Report. 72/TECH.DES/11

May, 1958

ANALYZED

AN ARRESTER WIRE RUNWAY BARRIER FOR THE ARROW AIRCRAFT

Compiled by: R. Bayliff
R. Bayliff

Approved by: name
F.H. Brame
Chief of Technical Design

Approved by: A.R. Buley
A. Buley
Project Designer - ARROW 2

Approved by: A.C.B. for
C.V. Lindow
Engineering Project
Manager - ARROW

72/TECH.DES/11
May, 1958

AN ARRESTER WIRE RUNWAY BARRIER FOR THE ARROW AIRCRAFT

1. SUMMARY

At the request of the RCAF, an investigation has been carried out to determine a satisfactory runway barrier for the Arrow aircraft, using the arrester wire principle. Various approaches to the problem are examined and a proposal employing this principle is discussed. This involves some redesign of the rear fuselage and a weight penalty of the order 200 lb.

It is recommended that the Nylon Net Barrier developed by the Swedish Air Board be given serious consideration, since no modification to the aircraft is involved and a preliminary review indicates the device to be simple and satisfactory.

2. INTRODUCTION

The object of this investigation is to evaluate the possibility of providing a means of arresting the aeroplane in such a way as to prevent crew injury, and to avoid sustaining extensive aircraft damage in event of abortive take-off or brake failure and non-operation of the tail parachute.

The proposal is to engage an arrester wire suspended or laid across the runway, attached at its ends to retarding devices which control the runout of the cables and bring the aircraft to rest without undue decelerations or shock loads.

3. REQUIREMENTS

3.1 The installation can be regarded as an emergency device and some degree of damage would be acceptable if an economical method of cable engagement is provided and crew injuries are prevented.

3.2 Barriers to handle aircraft weighing up to 70,000 lb. are envisaged with engagement speeds of up to 150 kts. Stopping distances after engagement of 1,000 ft. are required, so that installation can be placed towards the ends of runways in "overshoot" areas. Deceleration of the order of 2 'g' are anticipated.

4. DISCUSSION OF CABLE ARRESTING METHODS

4.1 Nose Undercarriage Engagement

The simplest method of arrester wire engagement is to suspend the cable across the runway at a suitable height and engage it directly with the nose undercarriage oleo strut.

Due to inad quate strength to withstand drag loads imposed, the strut would collapse and considerable damage would be sustained to the forward portion of the aircraft.

This method would involve fairly extensive aircraft damage and satisfactory engagement of the arrester wire would be most uncertain.

4.2 Nylon Ribbon Engagement

A method of engagement designed to ensure that the arrester wire is not engaged by the nose undercarriage, is as follows:-

The arrester wire lying on the runway is attached to a nylon harness suspended across the runway. This harness, engaged by the nose gear, lifts the arrester wire off the runway to sufficient height to enable it to fall over the main wheelsand around the shock absorber struts.

It can be shown that the undercarriage can withstand loads equivalent to decelerations of 1.0 'g' to 1.5 'g' approximately, depending on the weight.

If the cable becomes engaged around the main legs, considerable damage would be sustained to the undercarriage. The tie rod would be destroyed and its attachment arm to the bogie damaged. The hydraulic and electric services to the brakes would also be affected. It is considered, however, that this all falls within the permissable damage. Owing to the relatively long wheel base and wide track of the Arrow, considerable difficulty is involved in lifting the arrester wire sufficiently to passover the main wheels and engage both.

Were it possible to lift the cable sufficiently to clear the wheels, this method could only be used when the drop tank is not carried. The bottom profile of the drop tank is considerably below the level of the top of the wheels and this precludes any possibility of arrester wire engagement when it is fitted (Figure 2). There is the danger of the wire rising over the nose of the tank causing it to rupture, spilling fuel and creating a serious fire hazard. For this reason it is felt that the Nylon Ribbon method of engagement is not satisfactory.

4.3 Auxiliary Devices to Engage Arrester Wire

Due to the location of the armament pack, relative to the main gear, any fuselage mounted auxiliary device provided to lift the arrester wire over the main wheels would have to be attached so far aft (and therefore very close to the main gear) that is would be ineffective.

This implies that any means of lifting the wire would have to be attached to the bogie extending forward to engage the cable and lead it up over the forward wheels of the bogie to fall against the main leg. Space limitations in the undercarriage bay seriously prejudice any solution to this method of engagement. It should also be mentioned that the drop tank would be ruptured when the wire tightened after engagement.

