CONCORDE.

MORIEN MORGAN, R.A.E. — EARLY FEASIBILITY STUDIES ON A MACH 2.2 SUPER. TRANS. FUNDED BY HAWKER SIDDELEY. 1959–60.

NICHOLSON. — 1960 JOINT FEASIBILITY STUDY BY BAC–H.S.A.

GEORGE EDWARDS. — ARCH. RUSSELL LED BAC TEAM — I LED H.S.A. TEAM.

DESIGN STUDY CONTRACT GIVEN TO BAC. 1961.

I LEFT H.S.A. IN 1962 TO SET UP MY OWN. CONSULTING CO. AND SHORTLY AFTER I GOT A CALL FROM ROY JENKINS, WHO WAS MINISTER FOR AV. TECHNOLOGY IN THE U.K. GOV. AT THAT TIME. HE ASKED ME IF I WOULD BE PREPARED TO TAKE ON IN VIEW OF MY EARLIER WORK ON THE SST. THE JOB OF CONSULTANT ON CONCORDE. MY JOB WAS TO WORK WITH BAC AND B.O.A.C. AND THE CONCORDE DIRECTOR IN THE MIN OF TECH. ON SPECIFIC ASSIGNMENTS ON CONCORDE, INCLUDING SONIC BOOM ASSESSMENT & EFFECT ON OPERATIONS AND ECONOMICS. — BALAT WAS FRENCH CONSULTANT I.T.A. PARIS.

MIN OF TECH.	B.A.C.	B.O.A.C.
DIA MORRIS.	GEORGE EDWARDS.	CHARLES ABLE
JIM HAMILTON.	ARCHIE RUSSELL	CLIFF JACKSON.
CONCORDE DIREC.–DUNCAN CAMERON.	MICK WILDE.	WINN. BRAY.
A. COURTNEY.	PAT BURGESS.	ALEC FINLAY.
JOHN COLLINGBOURNE.	ALEC SYMON.	ERIC HALL.
CHARLES NAYLOR.	STUART MATTHEWS.	
HANDEL DAVIES.		

STEPHEN WHEATCROFT. — BRITISH AIRWAYS BOARD

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CONCORDE

SST-to-Concord-to-Concorde.

A look back at some of the untold history of the birth of Concorde.

Jim Floyd

January 90.

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My Personal Involvement in the Concorde Project.

One of the questions that I am frequently asked is about my personal role in the Concorde project, since there is little published information on the subject. This 'memo-to-file is intended to document the highlights of my participation in the UK supersonic transport project , including the part played by other ex-Avro Canada engineers who applied their knowledge gained on the design of the Arrow, to the studies on the UK supersonic transport.

In order to put the record into proper context it is necessary to distinguish between our work on supersonic transports in general and the Concorde work in particular, since much work had already been accomplished on the viability of a practical supersonic transport configuration prior to the commencement of the Concorde design in the early 60s.

The engineers in charge of the design of the Concorde on the British side, were Sir Archibald Russell, technical director of BAC Filton Division and Dr. Bill Strang, chief engineer at Filton. On the French side the design teams were led by Pierre Satre, the technical director of Sud-Aviation, and Lucien Servanty, chief engineer of Sud. These gentlemen deserve enormous credit for the dedicated and incredible job that they did on the design and development of the most advanced civil aviation project ever undertaken, the operational record of which speaks for itself.

However, I also had a deep personal involvement in that project, both in the early design and feasibility studies and later as Concorde consultant to the British government, despite the fact that you will probably find no mention of this work in the magazines and books on the Concorde. In many ways this is understandable, since most of the literature on Concorde was sponsored by the manufacturers, or at least was based on information received from them, and as a consultant to the government I was 'on the other side' so to speak and some of my reports did not necessarily find

absolute favour with those involved in building and selling the aircraft. In the case of the airline, BOAC were anxious about the possibility of having the government ram the aircraft 'down their throats', regardless of whether it was an economical proposition or not and they were very cautious and conservative in their approach to the project at that time.

I do not mean to imply that we were deprived of cooperation in any way and both BAC and BOAC were extremely cooperative and offered their help and facilities whenever they were needed.

It also has to be remembered that due to the competitive nature of the Concorde project at that time, the Americans and the Soviet Union were both working on SSTs, much of our work was classified as 'commercial in confidence'. Our work with the other airlines which were interested in taking options on Concorde was also highly confidential, so that little of the work that we were doing at that time was ever made public, although reference to it did appear in Hansard from time to time.

On completion of our Concorde consultancy in 1972, all classified material was deposited with the Concorde directorate in the Ministry of Technology and the only items retained in our offices were related correspondence and a few unclassified reports dealing with methodology or statistical data.

Even under the thirty year 'access of information' procedure, much of this work would not normally be released until after the turn of the century, so there are still distinct limitations on what can be disclosed in any published material or books about our work on Concorde during that period.

Within these limits, the following is a factual rundown on my personal involvement with the British Supersonic Transport Studies,

lasting from 1959 to 1961 and my consultancy work on the Concorde for the British government, from 1965 to 1972, a total period of nine years. Incidentally, the name of our government bosses changed a number of times, commencing as the Ministry of Aviation, then the Ministry of Technology and later the Department of Trade and Industry, as the project progressed from feasibility studies to first flight.

In the appendices, I have included some of the actual correspondence sent and received on the subject and minutes of one or two of the marathon Concorde meetings, to highlight and substantiate some of the work that we carried out during that time. I have also included some extracts from the submissions that we made on the SST work carried out in my Advanced Projects Group at HSA.

When I commenced this note I had intended to keep it as short as possible, merely to indicate my involvement on Concorde in general, but I found it difficult to record such an intensive effort, carried out over a relatively long period, in just a few pages. Although it has become a little longer than intended, it still does not begin to adequately cover my total involvement in the Concorde project, but I hope that, with the supporting documents in the appendices, it will at least put the record straight on some of the events of that period.

I remember the 'Concorde years' as a hectic and demanding period, but nevertheless rewarding. The Concorde finally went into service in 1976, seventeen years after our initial feasibility studies. I flew twice across the Atlantic on that remarkable airplane, just after it went into service with BOAC (now British Airways).That experience is recorded in Appendix 8.

The beginnings of Concorde.

The real starting point of the British Supersonic Transport Studies was the formation of the Supersonic Transport Aircraft Committee (STAC) in 1956, under the guidance of the Deputy Director of the Royal Aircraft Establishment (RAE) Mr. Morien Morgan (later Sir Morien Morgan, based on his contribution to Concorde.)

The committee consisted of representatives of the aircraft industry, the airlines and the various government research establishments and Ministries.

I was well aware of this work, since on my visits to the UK, I usually visited the RAE for discussions with Mr. Nicholson (Nick), the head of research and aerodynamics at the RAE, to swap technology on supersonics, based on our Arrow work and his work on the SST.

In March 1959, almost coincidental with the cancellation of the Arrow program, the STAC issued its first major report, suggesting that a contract be placed with industry to study the feasibility of a supersonic transport seating around 150 passengers and cruising at Mach 1.8, for a range of about 3,500 miles.

I should mention that in my Project Research Group at Malton, between 1957 and late 1958, we had been independently studying various configurations of supersonic transports, using the practical supersonic experience gained on the Arrow, and had come to the conclusion that a supersonic transport, cruising around Mach 2., could be an economical proposition.

During that time Bistol Aircraft in the UK had also been carrying out independent studies on various configurations of SSTs.

Shortly after the cancellation of the Arrow, when all of the engineers were having to seek new jobs and I, along with most other senior engineers , was being bombarded with offers from the United States, I received a phone call from Crawford Gordon, A.V.Roe Canada President, who was in Sir Roy Dobson's office in the UK. Crawford informed me that Sir Roy and Hawker Siddeley Aviation's Technical Director, Stuart Davies, wanted me to fly over to the UK immediately to discuss the possibility of my taking on the job of leading a team of hand-picked engineers in a 'think tank' operation that Davies wished to set up at the HSA headquarters in Kingston-on-Thames, the first job being a study on the supersonic transport suggested by the STAC.

At that time I was just on my way out to the West Coast to discuss the possibility of some of the aircraft firms out there taking groups of our engineers on a temporary basis, so that we could get them back when we had sorted out the horrible mess on the Arrow cancellation, so I was not ready to hop on an aircraft to the UK just like that. I wrote to Stuart Davies, who was also a close friend and the man reponsible for my being in Canada in the first place, telling him that my visit would have to be delayed until we had sorted something out for our engineers, who otherwise would be scattered all over North America.

On my return, I received a letter from Davies, outlining the proposal in some detail (Appendix 1) and asking me to "get into the first aircraft that you can and come to the UK to discuss the matter with me". I caught the next available flight and went straight to Kingston to see him.

On my arrival in the UK, Sir Roy and Stuart Davies both did a 'hard sell' job on me and made it all sound very attractive for both my family and myself. Meetings were also set up with Morien Morgan and others in the government, including members of the STAC who were

familiar with the supersonic work that we had been pioneering on the Arrow and on which I had presented a paper for the Royal Aeronautical Society as the British Commonwealth Lecture, in October 1958. All of the people contacted were apparently impressed by what had been going on in Canada in supersonics and the general atmosphere was perhaps best expressed by Morgan when he said that "You Canadians know as much about supersonics as anyone in this business".

It was all very persuasive and by the time that I was ready to return to Toronto, despite the beckoning affluence of a job in the United States, and the fact that it would involve the family in a traumatic move from their beloved Canada, I had confirmed to Dobbie and Davies that I would take a 'flyer' at it. After all, we were going to have to move anyway, since, with the demise of the Arrow, there was little challenge left for us in Canada.

I have to say that probably the strongest factor in my decision to take the job, was my respect and admiration for Stuart Davies. As a young and very junior designer, I had worked closely with him as his personal technical assistant when he was deputy chief designer to Roy Chadwick at Avro. He was one of the most capable and technically honest engineers that it had been my privilege to encounter and in those formative years I had learned a great deal about attention to detail, technical integrity and the noble art of compromise.

Six years later, in 1944, when Davies had been made chief designer at the newly formed Avro design office in Yorkshire, he asked me to go with him as his chief project engineer, heading up a group studying new projects, including jet applications.

In December 1945, while Davies was in Toronto helping Sir Roy to set up the A.V.Roe Canada scene, out of the blue I received an offer from the Chrislea Aircraft Company at Hendon, to become their chief designer.

It goes without saying that the ambition of every aircraft designer worth his salt is to ultimately become chief designer, which incidentally was the highest on the totem pole in those days, since the titles of chief engineer, director of engineering, etc. had not yet been invented. At 31 years of age, I felt that it was a great compliment and I told the managing director of Chrislea that I would accept the post, but that I wished to wait until Davies's return before completing the formalities.

When Davies returned, he was full of enthusiasm for the prospects in Canada and said that he had already discussed with Sir Roy the possibility of my going out to Toronto to take charge of the design of the proposed new jet passenger plane for TCA. In addition to his engineering and organisational ability Stuart Davies was a very persuasive man and I ended up having to inform Chrislea that I had decided to go to Canada.

Again in 1952, when I had taken over the job of chief engineer at Avro Canada, Davies, then chief designer at Avro in England, had come over to Toronto for a few days to assist me to set up a new engineering organisation at Malton.

So, when Stuart Davies invited me to take on the job of chief engineer of the HSA Advanced Projects Group in 1959, reporting directly to him as technical director of the whole of the Hawker Siddeley Aviation group of companies, I 'knew my man' and welcomed the opportunity of once again working with a man that I considered to be one of the top engineering brains in the UK.

I returned to Toronto after arranging for some of the senior HSA engineers who would probably be joining my new group, to spend some time at Malton, with a small group of Avro Canada engineers, to get updated on the Arrow technology and practical supersonics in general, which would be needed for the studies for the STAC in the UK.

I finally went over to the UK in June 1959, to set up the Advanced Projects Group at Kingston, recruiting some of the senior engineers in the Hawker Siddeley Aviation companies. Five of the senior Avro Canada engineers also joined the group. (Appendix 2)

Feasibility studies on the SST were started immediately and wind tunnel tests on a number of configurations were undertaken. During that time and up to September 1959, we were working closely with the RAE and the STAC members carrying out parametric studies of all shapes and sizes, in an attempt to establish the optimum configuration.

Bristol Aircraft were also continuing their studies, concentrating on a specific Mach 2.2 aircraft with 110 passengers, rather than the parametric type of studies that we were doing in APG.

At the beginning of September, the STAC decided that all work on the SST should be pooled and APG was asked to carry out a joint feasibility study with Bristol. It was also decided that cruising speeds up to Mach 3 should be examined, since Lockheed and others in the USA were at that time concentrating on a Mach 3 steel-structured aircraft and if that went ahead the Mach 2.2 aircraft would be obselete before it started.

Joint feasibility studies.

A summary of the period of joint studies is contained in App. 3, outlining the early work on the project and the conclusions reached. The Bristol team was lead by Dr. Bill Strang, chief engineer of Bristol, reporting to Dr. A.E.Russell, Bristol's technical director (later Sir Archibald Russell, based on his work on Concorde). The HSA-APG team was lead by myself, reporting to Stuart Davies, the technical director of the Hawker Siddeley group of companies.

The joint feasibility studies lasted until March 1960, when each company produced a series of substantial documents outlining their recommendations to the STAC and the Ministry of Aviation.

Cooperation between the two study groups during that period was excellent, with joint meetings taking place on all aspects. Design ideas were tabled and exchanged and there is no doubt that our earlier work on the Arrow and the supersonic transport had a marked influence on the general thinking and particularly on structural and systems design which had been successful on the Arrow. Configuration of the supersonic intakes was also influenced by the Arrow results, although it was necessary to go for variable geometry intakes on the SST to obtain the best fuel efficiency.

Early in our joint studies it was agreed that because of the tight time scale and to achieve the maximum results in the time available, Bristol would concentrate on their original concept of a finite fuselage and high wing arrangement, which was dubbed the 'non-integrated' solution, while APG would concentrate on an 'integrated' wing and fuselage combination, similar to the original RAE and STAC concept (see appendix 3)

APG had an advantage in this arrangement in that the aerodynamics expert who had worked on the three-dimensional flow patterns of the integrated designs at the National Physical Laboratories at

Teddington ,Dr Colin Sinnott, had joined our group as our senior theoretical aerodynamicist. It was his opinion that the integrated wing/fuselage combination was best from the point of view of reduced skin friction drag and also wave drag due to lift, without presenting problems in other areas. It was also structurally efficient,due to the increased depth of the wing.

However, and this was a big however!, it had one drawback in the eyes of the more conservative principals in the 'establishment'. It had no passenger windows! All of our arguments that well-placed TV screens would provide the passengers with a better view of the outside scene and the takeoff and landing, were dismissed and we were never able to convince certain of the Ministry people that passengers would fly in an airplane without passenger windows.

Our work on the Mach 3 aircraft had also lead us to believe that more work should be done on that variant prior to the final decision on the configuration tailored to Mach 2.2. We did, in fact, limit the speed to Mach 2.7. because of the limitations in non-metallic materials at that time. However, the faster aircraft was not popular with the RAE staff who were anxious to freeze the design at Mach 2.2 so that work could start on the project as soon as possible.

HSA-APG reports numbers 1000/2302 and 1000/2305, issued in December 1959 and March 1960 respectively, present in detail the arguments generated by our APG group, and the results anticipated.
The two companies presented their findings at marathon meetings at the RAE and the Ministries involved, with Dr. Strang and his staff presenting the BAC proposals and myself and members of my APG staff presenting the HSA-APG findings. We had both confirmed that a 100 seat transatlantic supersonic transport cruising at Mach 2.2, would be a feasible and viable proposition, the only difference in opinion being in the optimum wing/fuselage configuration.

The decision.

For the next few months there was a period of 'deathly silence'. It was explained that many internal meetings within the Ministry of Aviation were required before a definite decision was made to proceed with the project, and I well understood this, but what seemed rather ominous to me was that we knew that dialogue was going on between Bristol and the RAE on their results, but we found it difficult to get the RAE or anyone else to discuss our findings in detail.

Finally, I believe that it was around November 1960, it was announced that the Ministry of Aviation had awarded a design study to Bristol, which by that time had become a member of the British Aircraft Corporation (BAC), with a recommendation that they explore the possibility of collaboration with another country, to share the cost of development.

To my knowledge HSA were never formally told why they did not get any part of the follow-on contracts. Speculation within the company and odd conversations with the people within the Ministry of Aviation pointed to two possible reasons (a) that HSA were at that time swamped with work on a number of government and private venture projects, while BAC were operating well below capacity. and (b) that the RAE were not happy about our suggestion that a short period of further study should be carried out on the Mach 2.7 version prior to a firm decision being made. They wanted to push on with the Mach 2.2 aircraft as soon as possible, presumably because at that time the USA were also committed to the SST and Britain wanted to be first in the field.

It should be pointed out that the American SST effort was the very reason that we wished to at least carry out some additional study on the Mach 2.7 version, since the Americans seemed to be concentrating

on Mach 3. Ironically, because of the delay in placing the follow-on contract we could easily have completed our Mach 2.7 studies prior to the awarding of the design study contract to BAC.

From our preliminary studies on the Mach 2.7 version it was considered that the integrated shape designed for Mach 2.2 was also an ideal shape for the Mach 2.7 aircraft. This lead us to believe that this solution would have the maximum development potential and with a change of structural materials would be as fast as anything that the Americans could design.

My own personal belief is that the desire to freeze the design as quickly as possible and the controversial 'window' question were the main reasons for the decision in BAC's favour. In looking back I sometimes wonder how changed our lives may have been had HSA won the contest, since it was almost a foregone conclusion that had HSA been given the design job, I would have been asked to lead the team. As it was we licked our wounds and went on to concentrate our efforts on the many other projects that we had on stream, including a subsonic VTOL transport study, a nuclear-powered aircraft, a Naval weapons system and many other studies, including a number of space projects.

