

DISCUSSIONS WITH A.V. ROE MANCHESTER

Sir William Farren
Mr. J. R. Ewens
Mr. P. Sutcliffe
Mr. Aldridge
Mr. Bethwaite - Woodford
Mr. Olenski - Woodford
Mr. R. Falk - Woodford

The 720 is definitely cancelled. Avro are not proceeding with any hardware - but are completing the wind tunnel testing work that was started, so that reports can be written which may contribute to future projects.

The 730, which is a long range reconnaissance aircraft, and will later become a bomber, is in the design study stage at the moment and appears to be quite a business-like airplane; it has a straight wing, a canard horizontal stabilizer. I believe that there may be quite a few problems from the point of view of directional stability, but would not think there are any insurmountable ones, and generally the aircraft looks a sensible configuration for the Operational Requirements for which it is designed. It has a double wedge airfoil section of approximately 3% thickness and also has a wedge noseplane. A scale model is scheduled to fly in mid 1957.

VULCAN

The Mark 2 Vulcan with the extending leading edge seems to be coming along reasonably well in the shops, although production could not be said to be booming in the sense that we would describe this in Canada. The Mark 2C extended wing is still under design and undergoing wind tunnel test, but there is no hardware in the shops on this although jigs are being made.

I saw the new Ferranti computer and while I do not have time to go into this in any great detail, it appears to be a fantastic set-up compared with our own digital computer facility. It is housed in a room that I would guess is around 3,000 to 4,000 square feet.

DISCUSSIONS WITH A.V. MOE MANCHESTER (cont'd)

Avro have not put in a submission on O.R.329 mainly on the basis of their manpower requirements on the 730 reconnaissance aircraft and the work they have still to do on the Vulcan development.

DISCUSSIONS AT SIR W.G. ARMSTRONG
WHITWORTH AIRCRAFT LIMITED

Mr. H. R. Watson
Mr. Keen
Mr. H. J. Staite

I visited both the missile facility, which is now run by Watson, and the aircraft facility, now led by Keen.

MISSILE

The Sea Slug does not look like a very logical development to me and as a flying machine I must confess it looks atrocious. The problems associated with the drag of the crude structure, and the stability problems associated with the separation of the boosters, are problems which I would not like to have to tackle in the time in which AWA are expected to do it. It appears to be the opinion of the British Navy that even when these problems are sorted out, the missile will be obsolete, and unable to kill the threat which can be expected in that timescale. It, therefore, looks to me very like a Velvet Glove type of academic exercise.

AIRCRAFT

While I did not physically see all the submissions on O.R.329, and there are at least seven, I think that Armstrong Whitworth's submission is a pretty reasonable one, although I would question adequate directional stability with the very long fuselage they have, and was in fact pleased to learn that they feel, and the R.A.F. and the Air Ministry apparently agree, that they should have artificial

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DISCUSSIONS AT SIR W.G. ARMSTRONG WHITWORTH (cont'd)

augmentation of lateral stability similar to that used on the CP-105. I would also question the use of the extremely short bifurcated intakes which they use, and at supersonic speeds they are going to have, I am sure, a great deal of trouble with this. I believe that they realize this and there was an indication by Watson at the Design Council Meeting that they were going to change the intakes.

Although the aircraft would operate at Mach 2 $\frac{1}{2}$ for short periods and Mach 2.25 continuously, they are still sticking to aluminum. They have gone to an all-steel tail, mainly on the basis of aeroelastic problems with the very thin tail. The aircraft weighs 54,000 lbs. and all the O.R.329 submissions, except Hawkers, are over 48,000 lbs., and some are as high as 100,000 lbs (see list of O.R. 329 submissions attached to this report - Appendix 2).

DISCUSSIONS AT GLOSTER AIRCRAFT
LIMITED

With: Mr. R. W. Walker
Mr. H. Ward
Mr. Longford
Mr. J. F. Cuss
Mr. Absolon

The standard Javelin is now going into operational service with the R.A.F.. The thin wing Javelin is still under development, and is expected to be delivered by about the middle of 1957. My own feeling on this is that unless the Javelin has collision course weapons installed by that time it is in bad shape, since the so-called thin wing, which actually appeared to me to be thicker than the old one because of the gimmicks used on it, only increases the critical Mach number or drag rise from .92 to .95.

I would think that the Javelin could only be pulled out of the mire by the use of, say, the MG-2 Fire Control System, in conjunction with IR Falcons or some similar weapon, since it does not look as if the British A.I. and weapons will be ready in the time required.