4.4 Hook Type Engagement - Undercarriage Mounted

In view of the difficulties enumerated above, consideration has been given to use of an arrester hook to engage the wire.

An arrester hook mounted on the main undercarriage, though attractive in principle, presents certain design difficulties. Side load components would be critical for bogie strength and would also impose critical torques about the leg vertical axis.

Within space limitations of the undercarriage bay, it would be most diffifult to provide adequately wide hook attachments to resist the side loads.

4.5 Hook Type Engagement - Fuselage Mounted

A possibility would appear to lie in the use of a fuselage mounted arrester hook. Here the limitation lies in the fact that the underside of the body has no suitably strong structure on which to mount the hook at any point aft of the rear end of the weapon bay which is just forward of the main wheels.

The most promising approach is to attach the arrester hook to the bottom of frame 742.5. As this point is not sufficiently strong to withstand full drag loads, the scheme would allow the hook to carry away from the mounting on engaging the arrester wire, at the same time remaining attached to the aircraft by steel cables or ties secured to the structure adjacent to the parachute attachment at the top of Former 803.

5. BRIEF DESCRIPTION OF INSTALLATION

5.1 The installation consists basically of a Naval Type arrester hook carried beneath the rear fuselage between Frames 742 and 803. The hook is carried on a detachable arm which, under arrester wire engagement loads, breaks away from its attachment at a load of approximatel 400 lb. and travels back until finally restrained by members secured to the aircraft adjacent to the brake parachute attachment at the top of Frame 803. (this sequence is illustrated in Figures 1 and 2). The hook is normally in a fairing stowed flat with the bottom of the body and is lowered when required. Lowering of the hook might be designed to actuate catches securing the Centre Fairing and Stinger assembly which then moves back and falls from the aeroplane, so providing an unrestricted path for the attachment members to swing back under the influence of arrester wire loads into their final position. The hook attachment and operating mechanism is so designed that the hook is maintained in close contact with the runway, regardless of aircraft attitude, in order to ensure complete arrester wire engagement.

The device could be operated by further closing movement of the throttles through a gate, in a similar manner to some reverse pitch propeller controls.

5.2 Miscellaneous Considerations

5.2.1 The impact effects of the cable on the nosewheel when riding over it may well be serious and must be given due consideration if the arrester gear is to be used.

5.2.2 On the basis of preliminary information concerning decelerations and resulting loads, the weight penalty involved is of the order of 200 lb.

6. NYLON NET BARRIERS

6.1 In view of difficulties in providing means for satisfactory engagement of an arrester wire, it is suggested that the possibility of using a nylon net to engage the aircraft should be considered.

The system is such that the aircraft runs into a barrier consisting of two nylon ropes suspended at suitable heights across the runway and joined by pairs of vertical nylon ropes at suitable pitch. The vertical ropes engage the wings of the aircraft and transfer the loads to the horizontal cables which are attached to retarding devices which control the runout and bring the aircraft to rest.

6.1 (Continued)

This offers two main advantages over the arrester wire systems. No modifications to the aircraft with attendant weight penalties are required, and possible damage to the aircraft seems to be reduced to an absolute minimum.

The system has been developed by the Royal Swedish Air Board and it is believed that units are available to handle aircraft of 65,000 lb. all up weight at barrier engagement speeds of 160 kts. They are manufactured by Befab Borgs Fabriks A.B. Norrkopping.

From preliminary information at present to hand, it would appear that the system might well prove a simple and satisfactory answer to Arrow emergency braking problems.

7. CONCLUSIONS

Various methods of engaging the arrester wire were considered, ranging from direct contact of arrester wire across the landing gear, to the provision of special Naval Type arrester hooks. As a result of these investigations, the following conclusions were reached:-

7.1 That any attempts to directly or indirectly engage the arrester wire with the undercarriage would be unsatisfactory, and, under some conditions, impossible.

7.2 That "Hook Type" engagement can be achieved and an installation of the necessary hook and its operating mechanism and controls can be made. The existing aircraft structure at the rear end of the fuselage, though not in its present form adequate to withstand the drag loads, can, with some redesign, be made capable of meeting the loads in question. A weight penalty of the order of 200 lb. may well be incurred. The exact figure being dependent to some degree on the characteristics of the retarding device, at present unknown.

7.3 It is suggested that consideration be given to the possibility of using a Nylon net alone to arrest the aircraft. This method has been developed by the Swedish Air Board, and from preliminary information at present to hand, it would appear that the system might well provide a simple and satisfactory answer to Arrow emergency braking problems.