<u>The 'no-boom' supersonic airliner- Project 1011</u>.

It might be worth mentioning another very interesting project which really emerged as an offshoot of our SST work. Our detailed studies on the effects of the sonic boom generated by the Mach 2.2 SST, lead us into a major study of the design of a supersonic aircraft that would <u>not</u> make a sonic boom. Work done by John Morris ,an ex-Avro Canada engineer who had joined us in APG, concluded that a specially shaped aircraft could be cruised up to around Mach 1.15 to Mach 1.2 without the shock waves reaching the ground. This conclusion was accepted by the RAE and other 'boffins' and we proceeded with a

detailed design study on that concept.

This was one of the most exciting and feasible projects to come out of APG. Designed to carry 160 passengers over a range of 4,500 miles at Mach 1.15 (approximately 760 miles per hour at 40,000ft.) it would have had a speed advantage over contemporary civil transports of 25% to 30%. The use of a variable geometry wing also gave the aircraft excellent low speed performance. It had approach speeds in the order of 150 miles per hour and could operate from any of the normal runways in use at major airports throughout the world.

It could have been designed around existing technology at that time and no new development problems were envisaged, which meant that it could have been in service very quickly. Presenting no sonic boom problems, that aircraft would not be precluded from flying overland supersonically, as Concorde has been, and it could have replaced most of the subsonic fleet in operation today, cutting schedule times dramatically. (Appendix 4).

The project created a considerable amount of interest at the time, but the concentration on the Mach 2.2 transport made it difficult to get anyone in the UK to take the idea seriously and like so many other promising projects, it died in the design study stage. A detailed account of the studies on this fascinating project is contained in APG Summary report no 1011/0104, issued in June 1961.

Further notes on the Advanced Projects Group.

In March 1961, I was invited to give the Roy Chadwick Memorial Lecture to the Royal Aeronautical Society and I included many of the design considerations that we had encountered in our supersonic transport studies and our 'no-boom' aircraft. Many other design considerations were discussed in the paper titled " Some Current Problems Facing the Aircraft Designer". I gave the lecture at my old

Alma Mater, the Manchester College of Technology in the city where Roy Chadwick had designed most of his airplanes and many of my old Avro Manchester colleagues attended.

I was surprised, but highly honoured, when my Chadwick Memorial Lecture was chosen as the best technical paper of the year presented before the RAeS and I was awarded the RAeS George Taylor Gold Medal for it. I have since been told that it is still considered as something of an all-time classic paper on aircraft design and I got a great kick out of the fact that a couple of years ago I was asked for a copy of the paper and later found that it had been included in the proceedings of the' First International Conference on Hypersonic Flight in the 21st Century' held in the Center for Aerospace Sciences at the University of North Dakota on September 20th. to 23rd. 1988. The sponsors of this special event were NASA-AIAA-ESA and other international bodies and it was attended by delegates from all over the world. The paper had apparently been included in the proceedings because , although written some 28 years ago, it was considered to be a statement of problems still current and being addressed even today. Bearing in mind the nature and status of those conferences, that is probably the most generous gesture one could ever have and I was touched and honoured by that recognition, and also by the banquet given in my honour at the close of the sessions. All very 'heady' stuff!

Much of the credit for the success of that paper should be shared with my wonderful team in the APG. They were probably the best concentration of design and research brains in the UK at that time. My 'number two', Peter Sutcliffe, had been chief aerodynamicist at Avro Manchester before joining me at APG . A brilliant engineer, he was a most practical and likeable man and a pleasure to have by my side. Because of the importance attached to the APG by Sir Roy and Stuart Davies, I had been able to recruit some of the best people in the Hawker Siddeley Group of companies. These included Peter

Robinson and Vernon Merrick, two other top engineers from Avro, Alwyn Crowther from Gloster Aircraft and many others of that calibre. Dr. Bill Hilton, a well-known and respected engineer from Armstrong-Whitworth, joined us and was in charge of our space activities. Five of the senior ex-Avro Canada engineers who had worked with me on the Arrow were in the group, John McCulloch, who had been our UK liaison man on the Arrow, was brought in as chief of administration, Pat McKenzie, structural engineer on the Arrow was our chief of structural design, Colin Marshall, systems designer on the Arrow, was chief of systems design at APG, Ken Cooke, landing gear specialist on the Arrow was put in charge of landing gear design in APG, and Joe Farbridge, also an engineer on the Arrow, was in our tactical analysis team in APG. John Morris, who had been chief of performance on the Arrow, later joined APG in the same capacity.

Altogether, it was a fabulous team and with better support and recognition from the government organisations it would have been a great asset to British aviation technology.
Unfortunately, the political climate in the UK at that time was anything but encouraging and many promising projects, such as Sir Sydney Camm's supersonic Harrier, the type P1154 etc. were either not taken seriously or cancelled after much work had already been done on them, like the TSR2.
(Politicians in most countries certainly have a lot to answer for!)

There was tremendous rapport within the APG and the general atmosphere is perhaps best illustrated by the certificate which my staff presented to me on my first birthday after the formation of the group.(appendix 2)

A change in career.

Finally, in the Spring of 1962, in poor health and disappointed by

the lack of positive support and interest in our forward-looking studies at APG, I resigned from Hawker Siddeley Aviation, having served over 32years with the Hawker Siddeley Group at Avro Manchester, Avro Yeadon (Yorkshire), Avro Canada at Malton and the APG at Kingston. Unfortunately, partly because pensions had not been started prior to my departure for Canada and the Avro Canada pensions had only just been instituted prior to the 'Diefenplosion', my 32 years only qualified me for what can only be described as a 'peanut pension', bringing in the collosal sum of around $140 per month, or just about enough for one family meal out at todays prices!. Such is fame!!

After my departure, the APG continued for a short time under my replacement, Barry Laight, who had been chief designer at Blackburn Aircraft, but it finally disintegrated and like the Arrow team, was scattered all over the globe. Peter Sutcliffe went to Avco, then I believe to RCA in Boston, finally finishing up at Boeing in Seattle, where he is in charge of new product development. John Morris went to Douglas Aircraft and became one of the senior executives on the DC10. Joe Farbridge went to join the ex-Avro team at NASA, Ken Cooke joined McDonnell-Douglas and Colin Marshall went to North American Aviation.

After a short period of medical treatment and 'soul-searching', I decided that I had better get back to work. On learning that I was 'free', Phil Garratt, the MD of DH Canada had offered me the job of director of engineering at Downsview and since I had a great respect for Phil and many of my old gang from Avro Canada were there, I agreed to go over and spend a few days to check out the situation and the possibilities. On leaving, I told Phil that I would consider the offer very seriously. After a few more days of soul-searching, I finally and reluctantly wrote to Phil, to say that I did not feel that, at that point, I could uproot my family again so soon after they had become established in new schools in the UK and there were

other family matters that would make such a move difficult and I therefore could not take advantage of his very generous offer.

In fact, during my 'agonising reappraisal' of the overall situation in the industry and the trauma of seeing the Jetliner, the Arrow, and our APG work flushed down the drain, I had made a decision that I would never again join a large company, where such things were likely to happen again. From that point on I was determined to chart my own course, to take the gambles and the consequences, based on past experience and my ability to contribute, without depending on political factors or the 'swings and arrows' of establishment behaviour.

While I was still in the process of trying to decide the best way to achieve this, I received a call from Dixon Speas, the President of one of the major consulting firms in the USA. Dixon had been the Avro Canada USA office manager in the Jetliner days. He had heard that I had left HSA and asked if I would be available for some consulting work. A short time later I got a call from the Litton Systems World Trade office in Zurich asking me the same thing, so, in the late Spring of 1962 I established the consulting firm of J.C.Floyd and Associates (the associates came later!) and was off to the races on a new career as a self employed,(or self-unemployed, depending on my luck), aviation consultant. In those early days of J.C.F & Assoc. I operated from a room in our home in Surrey and had no idea at that time that this activity would blossom into one of the most hectic but rewarding periods of my working life.

Anglo-French cooperation and a return to Concorde.

In the meantime, after approaching the United States, Germany and France, BAC had made a collaborative agreement with Sud-Aviation in France to jointly design and build a Mach 2.2. transport. Sud had already been working on a supersonic transport design, which they had designated the Super-Caravelle.

That was the start of the Anglo-French Concorde project and with Dr. Russell and Bill Strang leading the British team of designers and Pierre Satre and Julien Servanty leading the French team, they started what was to become the longest and most expensive task ever undertaken by any aircraft manufacturers up to that time.

I have to say that as I witnessed the changes in design of the aircraft after Bristol and Sud became partners, I was amused (I think that is the word!) to see it change so radically. The original Bristol high wing arrangement, used for the feasibility studies, was abandoned in favour of a low/mid wing. The engines were moved from the top of the wing to the underside. The wing leading edge was pushed forward in a strake along the fuselage and in fact it was now beginning to look like a hybrid between the early Bristol design and the final HSA configuration. (see appendix 3). So perhaps our studies had more influence on the design than is ever admitted. I had better leave the reader to judge that, based on the outline drawings in the above appendix.

By 1964 critics in both Britain and France were working overtime to try to get the Concorde project cancelled, as the measure of that enormous task was realised and the cost of development was rising to what was then considered to be astronomical figures. As the design progressed it became obvious that the research program for this beyond-the-state-of-the-art project was going to take at least a

decade in time and thousands of hours of wind-tunnel and systems testing, before it would be ready for service. It was interesting to note that although the RAE had been impatient with us when we had suggested that we take a few more weeks to resolve the optimum configuration in 1961, it was to be 17 years after we commenced our feasibility studies, before the Concorde went into service!

I had tentatively been approached in late 1964, to once again become involved in the Concorde project, but by that time was involved in a number of urgent studies for Speas and Litton Systems. I was finally contacted by Mr. Handel Davies at the Ministry of Aviation, on behalf of the Minister, Mr. Roy Jenkins and a meeting was set up with the newly appointed director of civil and transport aircraft research and development, Dr. Duncan Cameron.

As a result of that meeting I was asked to carry out a study on the operation and economics of Concorde in service (see letter in appendix 5). I was also asked to monitor the work being done by BAC and BOAC on the same subject. At that time the BOAC planning department were casting some doubt about the viability of Concorde on their routes.

I accepted a contract to carry out this work and was allocated an office at BOAC headquarters at Heathrow. One of the senior staff of BAC, Stuart Matthews, was assigned to assist me and make available all of the necessary data to carry out the task. I was given full access to all of BAC's sales engineering reports and those of BOAC and the aeronautical information service at Pinner, concerning Concorde.

The results of this extensive study, which covered mixed fleet operations of Concorde and subsonic aircraft, were published in December 1965, in summary report no. F/MA/1C titled 'Study of Concord Operating Economics' (the 'e' in Concorde was not used by

the British until 1967, when the British Minister of Technology agreed to add it and please the French!)

My report showed that, provided that the cost per aircraft did not rise appreciably from that then being quoted, that the aircraft was utilised in an efficient manner in the mixed fleet and the sonic boom conditions did not preclude the overflying of certain areas on some sectors, the Concorde could be expected to generate a reasonable profit on most of the routes studied. (This conclusion was based on a Concorde price of $16M being quoted at that time and an average sector fuel price of around $0.15 US per imperial gallon. Both these prices later skyrocketed beyond imagination, increasing the break-even seat price on Concorde to what would at that time have been considered to be astronomical.)

In the report we highlighted the need for further study, to show the effect of the changes likely in certain parameters. We also suggested that much more study of the effects of the sonic boom restrictions should be undertaken.

The report was tabled in a number of meetings to representatives of the airlines, the manufacturers and the government people involved in Concorde and apparently did much to stabilise the situation and silence some of the critics, at least for the time being.

The results of my findings on the economics, lead Dr. Cameron to ask me to carry out further studies on Concorde operations, including scheduling and sonic boom considerations on the routes of other airlines. These continued on an independant basis until the end of 1966, at which time I was asked by the Concorde director-general in the Ministry, Mr. J.Hamilton (later made Sir James Hamilton, based on his work on Concorde), if I would be prepared to devote more of my time to Concorde work and agree to an appointment as Concorde consultant to the Ministry, working through Dr. Cameron's office.

I agreed to that arrangement, but since I was still heavily involved in my work for Litton Systems and other clients, I decided that I had to take on some help and asked one of my ex-APG engineers, Bernard Patrick, who had been my technical assistant at APG, to join me. He was at that time with the Battelle Institute in Geneva, but agreed to move back to the UK and join me in the Concorde studies.

Our reports covered everything from the effects of sonic boom restrictions, the estimated traffic that would probably 'slide over' from the subsonic fleet or be generated by Concorde speed, the best methods of operation of Concorde in a mixed fleet of subsonic aircraft and Concorde, fare structures that would allow Concorde to make a profit and general studies on Concorde operations in the airlines which at that time had options on the aircraft. This involved visits to the headquarters of the major airlines in North America and Europe. We also studied the effect of competitive American and Soviet proposals for supersonic transports.

I attended most of the early joint meetings between the British and French government personnel and the airlines, BAC and Sud Aviation, which later became Aerospatiale, attending as consultant to the British government on the project. The French government had also retained a consultant, Mr. John Balat of ITA and he and I interfaced on some of the joint studies. Appendix 5 includes examples of some of the activity during that period.

In order to carry out these extensive studies in the timescale laid down by MinTech.,I had to broaden our operations and we moved into a suite of offices in Lloyd's Bank Chambers in the centre of Epsom. Other members were added to our staff, including Ken Clarke ex-RAE and Ministry of Aviation. We also had an arrangement with Kingston Technical College to take engineering students for summer occupation and two of them later joined us on the permanent staff. Ray Lohr was one of the graduates that joined us after spending two summers with

us and he was also deeply engaged in the Concorde work. He went on to obtain his Ph.D. and as Dr. Lohr he is now technical director of an electronics company in central England.

While we were continuing with other tasks at the same time, the Concorde work dominated our practice and Bernard Patrick, Ray Lohr and myself spent most of our time on the Concorde studies until the end of 1972, when the political scene was a little clearer on the project. The prototypes had been flying for almost three years and more was known about the performance and potential of the aircraft. It was then felt that any further studies should be left to BOAC and Air France, as they prepared to put the aircraft into service, and our Concorde consultancy finally came to an end.

We carried out so many studies on the Concorde project that I have lost count of the exact number, but going through my files on that period, many of which were destroyed when we moved back to Canada in 1981, I estimate that we must have completed over 60 major studies on the Concorde operations between 1965 and 1972 (see list in appendix 6)

On the conclusion of that assignment we went on to other major studies for the Ministry of Technology, including quiet, reduced take-off and landing aircraft operations (QRTOL designation by Mintech.) and other studies for BOAC and industry. While I managed to keep our staff down to a reasonable level, due to an arrangement that we had with W.S.Atkins and Partners of Epsom, one of the largest consulting firms in the UK, we were able to take on projects which required a lot more manpower than we had available 'in house' at Epsom.

Our clients included a number of Canadian firms, so I never lost touch with Canada, making frequent visits to Toronto and some to Montreal. I was under contract as consultant to Litton Systems in both Canada and the United States from 1962 to 1968 and was UK

representative and consultant to Dominion Aluminum Fabrication Ltd. in Mississauga (now Indal Technologies),from 1974 to 1978. Under the latter contract I was working closely with Mario Pesando, at that time their Director of Product Development, on the helicopter recovery systems. That work required frequent visits to Westland Aircraft in Yeovil and I set up an office in the Old School House in the delightful village of Chilton Cantelo near Yeovil. That period is the subject of a separate story in my write-up of 'Projects Galore'.

After my retirement in 1979 and the closing of the Epsom operation, Bernard Patrick joined Atkins and is now technical director in charge of their mid-east operations. He is a very fine and capable man and I believe that our work on the Concorde at Epsom contributed greatly to the acceptance of Concorde as a viable and productive airplane.

Final comment.

Running through all of our Concorde reports, many of them completed almost a decade prior to the aircraft going into service, was the warning that sonic booms might preclude supersonic flights over land areas, which would drastically affect the economics of the aircraft on all but overwater routes. The Concorde was not designed for economic operation at subsonic speeds. We also warned about the particular sensitivity of Concorde to fuel price, since almost half of the total weight of Concorde on a transatlantic run is in fuel. The wild escalation in fuel price over the years has put Concorde out of reach of all but the wealthy or subsidised passenger and the overland sonic boom restrictions finally resulted in the loss of interest in the aircraft by all of the airlines which originally had options on it, with the exception of British Airways and Air France, the flag carriers of the two countries which sponsored the project.

Having said all that and despite the fact that the Concorde does not fit into the established category of economical transportation, the aircraft has been a magnificent technical success, with few aborted schedules due to technical problems. One can only admire the courage of the British and French 'Concordians', who, in the face of strong opposition in the early days, continued with a project which has revolutionised business travel across the Atlantic and brought incalculable prestige to the nations involved. What a great shame it is that our own politicians and service people did not have the same kind of courage when Canada was leading the world in aviation technology!

APPENDIX 1

Invitation to work on UK SST studies.

This letter is self-explanatory.

HAWKER SIDDELEY AVIATION LIMITED
Richmond Road, Kingston-upon-Thames, Surrey

Telex: 23726
Telegrams: HAWKER, KINGSTON-UPON-THAMES Telephone: KINGSTON 7741

AVCAN/2/SDD/CP

19th March, 1959

J.C. Floyd, Esq.,
Box 241,
Oakville,
Ontario,
Canada.