DISCUSSIONS AT GLOSTER AIRCRAFT (cont'd)

Glosters do not appear to be doing anything in the really supersonic line, again because of manpower and the problems they are having on the Javelin. The Ministry and the Air Force in general are somewhat in the doldrums on the Javelin because of the long time it has taken for development.

DISCUSSIONS AT HAWKER AIRCRAFT LTD.

With: Sir Sydney Gamm
Mr. Cross
Mr. Stanbury

The basic problems now appear to have been sorted out on the Hunter and this is considered to be a very good and flyable airplane, however, it is generally agreed that it is obsolete because of the fact that it only carries gun armament, which is considered to be useless against a contemporary Russian bomber.

Sir Sydney's submission on O.R.329 is a kind of super Hunter in the sense that the F-100 is a super F.86. It is an all-weather aircraft with a collision course A.I. and armament, although what exactly the weapon system will be is anybody's guess.

Sir Sydney was very interested in discussions we had on the MC-2, B9 and MI-1179 type of system, coupled with a Falcon I.R. or radar seeker type of missile and he feels that the Group should come to some arrangement to produce these in the United Kingdom.

The problem at Hawkers which Sir Sydney readily recognizes is that they have far too few men and virtually no computer capacity to carry out the various jobs in a reasonable time. On the whole I would say they do a magnificent job under very difficult circumstances.

DISCUSSIONS AT R.A.E. FARNBOROUGH

With: Mr. Nicholson
Mr. Newby
Dr. Kuchemann
Mr. Summerville
Mr. W.H. Stevens
Mr. Cornford
Mr. Hynd

The visit to Farnborough was mainly to bring the RAE people up-to-date on the CF-105 and to find out what was new on their side.

We had detailed discussions on the recent changes on the CF-105 and they agreed with our decision to incorporate a notched leading edge, leading edge extension and droop, but indicated that wind tunnel tests could give a pessimistic reading on these features, and that while it had been assumed from the tunnel tests that were done on the Fairey delta, which has a 60° sweep 4% wing, that there would be pitch-up, in fact this had not occurred, under normal full scale flight conditions, although they had apparently not pulled very high 'g' up to this time.

They again warned us, as two years ago, about believing everything that came out of the theory of Area Rule and said that, while trends can be checked by Area Rule calculations, the numerical results were not always borne out in practice. There had been no apparent reductions in drag on the "Area Ruled" Hunter.

Nicholson had all his experts in during our discussions and I asked him particularly if there was anything they could see about the present state of the CF-105 which would cause them to lose any sleep. Nicholson emphatically said that there was not and that he still believes that this aircraft is more advanced than any contemporary aircraft on the design boards this side of the Iron Curtain. He said that they were watching the project very carefully and had, in fact, put in good reports about it to the Ministry of Supply during consideration of the CF-105 for O.R.329.

DISCUSSIONS AT R.A.E. FARNBOROUGH (cont'd)

A number of detailed discussions took place, and the main feeling that I came away with from the RAE, was that here were a bunch of people attempting, by every means they had, to assist the industry in the fullest sense, but without bitter criticism if things went wrong; they are scientists trying to sort out the academic problems associated with supersonic flight, but at the same time with their feet firmly on the ground, and understanding very well the practical problems faced by the industry in incorporating some of their suggestions. The British Industry can certainly be thankful for the RAE.

DISCUSSIONS AT AIR MINISTRY

A number of visits were made to the Air Ministry and discussions took place with the following people:

Air Vice Marshal Gatterley
Mr. Handel Davies
Mr. Dickens
Mr. A. Walker
Group Captain Wheeler
Air Cdre D.R. Evans
Air Cdre H.J. Kirkpatrick
Air Cdre Brotherhood

There was considerable interest in the CF-105 and we went into detail with the various branches of the Ministry on aircraft and fire control system capabilities, and discussed the limitations of the aircraft available in the United Kingdom at the present time. The general consensus of opinion in the Air Ministry is that Britain must have collision course weapon systems; they have not as yet got any, and are trying to develop the Javelin to carry a more sophisticated fire control system and Red Dean or Blue Jay collision course missiles. They are, however, very worried about the subsonic limitations on the aircraft and are most anxious to get an aircraft meeting the O.R.329 supersonic specification as soon as possible. Seven companies have put in proposals on this and the weights of all except the Hawker submission are over 48,000 lbs. Sir Sydney's submission is around 35,000 to 40,000 lbs. They were very interested to learn that the CF-105 could be made to meet the O.R.329 requirements and have asked for considerable data on the aircraft, which we will send them from Canada.

