78

C-105 P/Wind Tunnel/99

BRIEF SUMMARY OF

LOW SPEED WIND TUNNEL TESTS AT N.A.E.

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.07 SCALE CF-105 MODEL

The wing of the .07 scale model was made by N.A.E. while the fuselage and vertical tail were supplied by Avro. C.A. drawings were sent to N.A.E. on the 24th, September 1954 followed by templates for the notched wing on October 4th. A request to incorperate leading edge extensions on the model was followed by templates on December 28th and Avro's portion of the model shipped to N.A.E. in April.

In May the tests were scheduled to start on June 1st, with the notched and extended wing.

First tests actually started a week ahead of schedule with an Avro representative present.

May 24

The leading edge extensions had not been completed but it was decided to start the tests with the notched wing fitted. During the first few runs both the elevators and ailerons blew down under load at 70q. At 100q the metal fairings at the leading edge of the duct started to separate from the model.

May 25

Metal fairings were bonded to the model and work started on modifying the control hinges by increasing the diameter of the hinge pins.

May 26

While waiting for the hinges an attempt was made to install the image struts, this was completed only after changes were made to the tunnel ceiling to accommedate them. The hinges were later received and fitted. During runs both elevaters again blow down and trouble was experienced with fouling between the image rear strut and the tail sting.

May 27

The image rear strut was filed to eliminate fouling and a run attempted at 50q. At this speed the elevator clamps held, but grounding occurred between the rear strut and fairing. The model was inverted but only a very limited α range was found possible because the front strut pivets fouled the cover plates on the undersurface of the wing.

Tests on this configuration were completed later for zero elevater angle and at 50q and the results published as N.A.E. report AE 46c. Avro was not informed that these tests were being run and no representatives were present.

PRESENT STATUS OF .07 MODEL TESTS

By January 1956 approximately 20% of the proposed .07 testing program had been completed. These tests covered elevator effectiveness and the effect of ground on elevator effectiveness only. A brief breakdown is as follows:

Period	Tunnel Time	Useful Runs	Data
May 1955	5 Days	1 + 5 correction	Analyzed
July 1955	14 Days (est.)	Nil	-
Nov.- Jan. 1956	35 Days	29 + 35 correction	Not yet analyzed
	54 days	30 + 40 correction	

In July 79 more runs were done by N.A.E. with the notched and extended wing. 50, 70, 100 and 130q runs were made at zero elevator, while deflection runs were done at 50q. No blowdown problems were mentioned. These results were obtained with only one print per point instead of the more usual 5 and perhaps for this reason considerable scatter was evident, particularly in pitching moment. This scatter made the derivation of corrections virtually impossible and data reduction was not completed.

On June 17th, N.A.E. were requested to modify the wings again to incorporate leading edge droop. Drawings were supplied on June 23rd, followed by templates on July 13th. Further tests with this configuration were started in November with two Avro representatives at N.A.E.

Nov. 21

The model was installed in the tunnel and it was found that an α range of only -10 to +35 was possible instead of -10 to +45 as requested.

Nov. 22

Day was spent trying to increase the α range, and failing this, to shift it to -5 to +40. This proved unsuccessful. Wind on values decreased the range to -6 to +35 due to earlier grounding between the rear strut and fairing.

Nov. 23

δ_e = 0 and +2 completed at 70q but at δ_e = 5 the elevator blew down. Methods of curing the problem discussed.

Nov. 24

Elevator hinges were drilled through and pinned with .040 drill rod. δ_e = -10, -15, -20, -25 and -30 runs completed. From the appearance of the lift curves plotted during the runs, these seemed successful.

Nov. 25

Above runs plotted, disclosing bad scatter in pitching moment.

Nov. 28

Consideration of lift, rolling moment and pitching moment values for off points led to the conclusion that the right rear lift balance was in error. The balance was inspected and found to be slow and minus its damper. The damper was installed and the faulty high-speed contacts repaired. On rerunning δ_e = -30 the rear strut fouling again occurred. This was eliminated and a further run at δ_e = -30 showed considerable improvement in scatter. At δ_e = +10 one elevator slipped, apparently due to a drill rod shearing.

It was found that the single strut support system was designed to use two auxiliary arms to give the required α range. This seemed very unsatisfactory because changing auxiliary arms would involve partially dismantling the single support. An extensible arm of some kind was suggested.

Nov. 29

Elevators slipped again during δ_e = +10 and -25 runs. The pin holes were becoming worn enough to allow a degree or two of play once the clamp friction had been overcome. A permanent fix was discussed. It was agreed that plates would be best but they would also take some time to make. A compromise decision was made to use new hinges drilled to take .078 taper pins. A similar method had been used with success at Cornell.

From data received it seemed impossible to obtain repeatability in pitching moment better than within $\pm$ 2 ft. lbs. in spite of claims to greater accuracy. Since the total range of moment is of the order of 40 ft. lbs. possible errors of 5% exist.

Main undercarriage received from Avro. Nosewheel had been supplied in June.

Nov. 30

No runs while awaiting hinges, expected December 1st.

Dec. 1

Hinges not expected for another day. It was thought that time could be saved by installing the ground board and work commenced.

Dec. 2

Ground board in place. This did not seem very rigid, particularly in pitch.