Dear Jim,

I have just received your letter with enclosures, dated 16th March, in answer to mine on the 15th. By the time you read this, you will possibly have heard from Crawford Gordon what is in the wind. However, to give you a quick appraisal of the position, please note:-

1. By great stroke of luck, Dobbie was here today when I received your letter, and I conveyed to him the gist of the private one to me.

2. At the same time, I have been trying to bring him up to scratch on my proposals for the future technical policy of the Group, starting off with the proposed Supersonic Transport.

3. In brief, the proposal is to set up a central advanced project group at Kingston, directly under my management as Technical Director, to prepare proposals to the Government for this aircraft.

4. If our proposals are attractive both technically and from the point of view of making a reality of a fully integrated Hawker Siddeley Aviation Company, we stand a more than fifty-fifty chance of getting the contract.

5. Dobbie agrees with me that you would be the ideal man to head up this thing, and you may be sure, without going into further detail, that I regard this as the key technical position in the Group, and it would be recognized as such.

6. One cannot go into a lot of detail in a letter, so I am authorised by Dobbie to ask you to get into the first aircraft that you can, to come to the U.K. to discuss the matter in detail with me, and all your own personal financial angles would be cleared at the same time if you felt attracted towards the proposal.

cont. ...

AVCAN/2/SDD/CP

19th March, 1959

7. He is telephoning Crawford Gordon tonight to let Crawford understand the importance that we all attach to this proposal.

Be assured, Jim, that I have read into your private letter all of your inner thoughts and forebodings, and I want to assure you that this is no political malarky, but is a square deal to which I am personally committed, and which I think will be in the best interests of you, Irene and the boys. Please let me know by cable when you are coming!

Yours sincerely,

Dave

S.D.Davies,
Technical Director

APPENDIX 2

Organisation of Advanced Projects Group.

ORGANISATION – ADVANCED PROJECTS GROUP

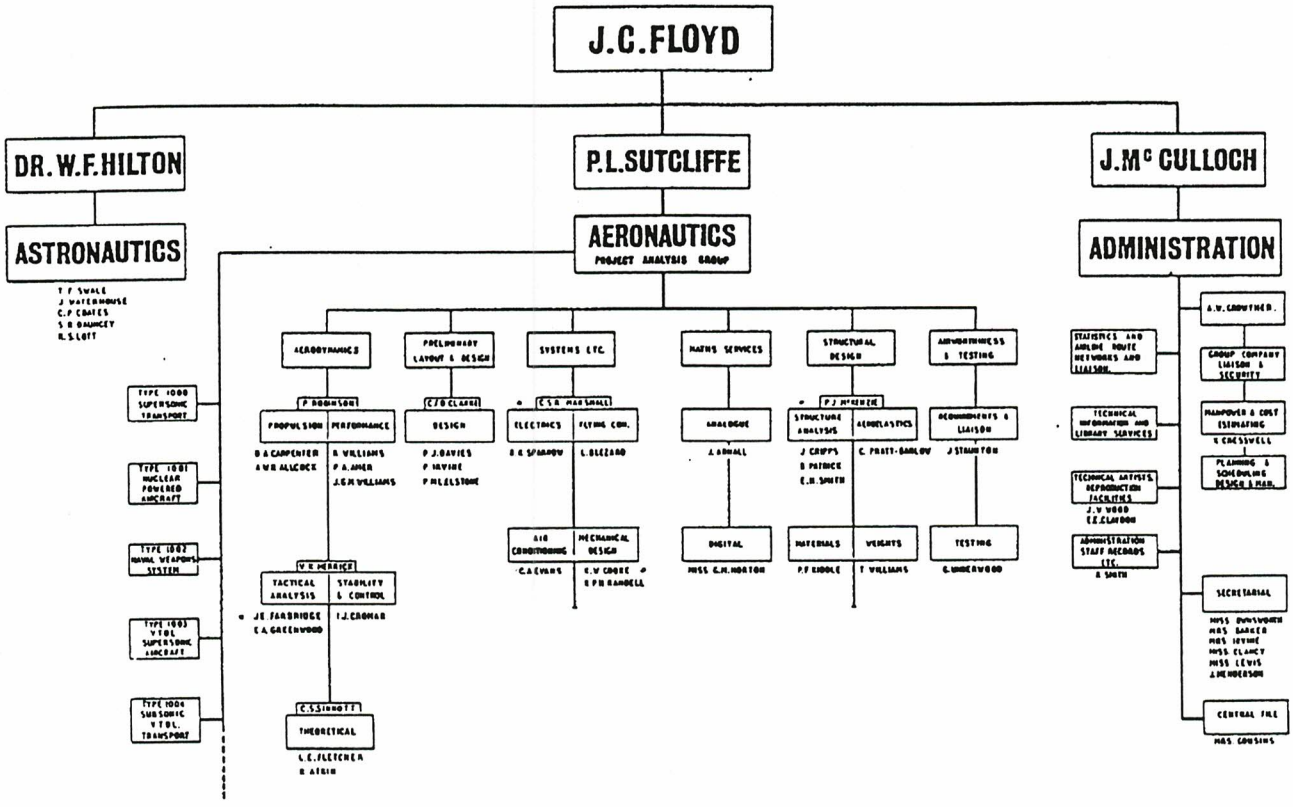


Chart 2. Notes on the Advanced Projects Group.

Historical :

The formation of the Advanced Projects Group was proposed and approved by the Hawker Siddeley Aviation Board of Directors early this year. The Group took up its quarters at Kingston on the 1st.June, 1959 but prior to this the original members spent some five weeks in Canada assimilating the results of the Arrow programme and carrying out initial design studies relevant to the supersonic transport, using the staff still employed at Malton.

Projects under Investigation.

The major job undertaken by the Group since its formation has been the supersonic transport following the work of the Supersonic Transport Aircraft Committee. The results to date of the work carried out on the supersonuc transport are summarised elsewhere in these notes.

Other projects being studied are:-

a) Nuclear powered aircraft carrying a powered bomb. At the present time the majority of the work on this project is being carried out by the Hawker Siddeley Nuclear Power Company in the form of a feasibility study into the design and construction of an airborne nuclear reactor.

b) Naval weapons system study. The Navy have formulated requirements for a strike/fighter aircraft to follow the NA.39. We have certain doubts as to the practicability of a single aircraft combining both strike and fighter features and are therefore carrying out tactical studies into the overall problem of the defence of the fleet. From these studies we hope to be able to formulate our suggestions for the appropriate aircraft.

c) Supersonic VTOL aircraft. As part of the feasibility study into supersonic transports we are evaluating the VTOL supersonic transport as suggested by Dr.Griffiths of Rolls Royce.

d) Subsonic VTOL transport aircraft. In conjunction with Armstrong Whitworth we are studying the use of the Argosy as a VTOL operational research aircraft by modifying it to incorporate Rolls Royce lightweight lifting engines in the booms.

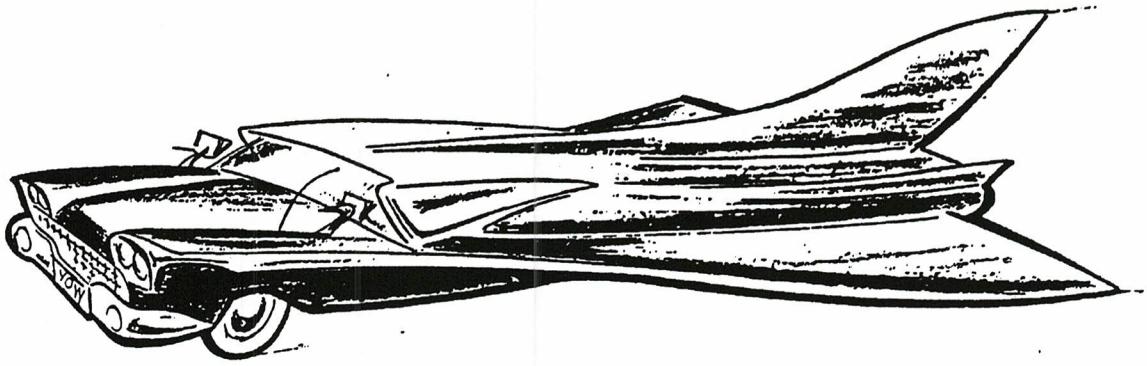
Astronautics

A small team has been formed to study the various problems of space travel, in particular orbital and re-entry vehicles.

Recruitment

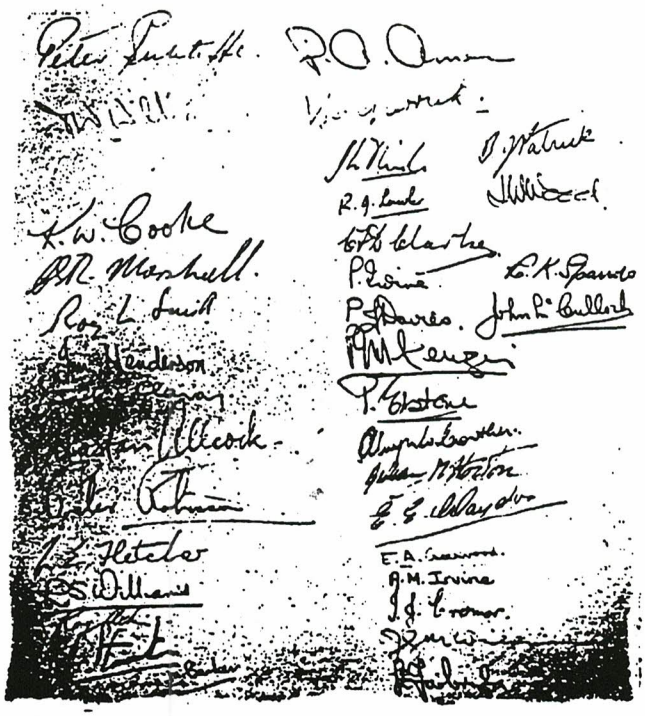
The original target for the A.P.G. was a total of 60 people by the end of September, 1959. Although we have had generous co-operation from Group Companies it was found to be impossible to recruit at this rate and the actual figure was 35 at the end of September. The present level at the 1st December is 50, but based on the replies to recent advertisements we expect to increase the staff at a steady rate up to a total of 83 by the end of July 1960.

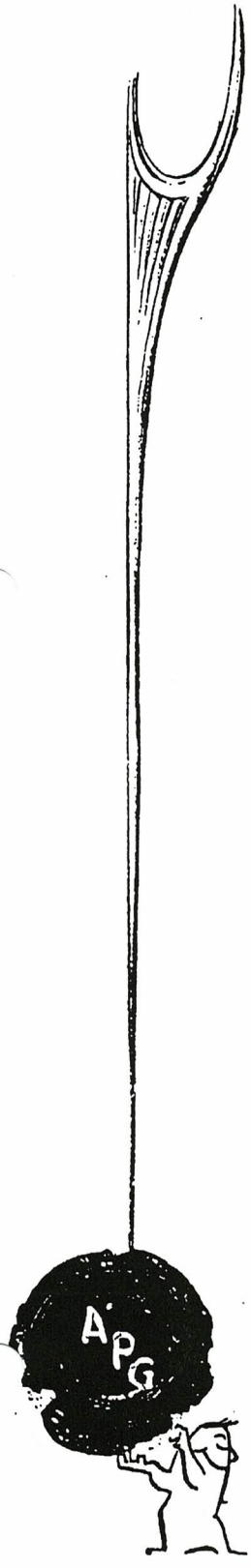
Up to date, the complement has been recruited from the following sources:- Gloster's (8), Armstrong Whitworth (8), AVRO Manchester (4), AVRO Canada (5), Hawkers (3), A.T.S. (1), Orenda (1), Bristol Siddeley (1), other sources (19).



"To integrate or not to integrate
that is the question ....
whether it is nobler in the mind
to suffer the slings and arrows
of outrageous compromise or
to take up arms against a
sea of troubles, and by opposing,
end them ...."

Many happy returns to 'Jaycee'
from the A.P.G.





20th OCTOBER 1959

APPENDIX 3

Extracts from joint feasibility studies.

HAWKER SIDDELEY AVIATION LIMITED

ADVANCED PROJECTS GROUP

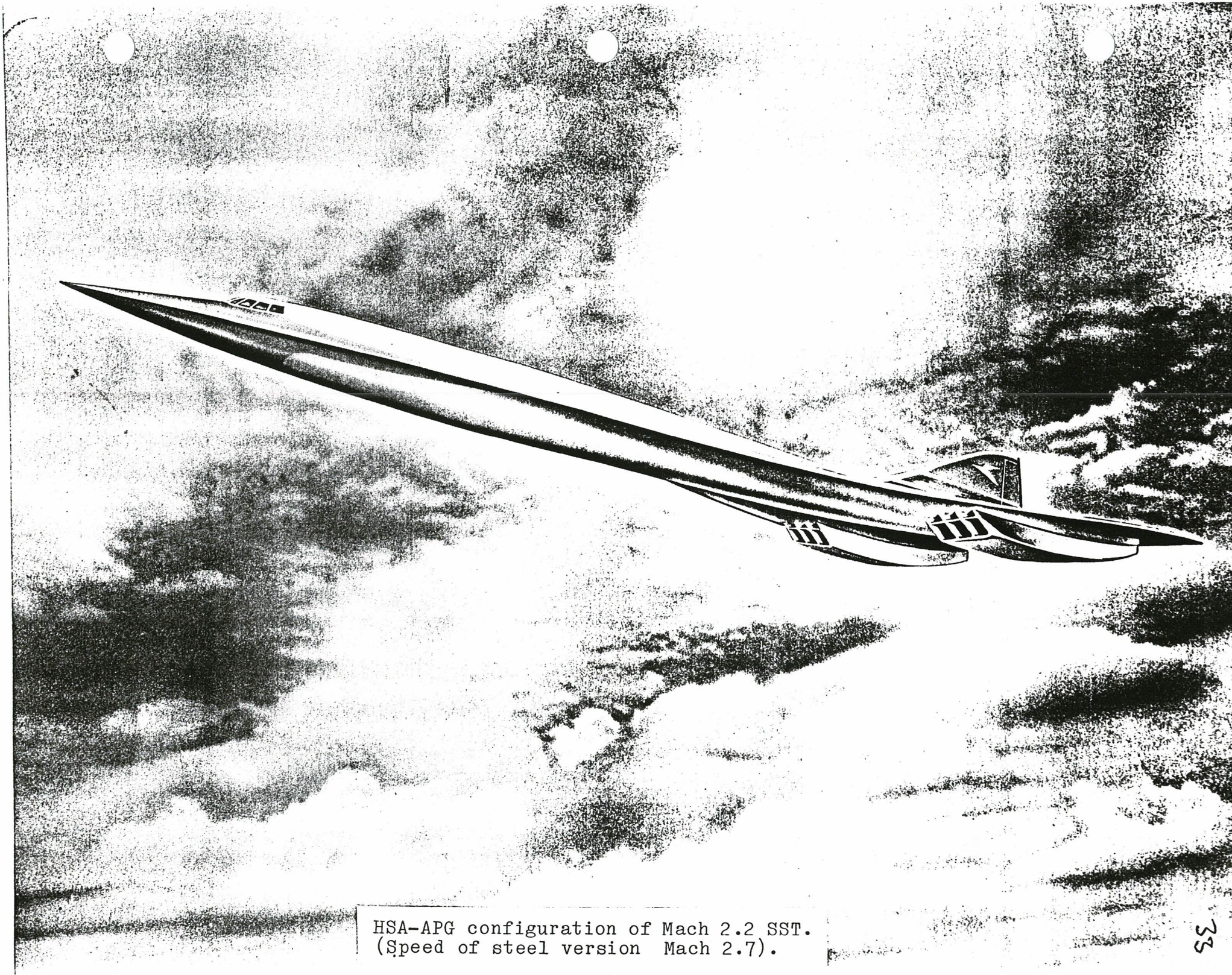
PROGRESS SUMMARY ON FEASIBILITY STUDY OF SUPERSONIC TRANSPORTS

1st. Dec. 1959

PRESENTED TO THE GROUP DESIGN COUNCIL
10th. Dec. 1959

REPORT No. 1000/2302

COPY No.



HSA-APG configuration of Mach 2.2 SST.
(Speed of steel version Mach 2.7).

CONTENTS

In addition to this brochure there are a number of separate appendices which contain the individual summaries of the detailed work on the various aspects of the study. These will be made available on limited circulation for perusal by the specialist on the subject covered.

LIST OF APPENDICES

INTRODUCTION

This report is a summary of the results of a study carried out for the Ministry of Aviation by the Advanced Projects Group of Hawker Siddeley Aviation Ltd. on the feasibility of the United Kingdom embarking on the design, development and manufacture of a transatlantic supersonic transport.

For convenience, this brochure is limited to a presentation of some of the major issues involved in the study, and the various appendices which supplement the brochure contain the individual summaries of the detailed work on the pertinent aspects of the study, for consideration by the specialists on the subjects covered.

The main objectives of the study are to establish:–

a). The best size and speed of the aircraft for economical transatlantic operation, bearing in mind its use on secondary routes.

b). The cost of financing such a project and the possibilities of a reasonable return on investment.

c). The management, facilities, and effort required to carry out the programme.

In the conduct of this study valuable assistance has been provided by the individual Hawker Siddeley Group Companies, the various Government Establishments, and the engine and accessories manufacturers, and the A.P.G. takes this opportunity to acknowledge this assistance and express its appreciation.

The programmes outlined in this report assume that the Supersonic Transport project is carried out entirely in the U.K. The possibilities of collaboration with other countries are outlined in Appendix 12.