MINISTRY OF SUPPLY

A number of visits were made to the MOS. Similar talks took place with Sir John Baker, Mr. Woodward Nutt, Group Captain Silyn Roberts, Mr. Shaw and Mr. Hockmeyer.

The general feeling left after the discussions was that MOS would be very keen to do a detailed analysis of the CF-105, and required information on the timing and cost of units for operation in the U.K., with a view to either manufacturing in the U.K. under licence or purchasing direct from Canada. They were worried about the price per unit, but realized that the aircraft was far more flexible than anything they had coming along in the U.K. and that it might be used as a dual purpose weapon, which might offset, to some extent, the unit cost.

As a result of the meetings at both the Air Ministry and the MOS I invited the various groups to form a team to come out in the Spring of 1956 and do an evaluation of the project, for European operation. AVM Satterley, Mr. Handel Davies and Sir John Baker are agreed that this would be a very good thing to do and I understand they will try and arrange for a team to come out around March or April of next year. In the meantime, we will attempt to keep the project active in the U.K. by submission of data and brochures, some of which were left with AVM Satterley and Sir John Baker.

R. A. F.

Sir William Dickson, Chief of the Air Staff, was invited to the Hawker Siddeley Group Management Luncheon and gave a very frank talk to the Group. He pointed out that the R.A.F. were very worried about the Javelin timing and not optimistic about the possibilities of getting the higher performance thin wing Javelin into the R.A.F. in time to be an answer to the threat. He also was a little critical of the slippage on the Hunter.

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R. A. F. (cont'd)

With regard to development projects, he felt that the Sea Slug was falling behind and was in a difficult position, since, by the time it was developed and produced, the threat would be far more sophisticated than that anticipated at the time the Sea Slug specification was laid down. He urged the Group to get into the transport business if possible, since his own feeling was that the chances of keeping in business with military aircraft only was dubious after the next five to six years. He felt that the number of units required, for instance, in a bomber force with nuclear weapons, would be much less than was previously assumed and that the manned military fighter would be replaced by missiles within the next 10 to 15 years.

VISIT TO S.H.A.P.E. TO SEE AVM CAMPBELL AND GROUP
CAPTAIN ARMOUR

I brought Air Vice Marshal Campbell up to date with the technical and political situation on both the CF-100 and CF-105 and he said that he was very happy indeed that I had taken time out to see him, since he had had some very depressing reports from Canada about the possible cancellation of the CF-105.

He was particularly keen to learn about the increased performance in the Mark 5 CF-100 and I left him some information and curves on this. He said that the Orinda Sabre had made such an impression in Europe that the Canadians were treated with a great deal of respect these days. The recent appearance of the North American F-100 did, however, mean that there was something better in the field than the Sabre 6, and he was most anxious to see CF-100 Mark 5's in operation in Europe as soon as possible, and some commitments made on the CF-105.

We had a detailed discussion on the CF-105 and AVM Campbell asked particularly if I could leave him a performance brochure, which I did, but with instructions for him to keep it in his bottom drawer, in view of Mr. Smye's

VISIT TO S.H.A.P.E. (cont'd)

cable of last week. We did not discuss the CF-105 with anyone else at S.H.A.P.E. and I purposely did not ask to see Norstad, in view of the fact that the last time we had discussions with him he was most anxious to have his people briefed and I did not want to be in the position of refusing to do this.

I feel that this visit was very useful since Campbell is in a very powerful position in Europe and seems to be regarded very highly by everyone over there.

VISIT TO M. ZBOROWSKI OF B.T.Z.

Present: M. Zborowski
M. Beriol
J. Waechter
J. McCulloch
J.C. Floyd

We spent the morning with the people at BTZ, with a view to lining up a design study contract on the Coleopter Drone and since Zborowski and Beriol could not speak English and, even their French was difficult to understand, we had quite a problem. The situation was something like this: Zborowski did most of the talking in French and the French interpreter translated this to us. In some cases, the French interpreter was a little lost because of Zborowski's imperfect French and then the translation had to be done by Zborowski in German to Beriol, Beriol in French to Rapoport (the French interpreter) and the French interpreter to ourselves. This made the going really rough, especially since in a project of this kind, there are many technical questions which can only be dealt with adequately by detailed discussion. However, it helped considerably to have M. Rapoport there since he was an engineer as well as an interpreter and we finally got down to looking at detailed drawings and some wind tunnel reports, and had a look at models that had been made on the premises.

