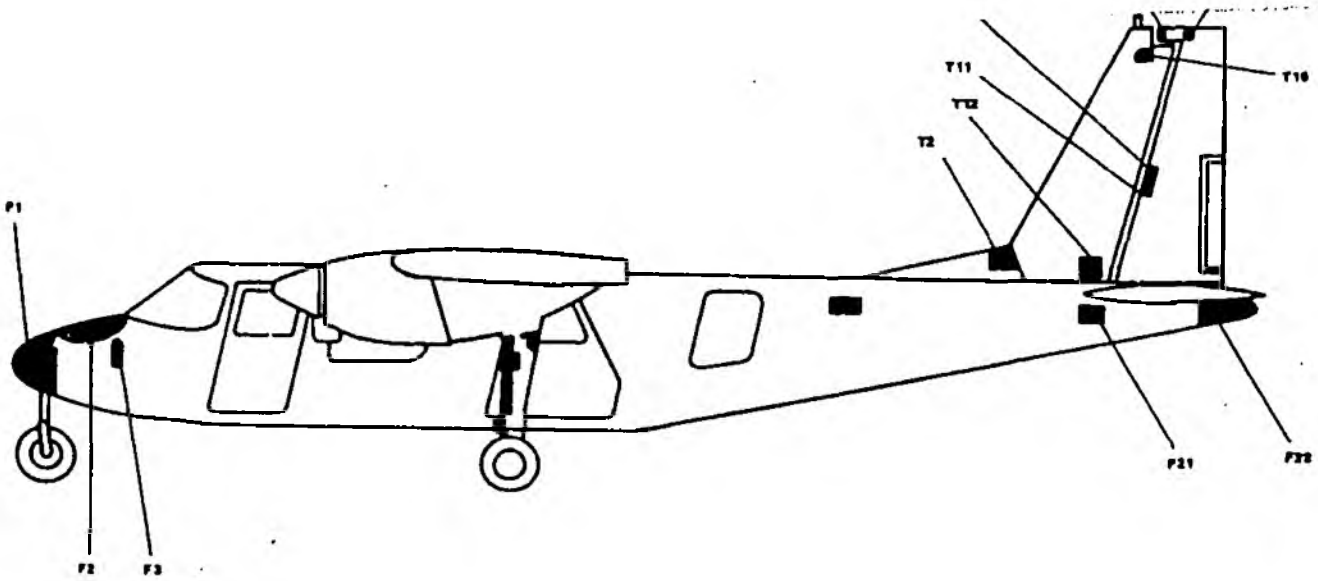


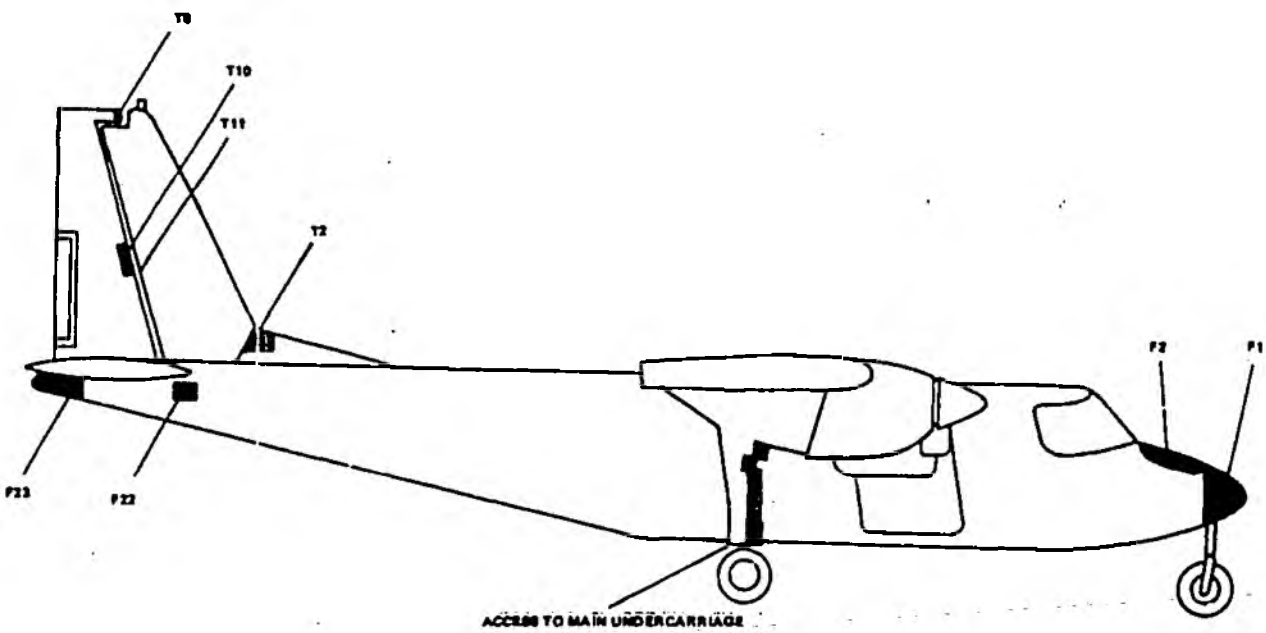
CESSNA 402 B

CESSNA 402 DIMENSIONS

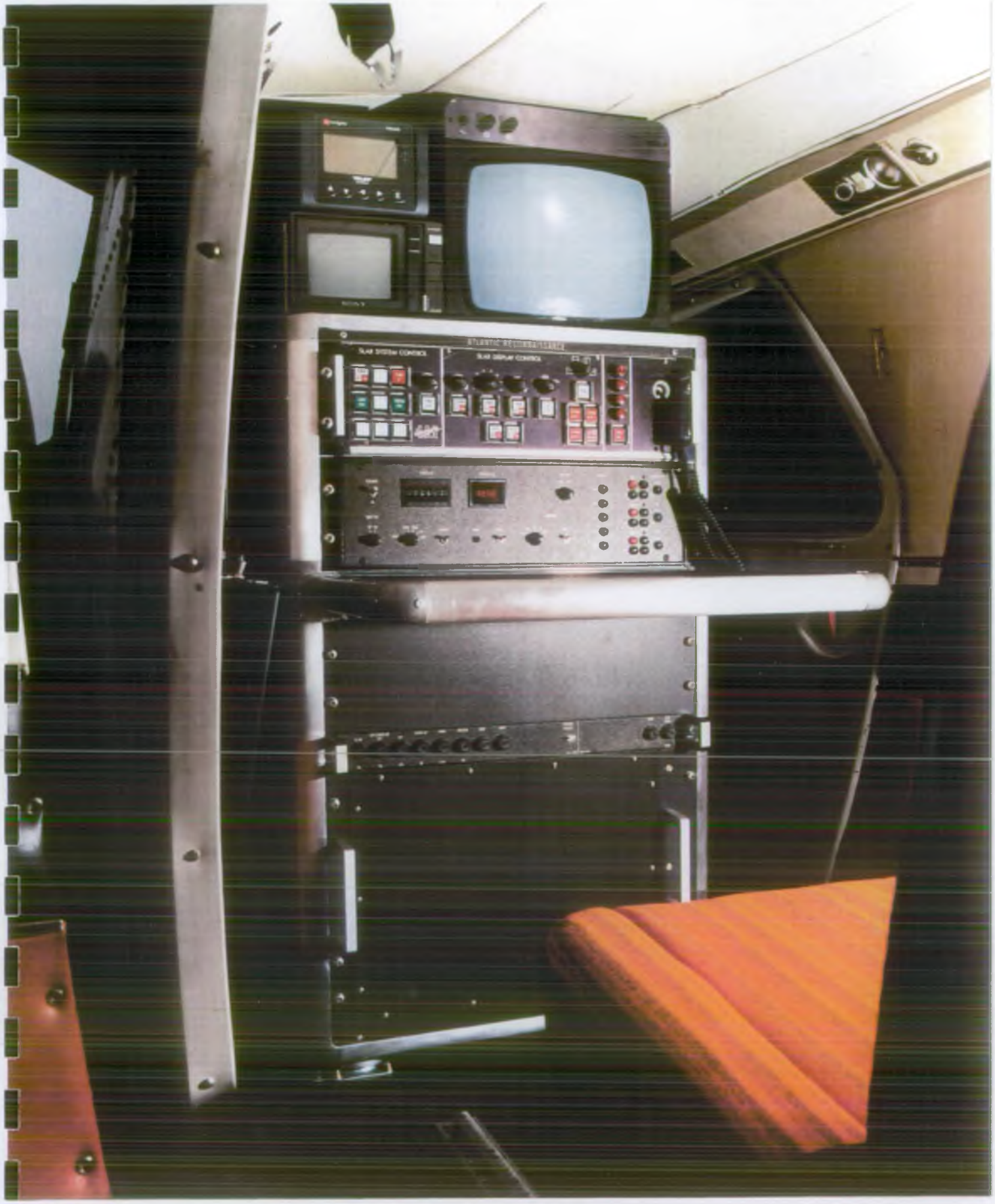








ACCESS TO MAIN UNDERCARRIAGE VARIES WITH AEROPLANE MOD STATE (REFER TO CHAPT. 2.0)



ATLANTIC RECONNAISSANCE REMOTE SENSING
SYSTEM MOUNTED IN BN2 ISLANDER

ANNEX 3.

List of Possible Contractors

Survey Companies.

Air Atlantique
Hangar 5
Coventry Airport
Coventry
CV8 3AZ.

Geonex UK Limited
92 - 94 Church Road
Mitcham
Surrey
CR4 3TD.

BKS Services
Ballycairn Road
Colraine
Northern Ireland
BT51 3HZ.

Surveillance Companies

Direct Flight Limited (DAFF)
Terminal Building
Norwich Airport
Norwich
NR6 6JA.

Flight Refuelling (MAFF)
Bournemouth Airport
Christchurch
Dorset
BH23 6EE.

Air Atlantique Limited (MPCU)
Hangar 5
Coventry Airport
Coventry
CV8 3AZ.

Your own list of air taxi and general operators is fairly comprehensive, should you decide to go down that path, perhaps CSE at Oxford should be added to the list.

Camera Port Installation

Mann Aviation Limited

Fairoaks Airport

Cobham

Surrey

GU24 8HX

Atlantic Aeroengineering Limited

Hangar 5

Coventry Airport

Coventry

CV8 3AZ.

Pilatus Britten-Norman Limited

Bembridge

Isle of Wight

PO35 5PR.

Other Operations

It has not been possible in the time given to analyse current helicopter and other operations in depth.

A quick reading would lead to believe that at least some of those task could be carried out by a fixed wing aircraft with a considerable reduction in costs.

If your chosen operator has the qualification outlined, they should be able to help in both this respect and the choice of sensors and equipment for those special operations.

HANGAR 5, COVENTRY AIRPORT, COVENTRY, WARWICKSHIRE CV8 3AZ
Tel: (0203) 307566 Fax: (0203) 307703