Chart 3. Flow Diagram of Joint Feasibility Study

A considerable amount of work had already been done on the supersonic transport prior to commencement of the feasibility study, and in fact, prior to the formation of the Advanced Projects Group. The actual date of commencement of the study was early in April, when it was decided to allocate 15 to 20 of the engineers who had become available at Avro in Canada, due to the cancellation of the Arrow, to carry out an extension of the study of the long range aircraft recommended by the S.T.A.C. At the same time they were extracting all of the pertinent information from the engineering and flight testing on the Arrow, for use on the 120 seater, Mach 1.8 transport. On the basis of this early work and the weight and cost studies carried out by the R.A.E. subsequent to the issue of the S.T.A.C. report, it appeared that this aircraft would weigh in the order of 550,000 lbs. gross, and have a very small percentage payload and consequent high operating costs.

From that datum, parametric studies were carried out to check the effects of change in payload from 90 to 150 passengers and changes in speed. This could be considered as Stage 1 of our studies. The family of aircraft considered were all heavy and costly and, in fact, the costs were not very different from those contained in the S.T.A.C. report. These studies highlighted a number of points indicating the possibility of considerably reduced weight, which are covered in detail later in this report.

At this time we became exposed to some of the Lockheed philosophy of designing a smaller aircraft, since while the S.T.A.C. had concluded that the larger aircraft carrying the highest possible payload must be the most economical, and on the basis of direct operating cost alone this is probably true, Lockheed had produced a report to show that not only could the smaller aircraft achieve a higher productivity in passenger miles per hour - partly due to increased traffic density induced by more frequent schedules, but the amortisation of the lower development costs for a smaller aircraft over the larger number of aircraft required, reduced the first costs and consequently resulted in reduced operating costs.

For the next stage in our studies, therefore, we decided to take a look at the smallest aircraft which could do a useful job, since this would require the minimum investment and possibly show gains in operating economy.

The payload was established at 80 tourist passengers, and the speed at Mach 2.2, and the range was limited to a one-stop transatlantic operation. We felt that this smaller aircraft could be put into operation quicker than the larger aircraft previously considered, and the range limitation could later be removed by development so that full transatlantic operation would still be available in reasonable time and ahead of the competition. At this stage we also carried out a more detailed study of the structure and systems, since the payload percentage was so small that an increase in the weight of any particular system could cut the payload down considerably, which made it necessary to carry out more than just a cursory and statistical check of the systems.

Most of this work was carried out during the four months prior to September 1st., and at that date we were well into the design of the smaller aircraft which had a gross weight for the one-stop transatlantic operation of about 210,000 lbs. with development to non-stop at about 250,000 lbs.

Joint Feasibility Study

At the beginning of September we were asked to do a joint feasibility study of a supersonic transport with Bristol Aircraft Company. Up to that time Bristol had been doing detailed studies of a 110 passenger, Mach 2.2 aircraft, with the full transatlantic stage length. In order to conserve manpower on our joint studies it was agreed that all further work should be done on a common configuration. The datum chosen was a payload of 100 passengers, speed of Mach 2.2, and the full non-stop transatlantic capability. This aircraft would be used as a basis on which to continue our parametric studies, on the effects of different payloads, speeds, ranges, etc. Having agreed on a basic specification we attempted to agree on a common aircraft configuration. Up to that time H.S.A. had been concentrating on what could be called an integrated design, similar to the early R.A.E. configuration, whereas Bristol had been concentrating on a high wing finite fuselage arrangement. After much discussion, including various sessions with the R.A.E., it was decided that sufficient information did not exist at the present time to prove the advantage of one configuration over the other, and it was decided to continue work on the two configurations, which would in turn supply two solutions to the common specification, both of which would be feasible.

Since it was felt that both configurations would do the job, and the weights and general performance of the two aircraft were approximately equal, the feasibility study should not be adversely affected by the continuation of the two distinct solutions.

Mach 2.5 to 3 Aircraft

For the studies on the higher speed aircraft at Mach 2.5 to 3 it was, however, decided that since neither Bristol nor ourselves had previously carried out detailed work on this, we would agree on a common specification and configuration on this aircraft. Various configurations are being considered for the higher speed steel aircraft, and this is the point reached at the date of issue of this report.

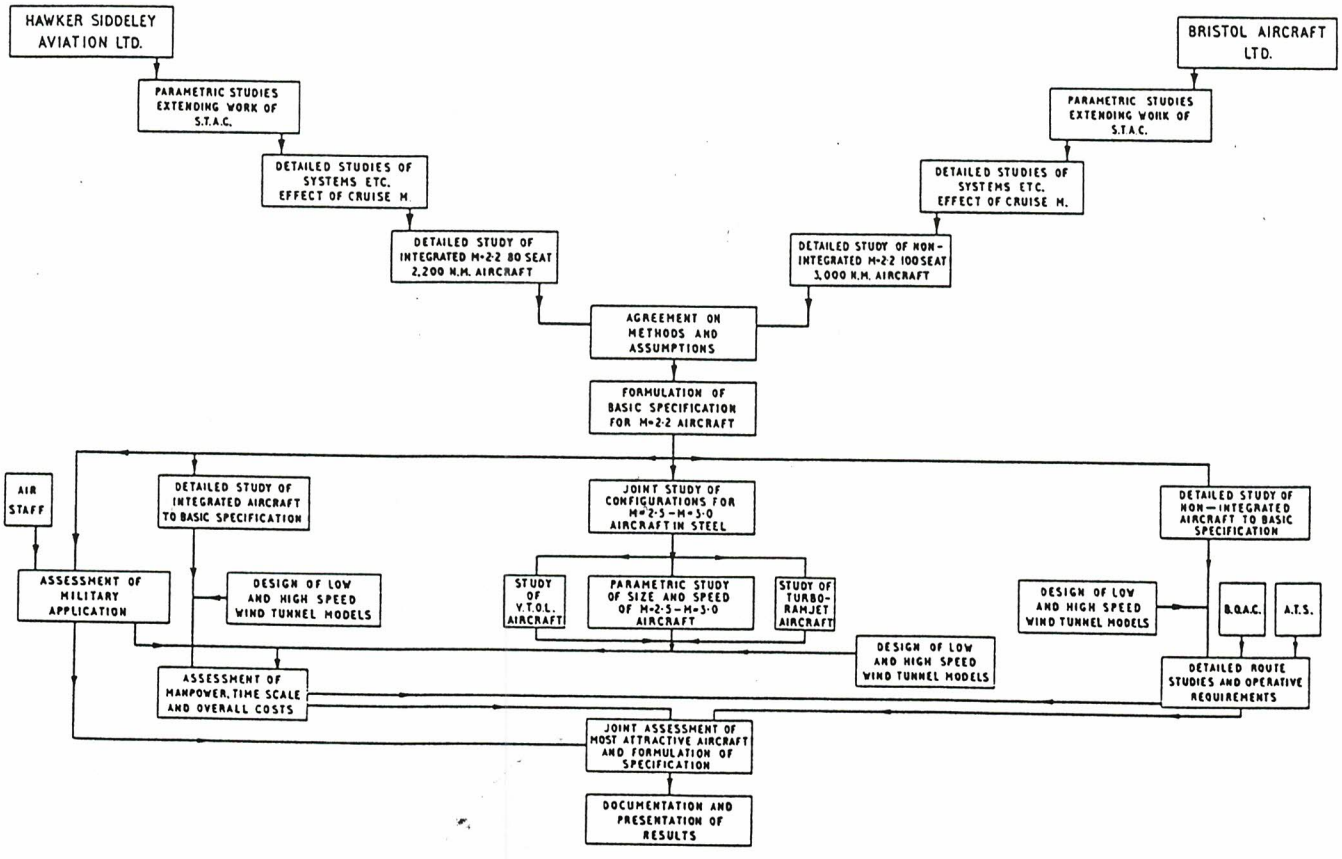
Chart 3 shows the work flow envisaged for the complete feasibility study.

Chart 4 shows in greater detail the timing of the various phases.

We consider that we are at this time a little less than halfway through the study, and that by the end of January 1960 we will begin to correlate all the technical data and be reaching firm conclusions on the feasibility study towards the beginning of March. On that basis it is anticipated that by March 31st we should be able to present the results of our study to the Minister of Aviation.

3

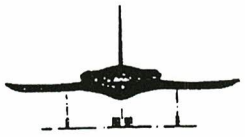
FLOW DIAGRAM OF JOINT FEASIBILITY STUDY



CONFIGURATION COMPARISON

(At start of joint feasibility studies.)

HAWKER SIDDELEY



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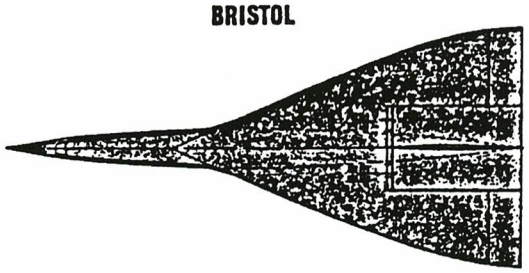
LENGTH - 185 Ft
HEIGHT - 41 Ft

BRISTOL

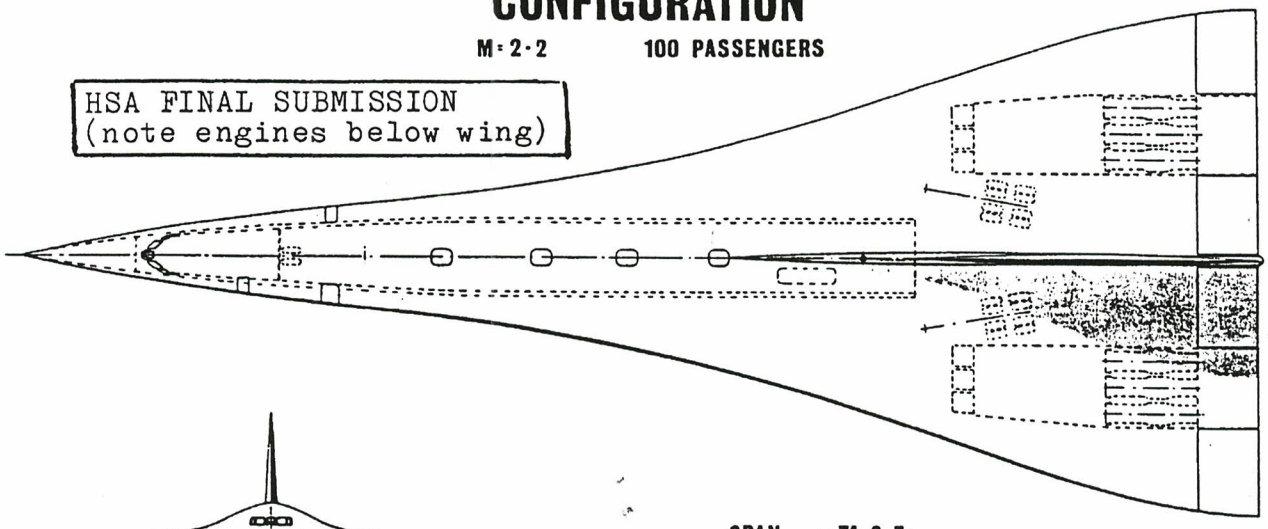


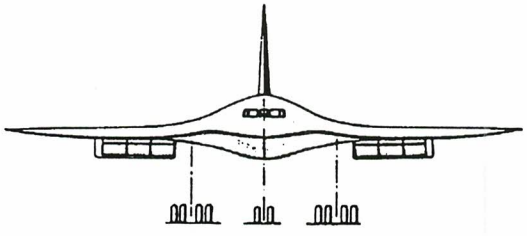
SPAN - 80 Ft
LENGTH - 171 Ft
HEIGHT - 35 Ft

CONFIGURATION

M = 2·2 100 PASSENGERS

HSA FINAL SUBMISSION
(note engines below wing)





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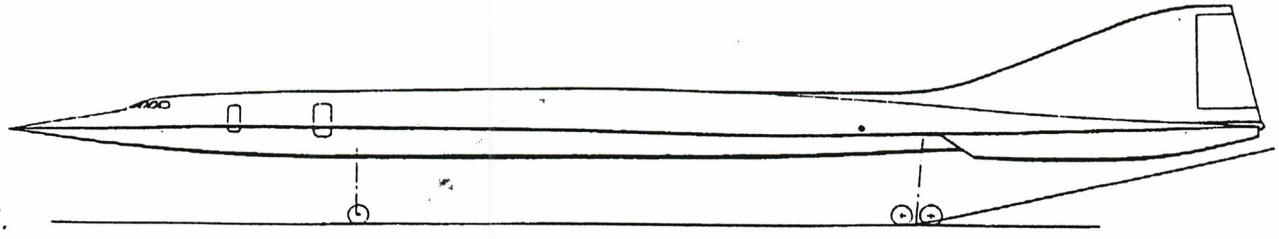
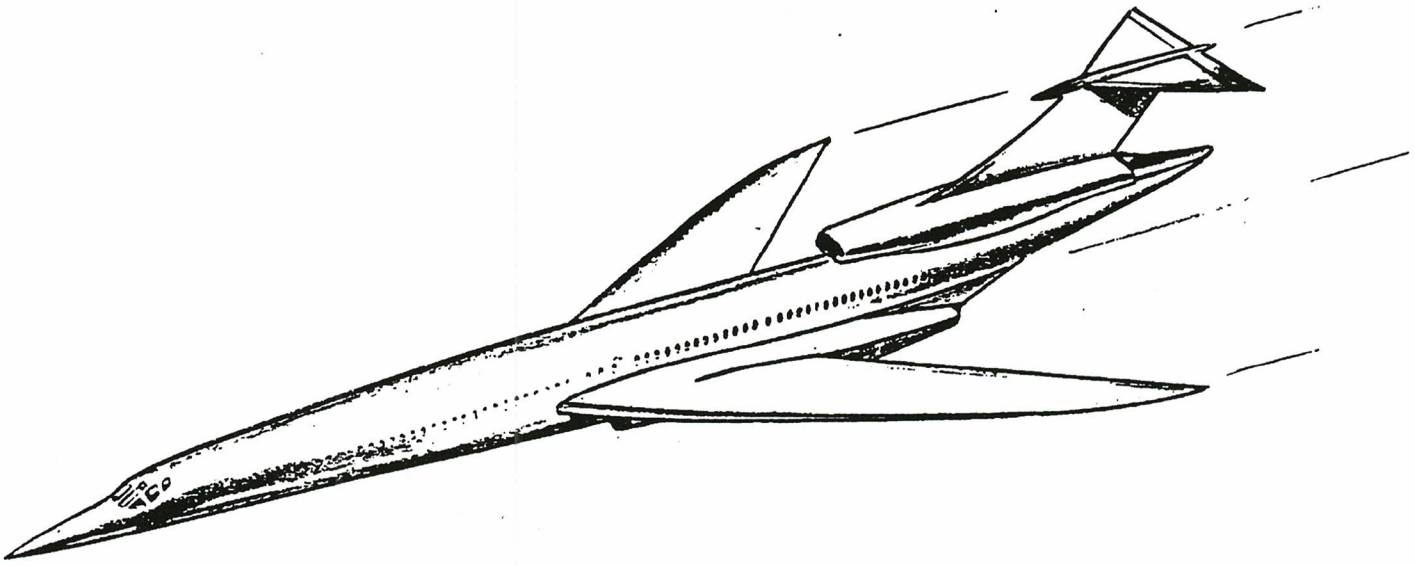


APPENDIX 4

Project 1011, the 'no-boom' supersonic airliner.



SECTION 1

1 INTRODUCTION

This brochure presents the results of a study of two versions of a Transonic Transport, Type 1011, by the Advanced Projects Group of Hawker Siddeley Aviation. Version A is a Transcontinental aircraft of medium to long range and Version B has full Transatlantic capability.

It has been generally assumed that the next major advance in the long range civil transport field will be the introduction of the Supersonic Transport cruising at two to three times the speed of sound. However, recent work has suggested that such an aircraft may be limited to over-ocean routes due to sonic boom considerations which may limit its operation to a few of the world's larger airlines. The supersonic transport becomes very uneconomic, due to increased time-dependent costs, if it is restricted to subsonic speeds overland.

It appears, therefore, that there is a market for an aircraft specifically designed to fly as fast as possible without producing a sonic boom, and that this aircraft should have a wide appeal to medium and long range operators whose route networks contain a large proportion of overland stages. Such an aircraft would cruise at about 660 knots TAS (i. e. M=1. 15 in the stratosphere).

This aircraft, which can be shown to be economically competitive with existing subsonic jet transports, would then be in a unique position regarding future competition. It could not easily be outmoded, as were the piston-engine and turbo-prop transports by the subsonic jets, and as the M=2 supersonic transports may be, by the later M=3 version, since it will be cruising at the maximum speed that will probably be allowed over land areas for large aircraft in the foreseeable future. It could only be made obsolete by a later version cruising at the same speed but with such an increase in efficiency (aerodynamic, propulsive, etc.) that the amortisation of the new design and development costs are offset in the operating costs. This would be a very difficult task, and therefore, the M=1. 15 civil transport could be expected to have a long operational life before being superseded.

The basic aircraft, Version A, has been designed to carry 160 economy class passengers plus freight over a stage length of 2, 500 n. m. with typical Airline allowance for Transcontinental aircraft and it has been estimated that there should be a potential world market for between 400 to 500 of this version of the aircraft. This version is also capable of flying the Transatlantic route at a reduced speed of M=0. 95.

The Transatlantic Version B will carry 160 economy class passengers plus freight across the Atlantic routes at M=1. 15 with typical Airline allowance for this route. Version B represents a development stage beyond the Transcontinental version, obtained by installing extra fuel tankage, which provides the aircraft with a stage length of 3, 850 n. m.