M. Zborowski at the present time operates from a country chalet with about 25 to 30 engineering personnel.

VISIT TO M. ZBOROWSKI (cont'd)

Jose Waechter considered that we had a very excellent meeting with him since he usually refuses to discuss details with visiting firemen, on the basis of protection of his project and patents. However, he did appear to be most anxious to tie up with somebody in North America, and on the basis of the items he had read in the technical press on the CF-100, CF-105 and the Frost project, he felt that we were a good outfit to work along with. At the present time SNECMA are financing the Coleopter projects although they are apparently negotiating an order with the French Air Force, who are taking a keen interest in the project. Zborowski has been approached by the U.K. Ministry of Supply, who wished to learn something about the project, and they came away apparently with little information due to Zborowski's reticence to disclose anything on the project.

Dr. Kuchemann at the RAE was given the assignment of analyzing the project, and, although he came away without sufficient information to really analyze it, he felt that someone would be well advised to go through the preliminary design study stage, since he knew most of the people who worked for Zborowski and considered them really excellent engineers. The general opinion of the RAE is that Zborowski has something unique but nobody, except SNECMA, has been able to find out in any detail what he really has, because of his peculiar personality.

Appendix I will give an idea of the preliminary design study contract which I suggest we should place with Zborowski. He was somewhat disturbed to find that we could only allocate \$25,000.00 for the work we required on the project, but finally agreed that this figure would be acceptable to him on the basis of tying up with a reliable outfit in America, despite the fact that the study cost to him would be in excess of this.

I feel that he probably will lose on it since the average pay for a good engineer in France is apparently about 2,000,000 francs per annum. He estimates that he would need most of his people on this study and \$25,000.00 amounts to some 9,000,000 francs.

Zborowski has done project studies on a drone with two Rolls Royce Scar engines, a study on an

VISIT TO M. ZBOROWSKI (cont'd)

interceptor, and a study on what he calls a touring airplane seating four people. He has done supersonic wind tunnel testing on the interceptor version up to Mach 1.7 and a considerable amount of subsonic wind tunnel testing. He has also done a considerable number of flights on a scale model of the aircraft with a 40 lb. thrust engine. We hope to get a copy of the films of these models in flight.

A more detailed write-up of this visit in the form of minutes has been prepared by J. McCulloch and is also included in Appendix I.

On the day I was leaving the U.K., I had two visits, one with Sir Thomas Pike, and another with Sir Arnold Hall. This was my second discussion with Sir Arnold Hall.

SIR THOMAS PIKE

I brought him up to date with the present status of the CF-105 and he indicated that the Air Staff had been giving some considerable thought to the CF-105 on the basis of my earlier discussions with A/V/M Satterley and other members of the various government groups.

He mentioned a new short step concept which was growing in popularity in the U.K. and which operated something like this. Instead of taking large steps between projects so that there were a considerable number of unknowns involving a very lengthy development time, they were now considering that it was preferable to take shorter steps in development and take a gamble on producing a number of aircraft on a kind of modified Cook-Craigie method. In this manner they hoped to get aircraft sooner and cut the technical risks on any one particular project. The disadvantage of this method of course is that the over-all development costs could be higher, since they would have to be faced oftener.

SIR THOMAS PIKE (cont'd)

I told A/V/M Pike that the CF-105 should fit very well with this philosophy since they could introduce it as an intermediate step between their presently programmed aircraft and O.R.329 without entailing large development costs. While Sir Thomas agreed with this, and said that technically, everyone in the U.K. was really sold on the CF-105, he felt that the biggest problem would be the actual hardware, since, as he saw it, there were only two ways to tackle this. One was to have the aircraft built outright in the U.K., including engines and fire control system, and the other method was to purchase aircraft from Avro in Canada. On the first proposal he felt that there would be a number of distinct problems, such as Anglicizing the equipment and skin gauges, etc., etc., and that they would probably run into the same type of problems which were encountered between English Electric and Martin's on the production of the Canberra in the U.S..

On the second proposal, i.e., purchasing from Canada, he felt that the round figure of 2 million dollars, which we anticipated the aircraft might cost them in the early stages, was completely prohibitive for U.K. economy. (After my meeting with Sir Thomas I checked with one or two of the people who had made submissions on O.R.329 and they were all talking somewhere between £500,000 to £700,000, i.e., around the 2 million dollar mark, so I can only conclude that he was not up to date at the time on the cost of a similar U.K. aircraft.)