Dec. 5

Hinges received and fitted and tunnel started. At 17q the leading edge of the ground board rose about 6 inches, coming close to the model. The tunnel was rapidly shut down, luckily in time to prevent any damage. It was not clear how the ground board could lift 6" at the leading with no appreciable drop at the trailing edge, so the tunnel was again cautiously run up while the ground board attachments were watched. It seemed that the scissors deflected enough to allow angular displacement and the vertical travel was permitted by the lower pair of channels (bolted to the floor at each end) bending in the middle where they were attached to the board proper through screw jacks.

Dec. 6

Methods of securing the ground board discussed with the final decision to use a pair of ties between the upper and lower channels at the upstream end. This method was simple but necessitated a separate pair of ties for each ground board position, making the jack screws rather superfluous. The lower channels were fixed to the floor by additional bolts at the center.

Inspection of the ground board revealed that although down loads seemed adequately taken care of by shoulders on the jack screws, up loads were taken only by a pair of circlips. If these had failed under the large up load at positive angle of attack the day before considerable damage could have been caused to both the model and the tunnel.

Work on one pair of ties was completed during the day and installed. The board now seemed quite rigid: partial dismantling of the ground board is necessary to change the ties in order to bolt them to the buried upper channels.

An extensible auxiliary arm had proved feasible and was received during the day.

Dec. 7

δ_e = -30, -20 and -10 were completed quite satisfactorily, however it proved impossible to set any further angles accurately. Investigation showed that the hinge pins had been hardened while the hinge proper was of mild steel. The holes in the mild steel portion had elongated while the hardened pin prevented driving the taper pins in far enough to obtain a positive lock. These holes could have been reamed, but constant re-reaming seemed very impractical and would make repeating the same elevator angles a matter of luck. Angled plates were decided to be the only foolproof solution and work was started on them. Time would no doubt have been saved if these had been made earlier, either before the tests started or when the elevators showed signs of continuing to blow down. This was first observed in May 1955.

Dec. 8

No runs while awaiting plates.

Dec. 9

The tie bars for the ground board at the two remaining positions were completed.

Elevator and aileron plates for δ = 0 were received during the day and initial fitting showed that the settings were not exactly zero. It appeared that the slots in the trailing edge of the wing were not identical so that shims would have to be used to obtain the correct setting.

Dec. 12

The fitting of the plates was completed.

Dec. 13

The model was put back in the tunnel and run 38 completed. It was found that the ground board position could not be changed without removing the model.

Dec. 14

Run 38 was repeated to check repeatability of the data since no other plates were available. Pitching moment values repeated to within 2 or 3 ft.lbs.

Plates for δ_e = -2 were received later, but when they were installed the plates could only be shimmed to the same angle at δ_e = 2 1/2. Present rate of delivery of plates would seriously delay the program and the problem was discussed.

Dec. 15

Discussion with N.A.E. to speed up the delivery of the plates resulted in the following decisions:

(a) To make the aileron plates at a later date

(b) To bend the plates instead of milling them

(c) To bend 4 elevator plates at one time, but only finish up the negative angles at present.

Plates for δ_e = -5 received and three runs completed.

Dec. 16

Plates for δ_e = -10 and -20 received during the day and four runs completed.

Dec. 19

Plates for δ_e = -15, -25 and -30 received, completing the set for negative angles. Eight runs completed with the tunnel now working overtime.

Dec. 20

Ground board position changed and four runs completed.

Dec. 21

Ground board runs completed and the ground board removed. The data fluctuated a little more in the upright runs than for the ground board runs.

The remaining positive elevator plates were received and four runs completed during the day.

Dec. 22

One run completed, then repeated because of fluctuations in most of the readings. Work ceased at noon.

Dec. 27

Three runs completed and dummy struts installed for correction runs.

Dec. 28

Five correction runs (upright with dummies) completed.

Dec. 29

The dummy structs were removed and the remaining of the upright runs started. Three runs completed.

Dec. 30

One run only completed: Work stopped at noon.

Jan. 3

Avro representatives arrived in the afternoon to find N.A.E. had tested an R.C.A.F. practice bomb until 11.30. The model was inverted and three runs completed during the afternoon and evening.

Jan. 4

During inverted with dummies correction runs difficulty was experienced in obtaining readings above $\alpha = 30$ due to excessive vibration. The rear strut fairing was grounding continually. It was decided to take these runs up to 30° only.

Six runs were completed on overtime, including one which was repeated due to a shift in tare values.

Jan. 5

The tare shift was traced to the right front lift balance which now seemed to be operating normally. The remaining 3 twin strut system runs were completed and work was started on the installation of the single strut mounting.

Jan. 6

Installation of the single strut system was continued and the auxiliary arm adjusted to give a small overlap between the two α ranges.

Jan. 7

Installation completed. It was found that the auxiliary arm could not be changed without removing the bottom portion of the model fuselage each time.

It was suggested by N.A.E. that the bottom piece of the model be cut at the aft end so that only a small part, held up by two screws, would have to be removed each time. N.A.E. was asked to do this at the end of this testing program.

Two half runs were completed during the rest of the day.

Jan. 10

Testing continued satisfactorily with eleven half runs completed.

Jan. 11

This portion of the program was completed with the final seven half runs.