The performance of Version B is indicated in red throughout the brochure, where this is different from the basic aircraft.

The flexibility which is obtained by the use of variable geometry also provides an ideal medium for use in various military roles, for instance as a weapon carrier, the excellent endurance characteristics with wings swept forward gives the aircraft good stand-by capability, and with wings swept back the penetration speed can be considerably increased beyond that to which the aircraft is restricted for Civil use because of the sonic boom.

Details of the military uses are not included in this brochure for security reasons, but are the subject of a separate brochure.

SECTION 2

2 CHOICE OF CRUISING SPEED AND CONFIGURATION

2.1 Reasons for choosing M=1.15

In recent months there has been much discussion about the future of the supersonic transport and its operational problems, and one of the greatest operational problems appears to be that of the sonic boom.

The sonic boom generated by a typical supersonic transport during cruising flight was initially considered to be inside the anticipated limits of public acceptability. However, it has been found that the calculations on which this conclusion was based were in error and that when the correct theory is used the calculated boom levels are, in fact, two to three times higher than those previously assumed, (see Fig. 1.) There are strong indications that the boom from the typical supersonic transport will be more intense than the public will tolerate and that the supersonic transport may have to be restricted, on overland flights, to speeds below which no sonic boom would be heard on the ground.

On a standard day, the maximum speed at which an aircraft can fly without a boom being heard on the ground corresponds to 660 knots T. A. S. or to a Mach number of 1.15 in the stratosphere, (see Fig. 2.) If, however, a supersonic transport with a design speed of M=2.2 is restricted to a Mach number of 1.15 overland, then its productivity is nearly halved and a very large increase in direct costs results on the overland segments. It would be a very uneconomic aircraft to operate on routes which involved appreciable overland segments and because of this it is anticipated that the large M=2 - M=3 supersonic transport will be restricted to a strictly over-ocean role.

For overland operations, the sonic boom is therefore likely to restrict the speed development of civil transports to M=1.15, and this speed has been chosen for the studies discussed in this brochure.

2.2 Choice of configuration

It is generally agreed that to obtain good aerodynamic efficiency at M=1.15 a mean wing sweep of about 55° plus a fairly low aspect ratio will be required. Unfortunately the low speed lift and handling characteristics of this sort of wing are poor. The maximum lift could be improved by flap blowing but impractically large quantities of air would be required to get a lift capability approaching that of the current subsonic jet transports. If landing speeds are to be kept down to those of current subsonic jets then a large increase in wing area would be required, with a consequent weight penalty. Satisfactory low speed handling characteristics would be very difficult to achieve and may only be made possible by installing a completely automatic flight control system.

There is no doubt that variable geometry in the form of variable wing sweep provides an answer to the above problems. By unsweeping the wings to about 30° sweep the aircraft would be converted to a configuration very comparable to that of existing subsonic jets and would therefore have similar lifting capability and handling characteristics.

Another important advantage of variable geometry is its ability to provide a very efficient aerodynamic shape at subsonic speeds.

Our studies have indicated that a wing and fuselage designed for optimum efficiency at M=1.15 (660 kt.), with a wing leading edge sweep of 58° and an aspect ratio of 3.5, could be transformed by variable geometry into a highly efficient subsonic configuration having 31° sweep and an aspect ratio of 7.5. Furthermore, a ducted-fan engine chosen for high efficiency at M=1.15 is not far from the optimum at subsonic speeds.

FIG. 1

BOOM DUE TO TYPICAL SUPERSONIC TRANSPORT

M = 2·2 W = 300,000 LB

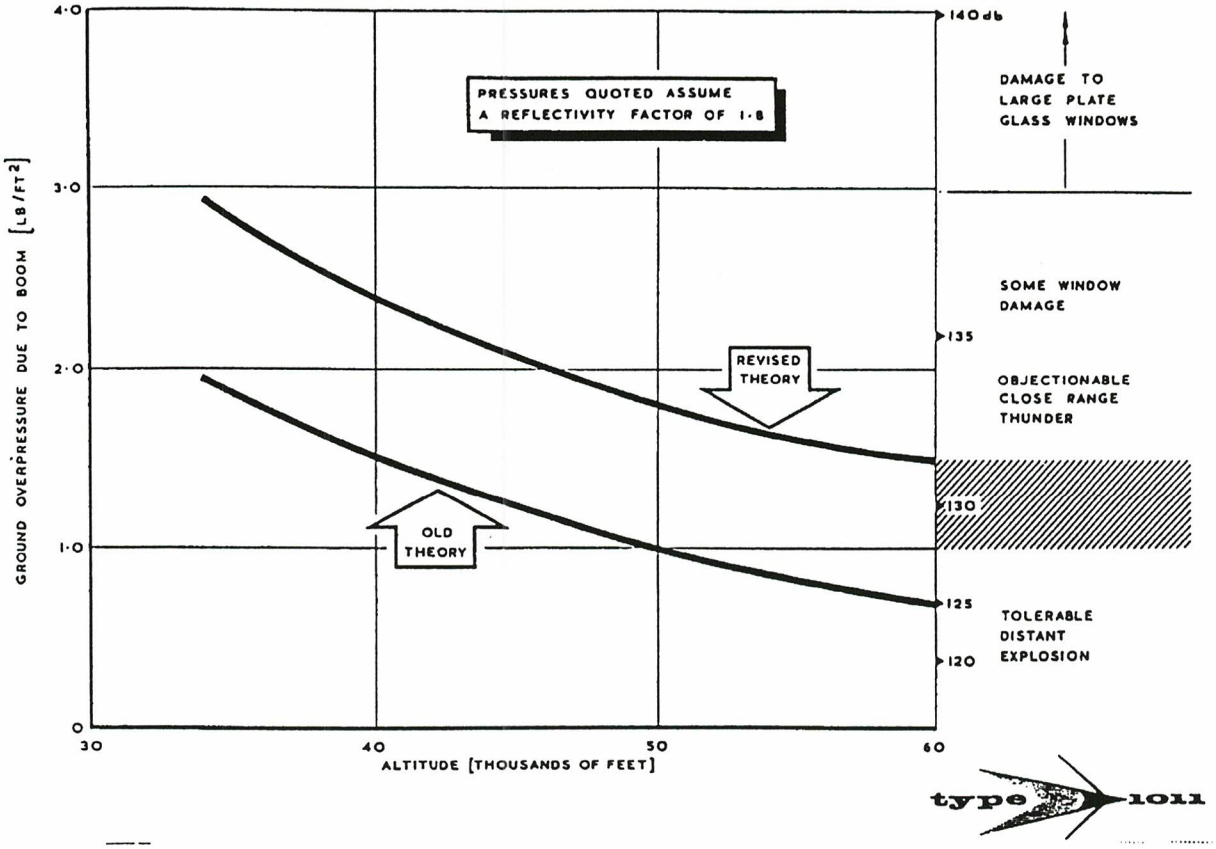


FIG. 2

SONIC BOOM BOUNDARY

I.S.A. CONDITIONS

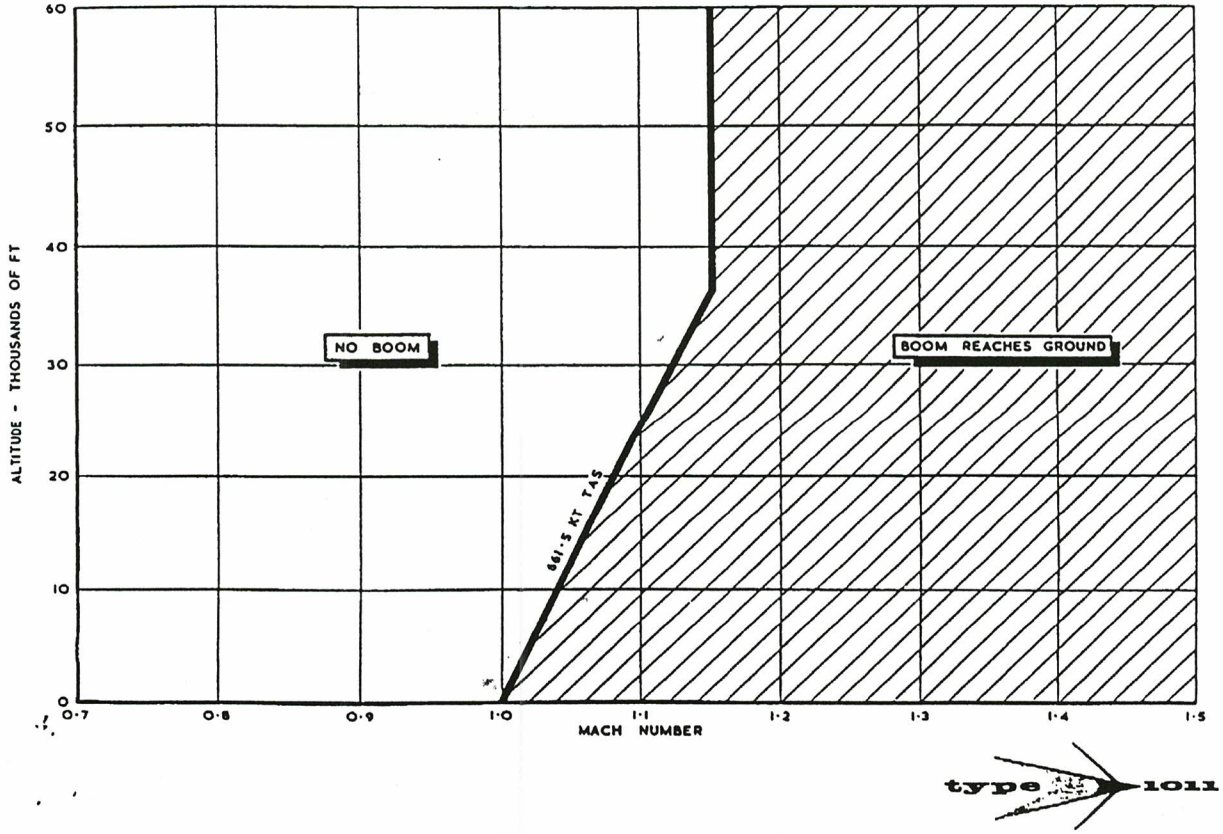
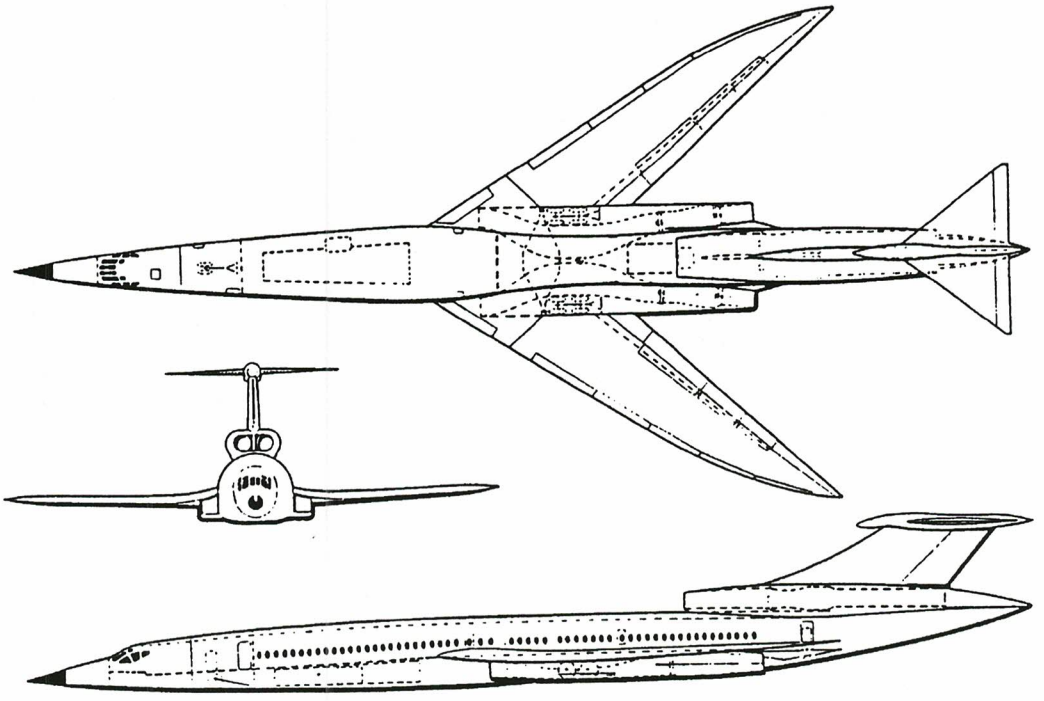


FIG. 3

GENERAL ARRANGEMENT
WINGS SWEPT

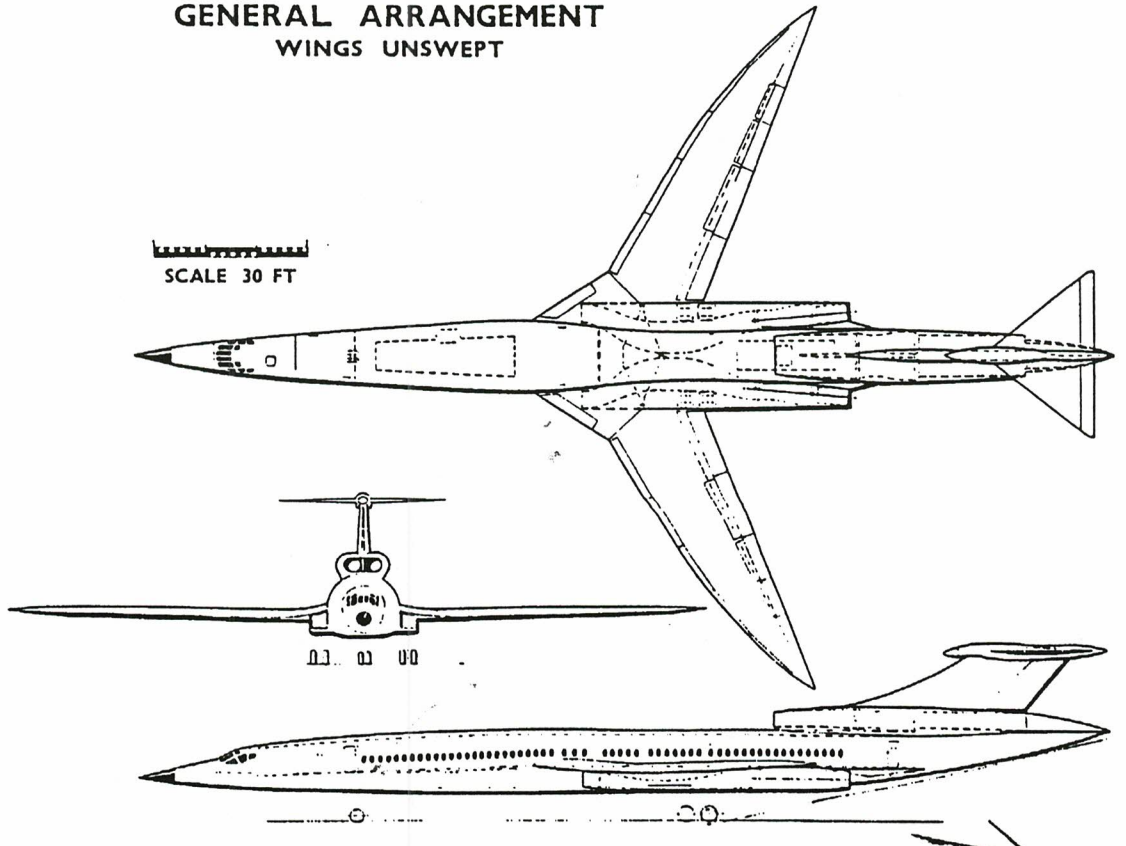


This design study was completed in mid-1961. The aircraft could have been flying by 1966 and in service by 1969.

type 1011

FIG. 4

GENERAL ARRANGEMENT
WINGS UNSWEPT



type 1011

Aide-memoire on Transonic Transport - Project 1011

Cruising speed M = 1.15 - established by Sonic Boom considerations. (No-boom speed for overland operations).

Range - whatever customer wants, but datum chosen for comparison 3,000 statute miles, on assumption that Transatlantic served by M = 2-3 Transports.

Size - 160 passengers + 5,000 lb. freight. This is also size which would match military requirements for weapon carrier, and troop transport. (140 fully equipped troops for 4,000 n.m. at M = 1.15 or 5,000 n.m. at M = .95).

Developments - it does not require any major breakthrough in design.

a) Structure. Since not operating at high temperature no new material problems, and can concentrate on variable geometry.

b) Systems. No new techniques required.

c) Aerodynamics. Mainly refinements on present knowledge to achieve optimum performance at transonic speed. Much work but fewer risks than M = 2-3.

Handling - landing and take-off will not require new pilot techniques or traffic control changes, since with wings forward it is not a 'hot' aircraft and approach speeds and circuit speeds are similar to present large jets.

Main advantages -

1) Unique flexibility of operations at various speeds. Can trade speed for range by changing wing sweep.

2) Cruising speed probably fastest that will be allowed over land areas for large aircraft in the foreseeable future, which puts it in a unique position regarding competition since there will not be the terrific pressure for speed development which has made aircraft types obsolescent in the past.

3) Long operational life because of 2) and will allow Manufacturers and Airlines to concentrate on important things such as development of power plants, reduction in seat mile costs etc.

Market - Appears to be world market (including U.S.) for about 400 - 450 Civil Transports of this size (neglecting Transatlantic). Additional Military market for unspecified numbers of these aircraft. The weapon carrier version will have a supersonic dash capability up to speeds of M = 2.

J. C. Floyd.

1961 — Advanced Projects Group.
HSA. Kingston / Surrey.