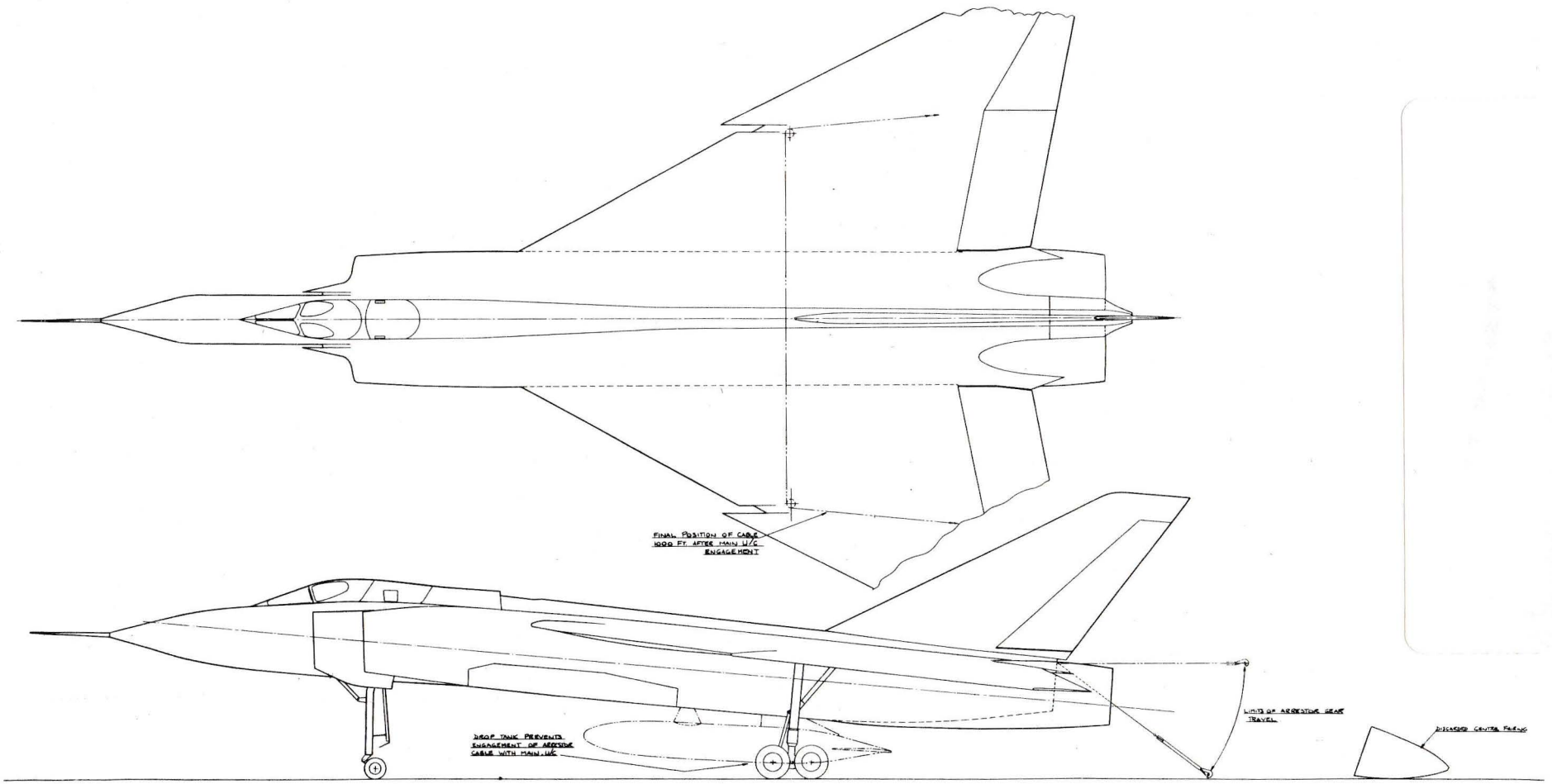
FINAL POSITION OF CABLE
1000 FT. AFTER MAIN U/C
ENGAGEMENT
DROP TANK PREVENTS
ENGAGEMENT OF ARRESTOR
CABLE WITH MAIN U/C
LIMITS OF ARRESTING GEAR
TRAVEL
DISCARDED CENTRE FAIRING