I suggested that there may be a middle course, which would be to purchase a fairly small number of aircraft from Avro, say ten or twelve, and produce the rest in the U.K., which would mean that for a commitment of maybe less than 25 million dollars, or 9 million pounds they would be able to swing into the program and do their evaluation, training, and operational trials considerably sooner than if they manufactured from scratch in the U.K. He felt that this was worth looking at and was very much in favor of a team going to Canada to assess possible ways of obtaining the aircraft. (I intend to write to Sir Roy, with whom I discussed this before his departure to Canada, and see if we can do an evaluation within the Group, on the cost of Anglicizing and manufacturing in the U.K., so that these check figures could be available for discussions with M.O.S. when the team comes over.) Sir Thomas said that

AIR THOMAS PIKE (cont'd)

they would never consider going into production or purchasing an aircraft unless they could bank on getting at least 200 units, which would ensure that they had a fighting force.

VISIT TO FAIRY'S

We had a very interesting discussion with Bob Lickley, Chief Engineer of Fairey Aviation, and I was particularly encouraged to find that a considerable amount of test flying had been done on the Fairey research delta, since it is closer to the CP-105 than anything else that is flying at the moment, it being a 60° delta, high wing, with a 4% thickness chord ratio and with no gismicks on the wing, such as conical camber or twist. Apart from the modified leading edge this aircraft is in fact almost a 1/3 scale model of the CP-105. The aircraft is doing remarkably well and has apparently done over 40 supersonic flights within the past six weeks. All of these were carried out in climb and the aircraft has been over Mach 1.5 on a number of occasions. An RA14 engine with afterburner is used.

The aircraft has been flown consistently through the transonic region and they have between 200 and 300 recorded tests in this region. Lickley said that their pilots have no problem whatsoever with violent trim changes at any of the speeds at which they have operated so far, and he says that there has been no evidence of pitch-up, despite the fact that the wind tunnel tests indicated fairly strong pitch-up at high subsonic Mach numbers.

The aircraft has pulled 3'g' at Mach 1.2 at 40,000 feet. I believe that one of the reasons they have no pitch-up is due to their spanwise intake configuration, the outer edge of which probably produces a fairly strong vortex, which probably does not collect the low pressure air from the fuselage, which is one of the causes of pitch-up on other aircraft.

VISIT TO FAIRLEY'S (cont'd)

The drooped nose for landing has worked out very well, and in the Fairley submission for O.R.329 this is used as a capsule for escape, and the configuration certainly lends itself very well to this arrangement.

Lickley indicated that the aircraft performance was higher than that estimated or expected by the R.A.F., indicating that the drag was less than estimated.

There had been no application of Area Rule to the aircraft, although their investigations had shown that the aircraft was not too bad in this regard due to the very long pointed nose and the delta configuration.

This visit was altogether very useful, since, in the absence of our supersonic wind tunnel tests, the fact that this aircraft of very similar configuration to the CF-105 is flying supersonically two or three times a day and exceeding the estimated performance certainly encouraged me personally.

SIR ARNOLD HALL

I had a couple of sessions with Sir Arnold and there is no doubt at all that he is really a going concern, and has given himself the job of trying to sort out the technical future of the Group. He is obviously a clear thinker, and I think the Group has a very good addition to its technical staff.

He was very interested in the briefing which I gave him on the CF-105 and supported completely our attempts to sell the aircraft to the R.A.F. He said that if he could be of any assistance in this regard he would certainly cooperate to the fullest extent.

He had already decided before my visit that the Javelin could only be saved by having collision course armament, probably a standard CF-100, M1-2 type of

SIR ARNOLD HALL (cont'd)

system with possibly Falcon IR missiles, and he intends to visit Hughes in the spring to discuss this with them. I suggested that he visit us first to become acquainted with the probability of kill studies which we carried out on the CF-100 fitted with this armament.

I discussed our interest in the Coleopter with him, since he had had the job of assessing the project for the M.O.S. while he was still at the R.A.E., and he confirmed Dr. Kuchemann's impressions that the Coleopter was a new, and, he considered, a pretty sound approach to certain problems, and he felt that our drone application of the project was an excellent one, since it would allow us, for a minimum cost, to assess the possibilities of the configuration for other uses. I promised to keep him up to date on the work we were doing with BTZ.

I also left him a brochure on the High Speed Transport and the Variable Characteristics Trainer, which he will send back to us with his comments. He agreed not to discuss these with anyone else in the Group at this time.

Sir Arnold will be coming over to visit us in the spring.

John McCulloch accompanied me on most of the visits to the Group Companies, the Air Ministry and Ministry of Supply, and also B.T.E. and S.H.A.P.E. Without his excellent assistance in lining up appointments and transportation it would have been impossible for me to cover this program in the time available.

He is certainly well known and respected in the Hawker Siddeley Group and at Farnborough, M.O.S., etc. and is doing an excellent job.

Everyone in the U.K. also has the highest regard for Ellis and felt that we had one of the best aerodynamicists that ever came out of the U.K.