APPENDIX 5

Examples of Concorde correspondence.

Short list of some of the main participants with whom we worked or had contact on the Concorde studies.

(Note; The job titles were those applicable at the time.)

British Government.

(Ministry of Aviation--Ministry of Technology--Dept.of Trade & Ind.)

* Sir Morien Morgan	Head of STAC.
* Sir James Hamilton	Director General Concorde.
Mr. Handel Davies	Deputy Controller of Aircraft.
Dr. Duncan Cameron	Director, Concorde Research and Development.
Mr. Bob Collingbourne	Dr. Cameron's Staff
Mr. Laurie Courtney	"
Mr. Charles Naylor	"

British Aircraft Corporation.

Sir George Edwards	Managing Director
* Sir Archibald Russell	Technical Director, Filton Division
Dr. Bill Strang	Chief Engineer, "
Mr. Pat Burgess	Director of Sales "
Mr. Mick Wilde	Engineering Manager, Concorde.
Mr. Ray Cooper	Technical Sales Manager
Mr. Alec Symon	Sales Engineering Manager
Mr. John Isles	Assistant Sales Engineering Manager
Mr. Stuart Matthews	Technical and Performance Manager.

British Overseas Airways Corporation.

Mr. Charles Able	Chief Engineer
Mr. Clifford Jackson	Assis. Chief Engineer
Mr. Winn Bray	Director of Planning
Mr. Alec Finlay	Manager, Fleet Planning
Mr. Eric Hall	Manager, Route Marketing
Mr. Alan Beaves	Manager, Business Travel

Rolls Royce.

* Sir Stanley Hooker	Technical Director, Bristol Engine Division.

ITA.

M. John Balat	Consultant on Concorde to French Government

* Note; Knighthoods were later bestowed on these gentlemen mainly because of their involvement in the Concorde project.

From: Dr. D. Cameron, Director of Civil and Transport Aircraft Research and Development

MINISTRY OF AVIATION,
ST. GILES COURT,
1-13 ST. GILES HIGH STREET,
LONDON, W.C.2.

Ref. F.9/3/65

5th August, 1965

Dear Mr. Floyd,

CONCORD
Operating Economics

At our discussion of 16th July I promised to let you have an outline of the task we have in mind for you.

As I explained, the Anglo-French Working Party in this field has so far confined itself to a mainly arithmetical formula comparison of the Concord and the Boeing 707 operating costs. It has, of course, been recognised that a more detailed and penetrating study is required aimed at producing an authoritative assessment of these factors, given the likely deployment of the Concord over typical airline route networks, which will, or could have, an influence on the aircraft's operating economics. Some examples of these factors are stage lengths likely to be flown, the associated block times and the resulting annual utilization of the aircraft. Possible restrictions due to sonic bang are another important aspect to be taken into account.

As BOAC and Air France should be two of the first airlines to take delivery of Concord, the deployment of the aircraft in service with these airlines should be studied first. But it has also to be remembered that Pan American are due to take 6 out of the first 18 aircraft pari passu with BOAC and Air France and the study should not therefore be confined to the two national airlines' network only. Account has also to be taken of the change, over a period of time, of the numbers of supersonic and subsonic aircraft in the fleets of airlines likely to be operating Concord.

Part of the task will be to monitor the work and studies which are already being done by BAC and Sud, and by BOAC and Air France. At the same time you will no doubt wish to undertake some independent studies yourself.

The target is that the Anglo/French Working Party should be given by BAC/Sud and BOAC/Air France, and yourself, sufficient information on which to submit by the turn of the year to the Concord Management Committees a statement on overall Concord operating economics.

I should add that the French are also considering the employment of a consultant, and it may be that you will be asked to collaborate with him.

I would be grateful if you would let me have a quotation for this task - your report to be submitted by 31st December - giving a breakdown of your costs, with supporting data in justification.

Yours sincerely,

D. Cameron

J. C. Floyd, Esq., P.Eng., F.R.Ae.S., F.C.A.I.,
Hon.F.C.A.S., A.F.I.A.S., A.M.C.T.,
"Avia",
Winchester Close,

Formal invitation to work on SST again.

From: C.S. MICKLEWRIGHT, Chief Administrative Officer Professional Staff Management

48

L.H.9B

Telegrams: Avmin, London, Telex.
Telex No.: 22110/22119.
Tel. No.: Temple Bar 1207.
Extn. 1681

Your Ref.

Any communication on the subject of this letter should be addressed to:

THE SECRETARY

and the following reference quoted:

MINISTRY OF AVIATION,
Room 414,
SAVOY HILL HOUSE,
SAVOY HILL,
STRAND, LONDON, W.C.2.

3rd. November, 1966

HC/256/03

Dear Sirs,

I refer to your appointment as Consultant to Dr. Cameron our Director of Civil and Transport Aircraft Research and Development in accordance with the terms set out in our letter of 7th September 1965.

It has now been decided that further study is necessary and I am therefore writing to invite you to undertake the following work on a consultancy basis.

A. A preliminary study of the development of the U.S. S.S.T. on a typical airline network and the preparation and submission of a report to Dr. Cameron by 31st December, 1966.

B. A study of the effect of sonic bang limitation on the T.W.A. network.

Messrs. J.C. Floyd & Associates,
'Avia',
Winchester Close,
Esher, Surrey.

Telegrams: Britair Bristol Telex *Telex: 44163*

British Aircraft Corporation (Operating) Limited

FILTON DIVISION

G.P.O. BOX No. 77

FILTON HOUSE - BRISTOL

TELEPHONE - BRISTOL 693831

Our ref: *Ext:*

C B122

November, 1966.

J.C. Floyd Esq.
Avia,
Winchester Close,
Esher.

My Dear Jim,

I was delighted to hear from Cameron's Directorate that they were utilising your services once again in aid of Concorde, and about this we are pleased. I am sure Russ would expect me to offer to you all the facilities which we have available to assist in your analyses. Please do not hesitate to call upon us if there is anything you require.

The one point I did raise, and I have raised it before with Dr. Cameron, is that whenever you wish to discuss specifically Concorde with a specific Concorde customer, as a matter of business ethics we would wish to know.

Stuart Matthews sends his kindest regards and we repeat that if there is anything we can do, either in the shape of labour or facilities, please do not hesitate to let me know.

With kindest personal regards,

Very Sincerely,

For. Bucknall

TRANS WORLD AIRLINES

605 THIRD AVENUE · NEW YORK, NEW YORK 10016 · U. S. A.

Office of the
VICE PRESIDENT
PLANNING AND RESEARCH

December 5, 1966

Mr. J. C. Floyd
J. C. Floyd & Associates
"AVIA"
Winchester Close
Esher
Surrey, England

Dear Jim:

I clearly remember in depth the early and mid 1950s association with yourself, Fred Smye, Crawford Gordon, Dixon Speas, and Howard Hughes. I have had numbers of occasions to think back on those interesting, difficult times on account of the Hughes - TWA litigation which is still proceeding. I believe you were present with Mr. Hughes and myself when a fairly historic purchase decision was made in less than five minutes. It involved the eventual procurement of nearly $60 million worth of powerplants.

Either February 20 or 24, 1967 would be agreeable to discuss Concorde sonic boom route analyses. At that time we could explore the feasibility of our supplying information you would need and the depth to which you plan to go with the study. The results could be of considerable interest to us.

Just let me know which date you prefer and I'll hold it open. Looking forward to seeing you once more,

Sincerely,

R. W. Rummel

RWR:am
cc: Messrs. N. R. Parmet
R. V. Radcliffe

TS/6/059
TS/3/08

The effect of sonic boom restrictions on Concorde operation

You are invited to attend a presentation on the effects of some possible sonic bang restrictions on Concorde operation on world-wide routes.

The presentation will be given in Room 129, Prospect House, New Oxford Street, W.C.1, at 10 a.m. on Friday 23rd February 1968. A copy of the programme is attached.

(M. A. Roberts)

Concorde 2,
St. Giles Court,
Ext.750.
9th January, 1968.

Copies to DACT

PROGRAMME

10.00	Introduction	- Dr. D. Cameron, DACT
	Potential Concorde Traffic - a World Picture	- Mr. J. R. Collingbourne, ACT/MR
10.30	Effect of Sonic Boom Restriction on Typical Airline Operation of Concorde Part I - Introduction and outline of assumptions	- Mr. J. C. Floyd
11.00	Coffee	
11.15	Effect of Sonic Boom Restriction on Typical Airline Operation of Concorde Part II - Presentation of Results	- Mr. B. Patrick
12.00 - 1.00	Discussion	

After lunch the room will be available for further discussion if necessary.

R.524223

This presentation was given to the senior people in the various Ministries concerned with Concorde and Board of Trade and political officials, some of them critical of the Concorde program. (see letter next page).

From: Dr. D. Cameron, Director of Civil and Transport Aircraft Research and Development

MINISTRY OF TECHNOLOGY
Room 208,
St. Giles Court,
1-13 St. Giles High Street,
LONDON, W.C.2.

27th February, 1968

(f)

Dear Jim,

Concorde Presentation - 23rd February

It does not need any words of mine to tell you how successful this presentation was - the evident appreciation of the audience of both its interest and clarity will already have done this. Nevertheless I would like to add my own thanks to you and to Bernard Patrick: I have no doubt that we achieved our aims of encouraging more rational thinking about these problems in Mintech and in BoT, and of arousing a wider interest in our studies.

I have written to ATP to thank them for their excellent work.

Yours sincerely,

Duncan.

J. C. Floyd, Esq.,
"Avia",
Winchester Close,
Esher,
Surrey.

From: Dr. D. Cameron, Director of Civil and Transport Aircraft Research and Development

MINISTRY OF TECHNOLOGY

Room 208,
St. Giles Court,
1-13 St. Giles High Street,
LONDON, W.C.2.

Tel. 01-636 3644
Extn. 112

T.94

18th March, 1968

Dear Jim,

Continuing Concorde Economics Studies

Thank you for your letter of 29th February setting out your proposals, following our discussion, for further short and long term work.

2. We agree the short-term items (1) to (4). Would (3) be on the assumption of (2) - i.e. at the beginning of the flight only? On (4) you will no doubt have a look - either here or at BOAC - at the BOAC figures for the polar route.

3. Jim Hamilton has suggested some further items, most of which could, I think, be regarded as short-term extensions:-

(a) effect of increased fuel cost;

(b) effect of a reduction of, say, 10% in the specified Paris-New York payload;

(c) effect of runway loading limitations on the BOAC network, including the network as amended by your item (4);

(d) effect of variation in the selling price.

He is also interested in the effect of delays in the C of A date but this may be more appropriate to your later long-term studies.

4. As you say, it will not be practicable to hold up the report for the results of all these extension items, but you should indicate in the report that they are being studied and that they will be added later.

5. We agree also with the outline, under (a) and (b) on page 2 of your letter, of the later studies. In addition to sonic boom effects, price variation and runway loadings should be taken into consideration. We should of course like to discuss the programme in more detail before you start work.

6. Would you therefore go ahead on the short-term extension items within the limits of your present authorization of time. We have action in hand to obtain authorization for the further period of 50 days which you will need from mid-April and we shall advise you when this has been obtained. For work beyond July we shall have to put up a further detailed case: this would be based on the discussions referred to in para. 5 above and we should therefore have these in good time.

7. A final point is the idea of putting some of your work onto a computor. Mathematics Dept., RAE, are interested in this and would like to talk to you. Charles Naylor would like to join in the talks, and if you would let him know when you are ready, he will make the arrangements.

Yours ever
Duncan.

J. C. Floyd, Esq.,
"Avia",
Winchester Close, Esher.

BRITISH OVERSEAS AIRWAYS CORPORATION

PLE 379

9 July 1969

Dr. D. Cameron,
Director of Civil Aircraft, Research and Development,
Ministry of Technology,
1-13 St. Giles High Street,
LONDON, W.C.2.

Dear Cameron,

Concorde - Floyd Report.

I refer to the notes of our meeting on 29 May which record the preliminary discussion on the Floyd Report, when it was generally agreed that the slideover curve used by Floyd from the DoD formula tended to overstate Concorde traffic particularly at the high range of surcharges. BOAC also expressed the view that higher revenue rates appear to have been used as a base than is happening now, even after allowance for the abolition of the roundtrip discount, and this aspect through overstating revenue raises the absolute profitability results in all phases of the study: the comparison between the fleets, however, remains valid providing account is taken of the fact that the profit overall is overstated, and that the traffic applied to Concorde at the high-range surcharges could reflect excessive slideover.

Since our meeting we have examined the study in so far as it affects scheduling and planning. Although generally there is no major discrepancy, the following points are worth making:-

Payload, sector times, etc.

In some cases supersonic flight times have been used in areas we regard as unrealistic, and only in very few cases are there flight time differences which are significant. Examples are:-

Nairobi-Johannesburg-Nairobi
Beirut-Bombay-Beirut
Nairobi-Beirut
Perth-Sydney-Perth

Similarly there are differences in payloads but they are insufficient to bias the report.

Time saved calculations.

Concorde elapsed times are compared with subsonic timings on parallel routings: in many cases the comparison should have been against non-stop

Continued ....

General.

In my view the very high seat factors applicable to London/New York and London/Montreal would not be sustained long term. The high rate of profit on these services would be reduced and this has serious impact overall. The base revenue rates used in the study are also high at present levels, consequently, the Concorde profit, assuming the traffic estimates are valid, is overstated - 7% overstatement in revenue causes the £10.4m. profit in "A" projection to be a break-even only.

The aircraft price also has considerable influence on the profit margin. Whilst £10.4m. profit is shown in "A" projection if the price is £24m., at £28m. it falls to £1m. profit only.

In my view, Floyd has produced a comprehensive and realistic assessment on the assumptions taken and it seems to us to be an exceptionally * thorough document. I believe, however, the results shown for Concorde in isolation could be optimistic in the long term for the reasons already stated.

I attach a statement showing the broad route results, on "A" plan at 25% surcharge, for Concorde operations.

In so far as the estimated passenger markets for Concorde are concerned, no doubt we shall be hearing from you as a follow up to our meeting of 29 May on this aspect.

Yours Sincerely,

W. Bray

W. Bray
Planning Director

* If you knew this gentleman you would realise that this is great praise indeed

Enc.

DEPARTMENT OF TRADE AND INDUSTRY
MONSANTO HOUSE
10-18 VICTORIA STREET
LONDON SW1H ONQ
01-222 7877

EHB/AMB/DoI

Mr. J.C. Floyd,
J.C. Floyd & Associates,
Lloyds Bank Chambers,
64 High Street,
Epsom,
SURREY.

14th August, 1974

Dear Jim,

Many thanks for your letter of 12th August, 1974. As was inevitable, Aviation Week got it wrong in theory but not in practice! I remain a BAC employee but have been seconded to the Department of Industry in a grade equivalent to that of an Assistant Secretary. I am finding it extremely interesting and challenging.

I think all of us who can look back on the last nine or ten years and see Concorde still in being have to have some pride! I know that you and Bernard were as much supersonic enthusiasts as I, but it has been a very difficult furrow to plough. I remain convinced that once the aeroplane goes into service, selling the next fifty or sixty will be comparitively easy.

I have your address very firmly in mind and if there is anything which arises of interest to you, I most certainly will let you know.

Kindest regards,

Yours,

E.H. BURGESS

(d)

R. DIXON SPEAS ASSOCIATES, INC.
Aviation Consultants

MANHASSET, NEW YORK 11030 - 516 627-7460
CABLE-SPEASAV MANHASSET NY

12 September 1974

Mr. E. H. Burgess
Concorde Division
Department of Trade and
Industry
1 Victoria Street
London SW1, England

Dear Pat:

The attached memo to me from Carl Robart of our staff summarizes his views concerning environmental considerations related to aircraft operations as being from our work to date in this area.

Should you and your associates consider that we might be of some assistance to you with respect to the environmental consideration in introducing the Concorde into operations to and from the United States, we would be pleased to discuss the subject with you.

As per our brief discussion at Farnborough, we would propose that any such work as did develop could be most effectively accomplished on our part in joint activity with J. C. Floyd & Associates. We have had occasion to work with Mr. Floyd and his associates over a number of years and the working relationship has proven highly effective in accomplishing tasks such as we would contemplate required in the achievement of environmental clearance for your anticipated operations. I am sending a copy of this along to Murry White of BAC since I have had occasion to chat with him a bit from time to time on environmental matters.

Best regards.

Sincerely yours,

R. Dixon Speas

Enc.
RDS:wg

cc: Mr. James C. Floyd,
J. C. Floyd & Associates

Mr. Murry P. White, President
British Aircraft Corporation (USA)

APPENDIX 6

Major studies carried out on Concorde.

Work carried out by Floyd Associates for Ministry of Technology (Ministry of Aviation Supply) during the the period from JANUARY 1968 to DECEMBER 1970

Two types of report are used in these studies, the main reports for multiple issue being numbered as follows F/MT/(number)C. The initials represent F for Floyd Associates - MT for Mintech - and C for Concorde. Reports after November 1970 are numbered F/MAS/(x)C reflecting the change of Ministry name.

A means of identification for reports which receive only limited or no external circulation was commenced in June 1970. These reports are given DN/(x) numbers, the initials standing for Draft Note.

In addition to the listed reports there are of course a large number of internal reports and calculation documents.

Reports F/MT/1C to 4C were issued prior to Jan 1968 and are not outlined in detail in this summary.

The following reports have been issued since January 1968.