FIG.2

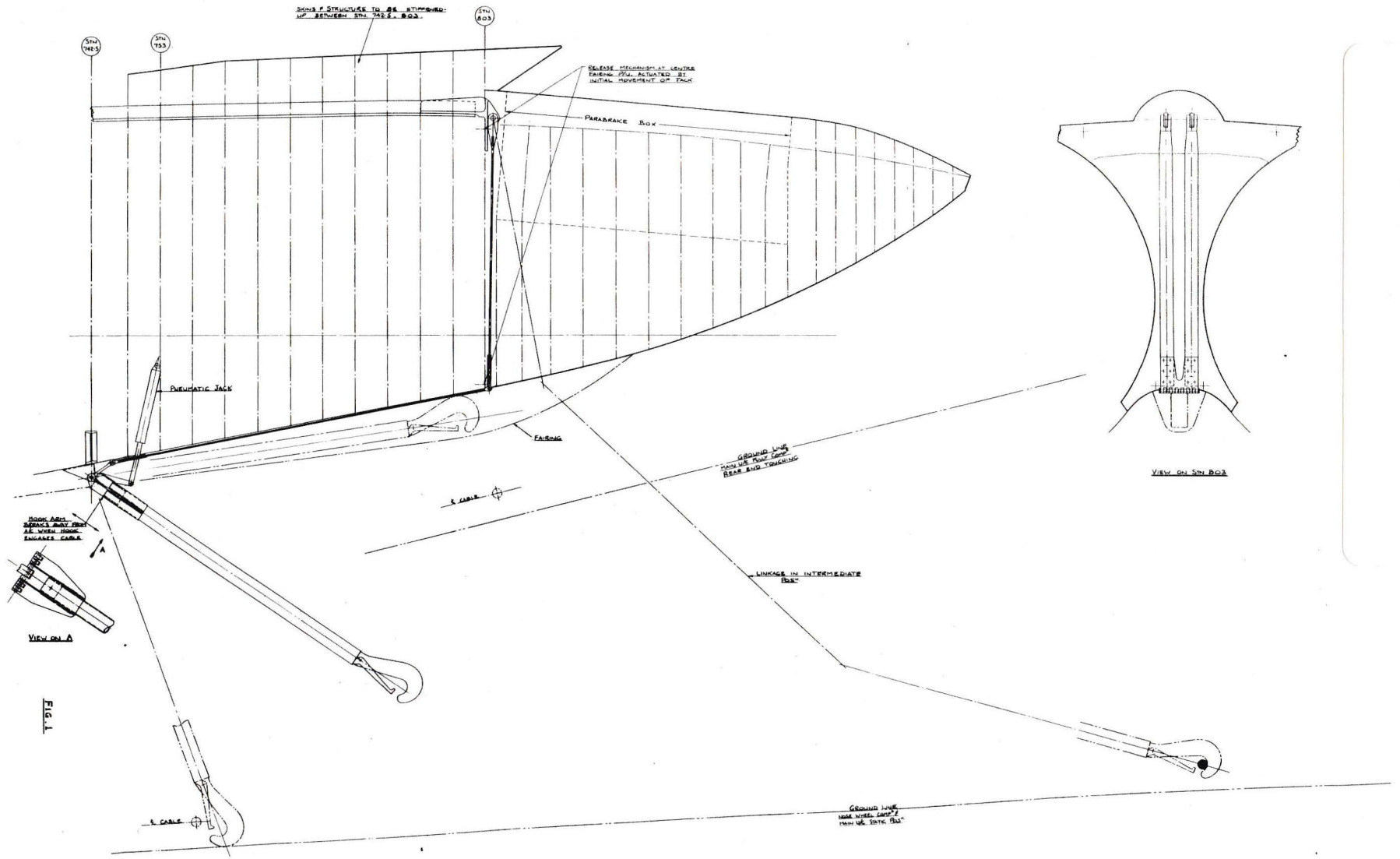
STN 742·5
STN 753
STN 803
SKINS & STRUCTURE TO BE STIFFENED-UP BETWEEN STN 742·5 & 803.
RELEASE MECHANISM AT CENTRE FAIRING P/U, ACTUATED BY INITIAL MOVEMENT OF JACK
PARABRAKE BOX
PNEUMATIC JACK
FAIRING
GROUND LINE MAIN WR TOUCH DOWN REAR END TOUCHING
℄ CABLE
HOOK ARM SWINGS AWAY FROM AC WHEN HOOK ENGAGES CABLE
A
VIEW ON A
LINKAGE IN INTERMEDIATE BAY
℄ CABLE
GROUND LINE NOSE WHEEL CONTACT MAIN WR STATIC POS.
VIEW ON STN 803

FIG. 1