Report No.	Subject	Date of Issue	Pages/Diagrams
F/MT/5C	Study on Effects of Sonic Boom Restrictions on Concorde Operations	May 1968	133 / 39
No.Number	Summary Presentation Document on above	Feb. 1968	7 / 36
"	Appendix 1 to 4 " "	May 1968	106 / -
"	Addendum 1 to "	Aug. 1968	1 / 4
F/MT/6C	Extension of Above Study to Additional Routes on BOAC Network	Sept. 1968	89 / 27
F/MT/7C	Preliminary Study of Mixed Fleet Profitability on BOAC Route Network	Feb. 1969	51 / 201
/MT/8C	Extension of Above Study to Alternative Routings	(Not Issued)	
F/MT/9C	Examination of Passenger Preference for Concorde, based on Fare, Speed, Comfort etc.	June 1969	28 / 5
F/MT/10C	Cost Analysis for Application to Projected Concorde, 747 and 707 Operations over a Pan Am Network in 1975 and 1980	July 1969	24 / 3
F/MT/11C	Performance Aspects of Projected Concorde Operations over a Pan Am Network in 1975 and 1980	July 1969	12 / 1
F/MT/12C	Traffic, Revenue & Journey Time Inputs to a Study of Integrated Concorde & Subsonic Operations over a Pan Am Network in 1975 and 1980	July 1969	20 / 6
F/MT/13C	Results of a Study of Integrated Concorde & Subsonic Operations over a Pan Am Network in 1975 and 1980	September 1969	
	Part 1 : Text		73 / -
	Part 2 : Illustrations		- / 42
F/MT/14C	Results of a Scheduling Study for Typical Concorde Operations by Pan Am in 1975-80 Timescale	November 1969	16 / 12
F/MT/15C	Cost Analysis for Application to Concorde and Subsonic Aircraft Operations over Part of the BOAC Network 1975/76 and 1980/81	May 1970	31 / 6
F/MT/16C	Parametric Study on Single Class Concorde, in 1975/76 and 1980/81 - Floyd/DOD Slideover	June 1970	46 / 36
F/MT/17C	The Significance of Frequency on Above Results	June 1970	36 / 17
F/MT/18C	Parametric Study on the Effect of Concorde in Single and Mixed Class in 1975/76 - Floyd/DOD & BOAC/IDA Slideover	September 1970	44 / 21

Report No.	Subject	Date of Issue	Pages/Diagrams
F/MT/19C	Miscellaneous Items - BOAC/IDA Slideover (a) The effect of reducing the number of single class Concorde seats from 108 to 96 in 1975/76 (b) The effect of frequency when Concorde is operated in mixed class in 1975/76 (c) The effect of F passengers transferring to Y Concorde when Concorde is operated in mixed class in 1975/76 (d) A preliminary investigation of operations in 1980/81	October 1970	31 / 6
	Addendum - Frequency Studies on Concorde Single and Mixed Class in 1980/81 - BOAC/IDA Slideover	November 1970	6 / -
F/MAS/20C	Effect of Concorde on BOAC London-Tokyo Operations Part 1 - Inputs	December 1970	77 / 8
F/MAS/21C	Part 2 - Financial Results	December 1970	17 / -
DN/1	Slide-over Adjustments - Discussion of composition of any possible additional slide-over from subsonics to Concorde	June 1970	2 / 1
DN/2	Concorde Fare Levels - Examination of financial results at fare levels of first-class and above	June 1970	4 / 2
DN/3	Matching Frequency to Traffic - Examination of Concorde load factor over five-year period	June 1970	2 / 2
DN/4	Single Class Concorde vs Mixed Class - First order examination of mixed class Concorde	June 1970	9 / 3
DN/5	Examination of Mixed Class Concorde - Second order examination of mixed class Concorde, including revenue results for various layouts and surcharges	June 1970	12 / 3
DN/6	Notes on Concorde Economic Studies London-New York - Relationship between schedules, frequency, passenger type and market share. Load factor vs frequency etc.	Nov. 1970	17 / 6
DN/7	Results and Conclusions of Economic Studies of Mixed Fleet on Lon-NYC	Dec. 1970	11 / 3
DN/8	Financial Results on Lon-Tokyo Route	Dec. 1970	1 / 5
DN/9	Financial Results on Lon-Johannesburg Route	Dec. 1970	1 / 4
DN/10	Summary of Notes 6 to 9 and Appendices	Dec. 1970	
DN/11	Application of Concorde by BOAC to the London-Johann. Route - Preliminary Investigation	Dec. 1970	5 / -

C O N C O R D E

Catalogue of Draft Notes Issued since 1st June 1970

No.	Date	Title & Subject	Originated
DN/1	June 1970	Slide-over Adjustments Discussion of composition of any possible additional slide-over from subsonics to Concorde	JCF
DN/2	June 1970	Concorde Fare Levels Examination of financial results at fare levels of first-class and above	JCF
DN/3	June 1970	Matching Frequency to Traffic Examination of Concorde load factor over five-year period	JCF
DN/4	June 1970	Single Class Concorde vs Mixed Class First order examination of mixed class Concorde	JCF
DN/5	June 1970	Examination of Mixed Class Concorde Second order examination of mixed class Concorde, including revenue results for various layouts and surcharges	JCF
DN/6	Nov. 1970	Notes on Concorde Economic Studies London-New York Relationship between schedules, frequency passenger type and market share. Load factor vs frequency etc.	JCF
DN/7	Dec. 1970	Results and Conclusions of Economic Studies of Mixed Fleet on Lon-NYC	JCF
DN/8	Dec. 1970	Financial Results on Lon-Tokyo Route	JCF
DN/9	Dec. 1970	Financial Results on Lon-Johannesburg Route	JCF
DN/10	Dec. 1970	Summary of Notes 6 to 9 and Appendices	JCF
DN/11	Dec. 1970	Application of Concorde by BOAC to the London-Johann. Route - Preliminary Investigation	BJP

APPENDIX 7

J.C.Floyd & Associates organisation.

J. C. FLOYD & ASSOCIATES

Aviation and Transportation Consultants

LLOYDS BANK CHAMBERS 64 HIGH STREET EPSOM SURREY

Telephone: EPSOM 27987 Cable: AVIA ESHER

J.C. FLOYD & ASSOCIATES

This consulting firm, usually referred to as 'Floyd Associates' was established in 1962 when Mr. J.C. Floyd left Hawker Siddeley Aviation Ltd. after some 30 years of service with that Company, in order to set up an aviation consulting practice.

Whilst the firm's current activities cover a much broader base, embracing the general transportation fields and commercial planning in addition to its aviation activities, the basic concept of a direct and personal service to clients inherent in a relatively small practice has been retained.

The aim of the firm is to provide clients with a complete and integrated service, and where assignments require additional skills and manpower over and above those available 'in house', our close collaboration with other responsible consulting firms in the United Kingdom and North America ensures that the firm can offer this type of service, in any part of the World.

The firm has undertaken prime contractual responsibility for a number of major independent studies in the past, but is also prepared to work closely with the client's staff, providing advice on either a full or part-time basis.

A brief summary of some of the types of work undertaken is shown in Appendix 1 and brief Curriculum Vitae of our senior consultants in Appendix 2. The senior members of the team are adequately backed up by technical and clerical skills and the firm is well served by local computing facilities.

Appendix 1

SOME ACTIVITIES UNDERTAKEN BY J.C. FLOYD & ASSOCIATES

Evaluation of civil and military aircraft projects including the technical and economic assessment of projects and systems.

Planning and economic studies on the integration of Concorde into airline operations for the Ministry of Technology/Department of Trade and Industry.

Studies of complete and integrated ground transportation systems, including rapid transit developments.

Studies on an optimum air freight system for one of the largest European carriers, including assessment of market potential, equipment, depot facilities, and ground transportation required. Establishment of tariff structure and marketing procedures to promote sales.

Studies on V/STOL transport aircraft and systems, including the requirements for terminal facilities, the effects of size and frequency on operating costs and marketability, etc.

Studies on Noise and Pollution and the effect of suggested regulations on the economics of airline operations.

European representatives from 1962 to 1968, for a major U.S. company with gross sales of over two billion dollars per annum, during which time were involved in choice of navigation systems for a number of new aircraft types, including Concorde.

The firm is prepared to accept assignments in Aviation, Transportation, Industrial and Civil Facilities Planning, and Commercial and Economic Studies.

Appendix 2

BRIEF PROFILES OF SENIOR PEOPLE

J.C. FLOYD - P.Eng., C.Eng., F.R.Ae.S., F.A.I.A.A., F.C.A.S.I., A.M.C.T.

Over 35 years in the aerospace industry in the United Kingdom and Canada. Vice President and Director of Engineering of Avro Canada for many years. Responsible for design of first jet transport in North America. Responsible for system management of one of Canada's largest and most complex weapon systems, including design of the aircraft and integration of relevant systems. Chief Engineer of Hawker Siddeley Aviation's Advanced Project Group at Kingston, prior to establishing J.C. Floyd & Associates in 1962.

Awards include:

Wright Brothers Gold Medal	(First Non-American Recipient)
J.D. McCurdy Award	(Highest award of Canadian Aeronautics & Space Institute)
George Taylor Gold Medal	(Royal Aeronautical Society)

Has also published a number of papers and reference works on aviation, and gave the 1958 British Commonwealth Lecture to the Royal Aeronautical Society.

B.J. PATRICK - B.Sc.(Eng.), Dip.Eng., C.Eng., A.F.R.Ae.S., M.I.Mech.S.

17 years in the aerospace industry. With Hawker Aircraft for many years and later joined the Advanced Projects Group of Hawker Siddeley Aviation at Kingston. Latterly with Taylor-Woodrow Ltd., engaged in Transportation Development, including Rapid Transit Systems and prior to joining J.C. Floyd & Associates in 1967, was engaged in Transportation Studies at Battelle Memorial Institute in Geneva.

Awards include:

Walmsley Memorial Prize	(Northampton Engineering College)

Papers:

The Supersonic Airliner	'Impulse'	1962
Monorails - The Position Today	International Ropeway Review	1966

K.W. CLARK - B.Sc.(Hons.)Eng., A.C.G.I., D.I.C., C.Eng., A.F.R.Ae.S.

Over 40 years in the aerospace field, commencing at the R.A.E. Farnborough in the Research and Development Establishment. With the Ministry of Technology, latterly involved in the management of the U.K. effort for the E.L.D.O. Launch Programme, co-ordinating the work of the vehicle manufacturers. Prior to 1964, was in charge of the assessment of future weapons systems for the Ministry of Aviation.

Has attended a number of recent International Space Symposia as U.K. Representative, and read papers at N.A.T.O. conferences.

APPENDIX 8

Flights on the Concorde.

British Airways Travel Division

British airways

PO Box 115
West London Terminal
Cromwell Road, London SW7 4ED
Telephone: 01-370 4255
Telegrams: Batravel, London

J.Floyd,Esq.
Aviation Consultant
'Avia'
12 Winchester Close
Esher
Surrey KT10 8QH

12th January 1978

Dear Jim,

Thank you for your letter of the 3rd January. I was very pleased to hear that you are flying Concorde - and amazed that it is your first flight after all the work you did on it.

I enclose a batch of Concorde postcards in preparation for the trip. You will also find there are ample stocks in the Gate Lounge and one in the flight pack in your seat pocket.

I hope you enjoy the trip.

I was pleased to hear the news of Bernie Patrick and do please give him my regards when you next see him.

Kind regards,

Yours sincerely,

ALAN BEAVES
MANAGER BUSINESS TRAVEL

Ironically, although hundreds of people were invited to fly in Concorde, including politicians, clergymen, doctors and the general public, during the 'passenger acceptance' and other early flights, I was obliged to purchase a full-fare ticket for my first flight in the airplane which had consumed so much of my time over a thirteen year period. Luckily, my client in New York paid the 'tab', so the blow was softened somewhat, at least financially!

FIRST FLIGHT IN CONCORDE

My schedule called for departing on Concorde flight BA.171 from Heathrow to New York at 11.15 on January 23rd, arriving in New York at 10.00 local time, being whisked off to a meeting with Dixon Speas in Manhasset, hopefully arriving at his office at 11.00 and spending that afternoon and the following morning on the business we had together, then returning on Concorde flight BA.170 at 12.15 and arriving back in London at 21.00.

It all looked too good to be true ..... and was!

At 08.30 on the 23rd a very pleasant voice from British Airways informed me by phone that due to the bad weather conditions in New York, flight BA.171 would not be departing until 13.00, i.e. one and three quarter hours late.

I arrived at Heathrow at 12.00, parked my car and went to check in at the special departure area for Concorde at building No. 3 and from there into the special Concorde lounge, where drinks were being served. A few passengers had obviously arrived earlier, probably due to the inability of 'pleasant voice' to reach them and one in particular had apparently spent the prece ding hour or so taking full advantage of the free drinks. He was by that time looking very happy and uninhibited and seemed to feel that it was his duty to count the new arrivals and welcome them. Although it is probably not fair to say that at this stage he had matured to the nom de plume I will give him from this point on, I will refer to him later as 'THE DRUNK'.

The first procedure on entering the lounge is for the hostess to take your coats and arrange for them to be put into the aircraft ahead of the passengers, Concorde being very narrow-bodied with little room to manoeuvre. I only had a Parka-type coat (in deference to the reports of a blizzard in New York) and so kept mine with me, which turned out later to have been a very good move. The end doors to the lounge opened

directly on to the passenger loading ramp to the aircraft and since the Concorde fuselage is much smaller than the wide-bodied aircraft for which the ramp-to-aircraft weather seals were designed, a gale was blowing through the gap above the Concorde door, treating the lounge occupants to a taste of the Arctic every time the lounge door was opened to load something into the aircraft, which was plenty!

By 12.45 it was obvious that Concorde was going to have a full load, due to the fact that the previous Concorde Washington flight had been cancelled as the result of a severe blizzard on the U.S. Eastern coast and the passengers had been re-routed on this New York flight.

At 13.08 departure was announced and we trooped into the aircraft and made our way to the seats reserved several days before. With my flair for landing next to a fellow passenger with a heavy cold or something that his best friend would not tell him about, guess who I had 'won' this time? Yes, you guessed it.

He was in the aisle seat and I had to get into the window seat, (Concorde has two seats each side of a single aisle). He had arrived a little ahead of me and his two bags were already occupying my seat. He appeared to be incapable of removing them and I spent the next few minutes trying to lean over him and move the bags into the aisle, which besides being very narrow was now full of passengers trying to get past me and the bags. My 'problem' did try to get out of his seat to help but after a couple of non-productive attempts left me to it.

I finally made it and settled down to parking my briefcase between my feet and finding the elusive end of the seat belt. Incredibly, by the time I had found and latched the belt, my companion had informed me that he was a photographic technician from Scandinavia, had invented a great number of photographic gadgets, was a ba che..lor, was on his way to Washington to join a World Cruise, was on his first Concorde trip,

had sailed in the Q.E.2 five times, etc., etc. It was like listening to a tape recorded at 1.7/8 ins. per sec. being run through at 15 ins. per sec.! I decided at that point that the best ploy would be to nod at frequent intervals and not even attempt to try to either stop him or digest the deluge.

We rolled from the gate at 13.29 and joined the take-off queue at 13.44. At 13.58 plus 10 secs. we started take-off and I settled down to timing the various stages. At 13.58 plus 58 secs. when we were going like hell along the runway and seemed just about to rotate, the power was cut and the brakes applied, a second later reverse thrust was engaged and we finally came to a screaming halt at what I judge by the timing and familiar landmarks to be uncomfortably close to the end of the runway. I had visions of that 'leggy' nose gear giving up the struggle on the soft ground and the drooped nose digging a path into the earth like a giant tulip planter. Needless to say none of this happened but it might just as well have done so far as the reaction of my companion was concerned. 'THE DRUNK' went into a quiet panic and between his nose being pushed into the seat ahead by the deceleration and his bag dropping off his knees and landing heavily on his feet, it was apparent that he thought that his time had come.

We came to a stop at 14.09 and the captain announced that he had had a red light warning in the cockpit that there was a malfunction in the trim system. We taxied to the nearest gate and were asked to deplane whilst the aircraft was checked and refuelled, but asked to leave all personal items in the cabin.

A temporary mobile step unit was wheeled to the aircraft and the passengers disembarked through the small crew door. It was blowing a gale outside and I was glad that I had not let the obliging stewardess take my Parka.

We were 'bussed' to the nearest lounge and within a few minutes drinks appeared and a little later hot scampi was handed round. I appreciated this move since by this time it was around 15.00 and we were all getting a little hungry, having had no lunch, but I must admit to being more than a trifle apprehensive about the condition of my unchosen companion after a further drinking session.

He was, however, now engaged on putting the 'wind up' all of the passengers who were willing enough to listen. He had corralled a small group of women who were looking a little unhappy anyway by this time and proceeded to tell them that "as a technician" he realized how close to death we had all been and that the airline should not under any circumstances put us back into that aircraft.

Queues had by this time gathered at all the available telephones in the lounge as the business passengers in particular tried to call the United States or someone in London. I finally managed to ring Dixon Speas in New York, who had arranged for me to be met at Kennedy on arrival, and also phoned Irene to tell her that I was still in London.

We finally reboarded the same aircraft at 16.20 and started to taxi out at 16.30.

We commenced take-off roll at 16.48 and were airborne at 16.48 + 50 secs.

Having worked on the Supersonic Transport in the early days of the feasibility and design studies I decided to plot the speed versus time and later check against our early calculations on this relationship. There is an illuminated display panel in the forward end of the Concorde cabin where the speed in terms of MACH No. is continuously presented.

The attached fig. 1. shows the MACH No. on a 'time from leaving gate' basis and also indicates the altitude corresponding to the MACH No., where available.

The MACH display proved to be a mixed blessing as although it provided me with the data required to plot my curve it also provided 'THE DRUNK' with the opportunity to demonstrate his claimed capability as a technician.

Every increase of 0.01 MACH No. was not only announced to everyone in a loud voice but being available I was prodded in the arm by a bony elbow every time the display changed, whether up or down, and despite my protests at the start, he obviously felt that it was his duty to keep me fully informed. I was doubly relieved when the MACH display came to a rest at M = 2.0, both on account of my almost embarrassing knowledge of what goes on in the structure and systems in that aircraft as it accelerates up to that speed and also because my arm by this time felt that it had been through the proverbial wringer.

We were served a most magnificant lunch of caviar and smoked salmon, followed by the most delicious filet steak, etc., etc., topped off by pineapple in Kirsch and liquers and washed down with endless Champagne. (If you liked the stuff.) After the meal 'THE DRUNK' was obviously feeling a little sleepy and I welcomed the chance to do some reading of my notes for the forthcoming meeting and my arm began to feel that it was attached to me again, albeit still a little painfully.

I had noticed that although it had been going quite dark when we left London, it had steadily been getting lighter as we flew West faster than the sun. Captain Duff eyreported that for the first time in his flights in Concorde he had observed the sun rising in the West! This phenomena only happens on Concorde and military aircraft flying at very high speed and only at a certain time, e.g. take-off at dusk from London, and so our $5\frac{1}{2}$ hrs. late take-off had at least provided us all with this unique opportunity.

We were now cruising steadily at twice the speed of sound and yet the Mach display was the only evidence of it. Concorde climbs steadily in the cruise as she swallows the enormous quantity of fuel required at M = 2 and the Captain announced at 19.05 that we were now at 56,000', i.e. over 10 miles above sea level, and would be commencing the descent shortly. A little after this the Mach display commenced to move down the scale and at 19.40 we were back at subsonic speed (M = .95) and 28,000'.

The speed was reduced to M = 0.35 as we went into the holding pattern over Kennedy and we touched down at 20.27 by my watch (London time) just 3 hrs. and 39 mins. after leaving London. This time was a little slower than scheduled, due, according to the Captain, to a 110 mph jet-stream headwind at high altitude.

The Concorde pulled into its reserved slot at Kennedy and the deplaning chaos was similar to any other flight, with passengers jostling to get items out of the overhead racks and queuing in the aisle well before the doors were open.

The overhead baggage storage compartments in Concorde are very low due to the small fuselage diameter and many of the passengers were bashing their heads on them despite the warnings from the crew.

THE DRUNK had made a remarkable transition to sobriety apparently as the result of his short nap and although a little unsteady was quiet and most polite in his thanks to the crew and even to me'for my very good company' ! He was going on to Washington so that was the last I saw of him.

We were quickly through U.S. Immigration and Customs procedures, accompanied by the familiar "have a nice stay now" and I finally located the patient cab driver sent by Dixon Speas to pick me up and I reset my watch five hours back to New York time, which was then 16.00.

I was in Manhasset with my old friend and colleague Dixon Speas by 17.00 and after an hour or so in his office, collected a report that he wished me to read before the morning meeting and was taken to my hotel around 18.00. I sent for a chicken sandwich and coffee and settled down to read through the 50 odd pages of a technical report. The chicken sandwiches which room service delivered were the usual American massive acreage of rye bread with at least a young chicken farm on each and by the time I had got through the last chicken and digested the first 20 pages of the report I began to realize that although my watch now read 10.15 p.m. it was in fact 3.15 a.m. Tuesday, by Floyd stomach and eyelid time! I had a bath, went under the covers at 4 a.m. my time and promptly woke up again as usual at 7 a.m. my time, which was 2 a.m. New York time. (Are you following me or did you drop off 3 pages ago?)

I found that I could not go back to sleep, so at 4 a.m., with three hours to spare before the breakfast meeting arranged by Dixon and colleagues for 7 a.m., I finished reading the report and made suitable notes, showered, shaved and met the 'confederates' in the Dining Room at 7 a.m.

I only mention the above somewhat boring details to illustrate that despite all the advantages of Concorde and supersonic flight, if you plan a tight business schedule on the basis of taking advantage of the 'here-today-gone-tomorrow' facility which Concorde <u>can</u> offer, and the take-off is delayed for any reason, as ours was, it can play merry hell with all the good intentions and result in a final schedule which I could in fact have achieved on a jumbo at half the fare!

Business over, I was whisked back to Kennedy for the 12.15 return Concorde to London which actually took off at around 12.50 and in exactly 3 hrs and 8 minutes we touched down at Heathrow after a very pleasant and uneventful flight, the details of which are recorded on fig. 2 .

General Impressions of Concorde

There is little doubt about the advantages of halving the flight time from London to New York. On the return journey, with a tailwind in our favour, the flight time of 3 hrs and a few minutes went very quickly and by the time we had settled down to cocktails followed by a leisurely and beautifully prepared and presented 6 course meal with all the trimmings, and written a few of the inaugural flights postcards provided, we were rolling into the gate at Heathrow. This is the only occasion on which, despite the sleep-denying schedule in New York, I have not suffered from frustrating jet-lag as the result of a return visit to North America.

The flight out was a disaster, schedule-wise, and since the home-to-New York office time eventually turned out to be over $10\frac{1}{2}$ hours, some 50 minutes longer than my expected subsonic 'jumbo' time, one had to conclude that I wasted the Concorde premium on that abortive flight if I normally travelled first class and if I normally travelled economy I wasted over £200. This indicates the sensitivity of Concorde to mechanical and routing delays. It will only be a success, even with the wealthy business passengers, if it has a very high level of dispatch reliability, with minimal technical or scheduling delays.

The Concorde marketing approach uses the value of business time saving as a powerful argument for going Concorde in preference to subsonic.

By the same token time delays act as a powerful argument against spending the quite appreciable extra fare on Concorde, especially when the first flush of novelty has been fully exploited by the regular Atlanticites.

The interior of Concorde reminded me of the old Convair 240 or the later Fokker F27. The leg room is good, but I did not find the seats as comfortable as the old VC10 type, although I understand that they are based on this original seat design.

The overhead baggage compartments are a menace for window seat occupants, even for short passengers, and yet in this size of cabin it is difficult to know what can be done about it.

Noise levels were higher than I anticipated in the forward cabin and although I listened carefully for the change in frequency and general level as the aircraft accelerated through sonic speeds and beyond, where aerodynamic noise takes over from engine noise, I could not detect any change in the noise level or quality.

The general cabin air conditioning system is excellent and no changes in temperature or pressure were experienced despite the rapid rates of descent and the marked reduction in outside skin temperature as the aircraft reduces speed for descent.

The general cabin service and the meals in particular, were 'out of this world' and were without any doubt better than anything I have ever experienced in over 32 years and well over a quarter of a million miles flown in both first and economy class, all over the Western World.

I spent about 15 minutes in the flight compartment during the cruise on the outbound flight and although I was fairly familiar with the layout and instruments in the prototypes, the Flight Engineer's panel in the service aircraft was a revelation. There seemed to be many more third-crew-member dials than normally found in the 'front office', due no doubt to the sophistication of the systems in the aircraft, such as fuel transfer for C.G. monitoring, variable-area engine intake ramps, three-axis autostablization and the triplication of most systems, including the inertial navigation system. Condition-monitoring of items such as the hydraulic components is employed in this near-space plane and I would be surprised if the Flight Engineer has much time left to catch up with many chapters of his favourite novel during flight.

The view through the cockpit windows was almost non-existent from where I was standing, since the visor for cutting down drag and protecting the cockpit windows from aerodynamic heat at cruise speeds was in place, however I was assured that the Captain could see sufficiently well ahead to locate any military aircraft or other Concordes (or UFO's). There certainly would not be any other civil aircraft at that altitude!

Concorde has a three man crew, with Pilot, Co-pilot and Flight Engineer. The cockpit is very narrow and seemed to have much less cross-section than even the old D.C.3., but this may have been due to the long length of the flight compartment on Concorde. The whole atmosphere of the 'workshop' was of neatness, compactness and efficiency and everyone seemed to be enjoying the flight as much as the passengers.

From the passenger's point of view the differences in the Concorde aerodynamics and operational behaviour, such as the high angle of attack on take off and landing with the ogival delta wing, and the supersonic cruise, are not reflected into the cabin 'feel' and my American 'seat-twin' on the return journey expressed the opinion that to him, the London to New York journey was now very much like any $3\frac{1}{2}$ hour domestic flight in a small aircraft, (except for the food and attention). He was completely sold on the saving in time and absence of jet-lag and said that he would not want to 'Jumbo' across again if he could find a convenient Concorde schedule. He had of course not been on the abortive flight out.

Despite whatever qualifications I might have mentioned earlier, I thoroughly enjoyed my first Concorde flights and if I could be more sure of the schedule reliability (and one of my rich clients was willing to provide the ticket) I would fly Concorde every time.

Jim Floyd 1978.

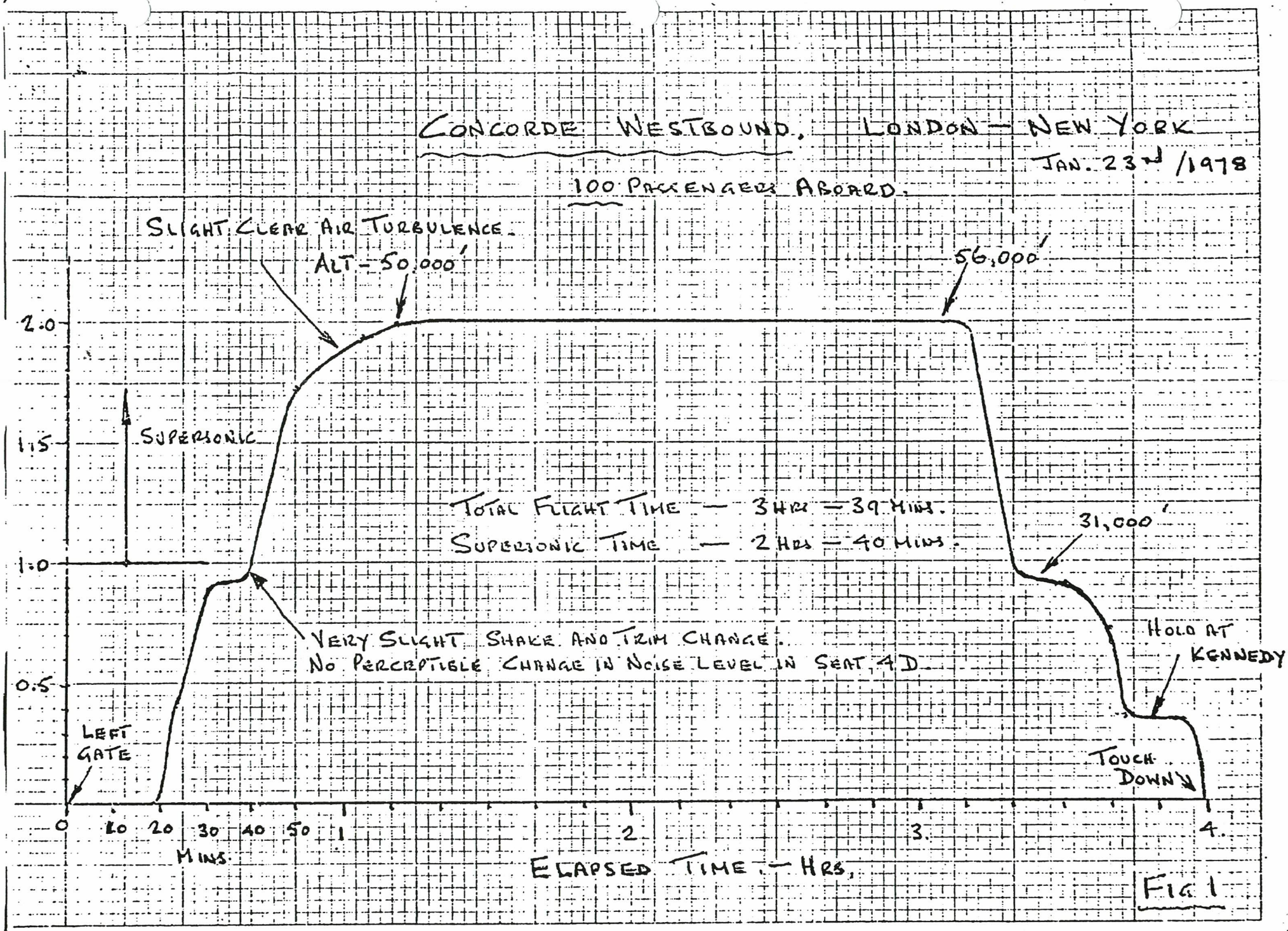

CONCORDE WESTBOUND. LONDON — NEW YORK
JAN. 23rd /1978
100 PASSENGERS ABOARD.
SLIGHT CLEAR AIR TURBULENCE.
ALT - 50,000'
56,000'
2.0
1.5
SUPERSONIC
1.0
0.5
TOTAL FLIGHT TIME — 3 HRS — 39 MINS.
SUPERSONIC TIME — 2 HRS — 40 MINS.
31,000'
VERY SLIGHT SHAKE AND TRIM CHANGE.
NO PERCEPTIBLE CHANGE IN NOISE LEVEL IN SEAT 4D
HOLD AT KENNEDY
LEFT GATE
TOUCH DOWN
0
10
20
30
40
50
1
2
3
4.
MINS.
ELAPSED TIME — HRS.

Fig 1

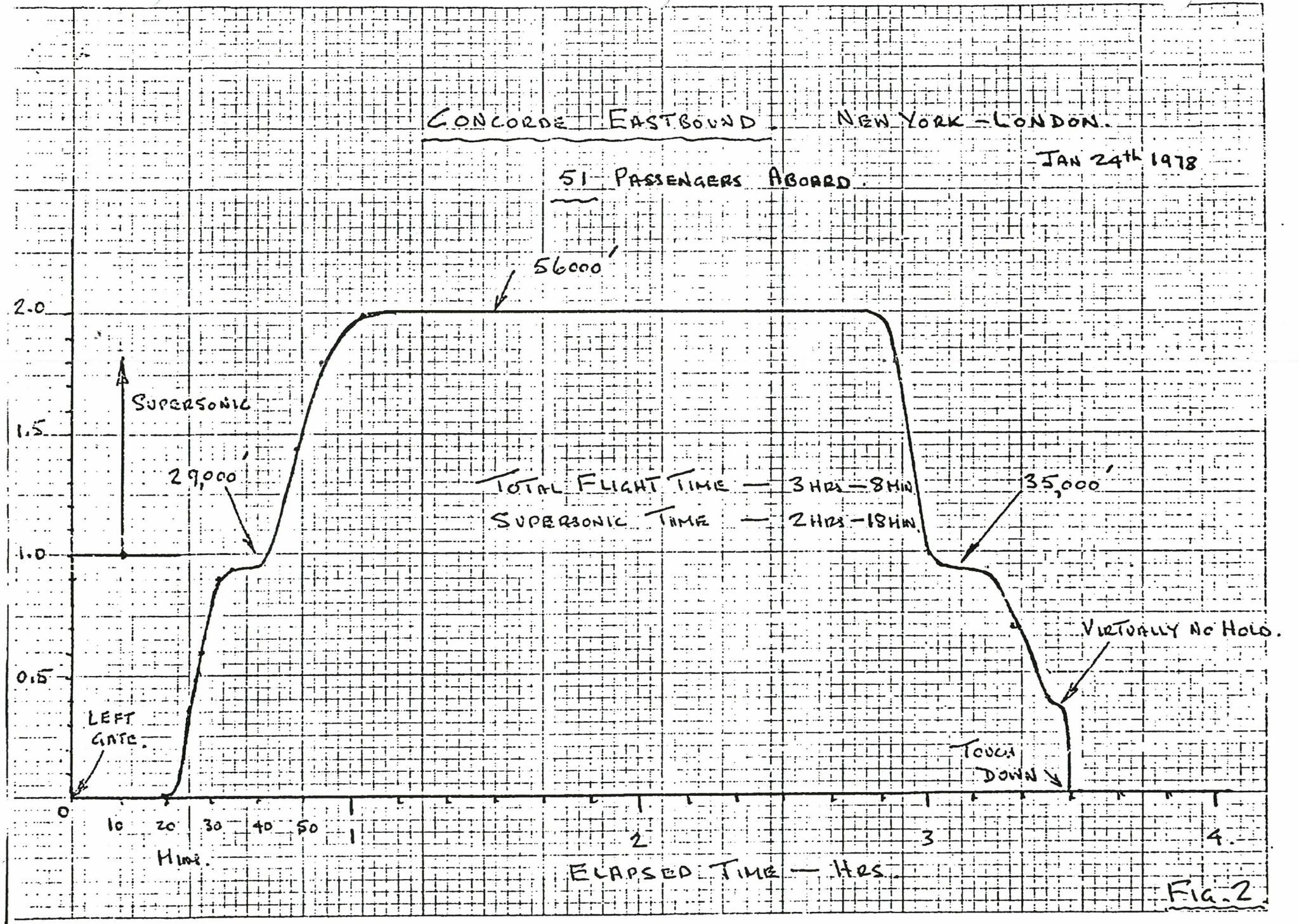

CONCORDE EASTBOUND NEW YORK – LONDON.
JAN 24th 1978
51 PASSENGERS ABOARD.
56000'
2.0
1.5
1.0
0.5
SUPERSONIC
29,000'
TOTAL FLIGHT TIME — 3 HRS – 8 MIN.
SUPERSONIC TIME — 2 HRS – 18 MIN.
35,000'
VIRTUALLY NO HOLD.
LEFT GATE.
TOUCH DOWN
0
10
20
30
40
50
1
2
3
4.
MINS.
ELAPSED TIME — HRS.

Fig. 2